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## Preface

For the twenty-eighth year, the Research and Theory Division of the Association for Educational Communications and Technology (AECT) is sponsoring the publication of these Proceedings. This is *Volume #2 of the 28th Annual Proceedings of Selected Papers On the Practice of Educational Communications and Technology* Presented at The National Convention of the Association for Educational Communications and Technology held in Orlando, FL. Copies of both volumes were distributed to Convention attendees on compact disk Volume #2 will also be available on microfiche through the Educational Resources Clearinghouse (ERIC) system.

This volume contains papers primarily dealing with instruction and training issues. Papers dealing with research and development are contained in the companion volume (28th Annual, Volume #1), which also contains over 100 papers.

REFEREEING PROCESS: Papers selected for presentation at the AECT Convention and included in these Proceedings were subjected to a reviewing process. All references to authorship were removed from proposals before they were submitted to referees for review. Approximately sixty percent of the manuscripts submitted for consideration were selected for presentation at the convention and for publication in these Proceedings. The papers contained in this document represent some of the most current thinking in educational communications and technology.

M. R. Simonson
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# Improving School Children's Mathematical Word Problem Solving Skills through Computer-Based Multiple Representations

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**Abstract**

*Instructional resources that employ multiple representations have become commonplace in mathematics classrooms. This study will present computer software, LaborScale which was designed to improve seventh grade students' word problem-solving skills through computer-based multiple representations including graphic, symbolic, and audio representations. The proposed presentation will illustrate the design, implementation and validation of an interactive learning environment (ILE), LaborScale. This ILE is based upon the principles of computer based interactive problem solving environments, which connects different types of knowledge representation forms, and aims primarily to assist students as they explore symbolic representations used in word-problem solving process.*

## Problem Solving

When solving problems, a learner combines previously learned elements of knowledge, rules, techniques, skills, and concepts to provide a solution to a novel situation. It is generally accepted that mathematics is both process and product: both an organized body of knowledge and a creative activity in which the learner participates. It might, in fact, be claimed that the real purpose of learning rules, techniques, and content is to enable the learner to do mathematics, indeed to solve problems (Orton, 1987). Thus problem solving can be considered to be the real essence of mathematics. Gagnè (1985) has expressed the view that problem solving is the highest form of learning. Having solved a problem, one has learned. One might only have learned to solve that problem, but it is more likely that one has learned to solve a variety of similar problems and perhaps even a variety of problems possessing some similar characteristics. Jonassen, Howland, Moore, and Marra (2003) also point out that solving problems are meaningful kind of learning activity in educational settings.

Problem solving activities introduce difficulties for management by teachers. For example: choosing and sequencing problem solving tasks, determining the degree and type of assistance to be given to students, maintaining motivation, and knowing how to consolidate understanding through reflection and follow-up discussions, demand continuous decision making on the part of teachers. Similarly, learners have complicated tasks to complete during problem solving, especially when solving word problems. Word problems are set in specific contexts from which students have to develop representations. Learners have to link representations to appropriate mathematical formulations, and to apply appropriate techniques in order to produce a solution. Learners have to monitor and evaluate this problem solving process, and consider the implications of the solution. In consequence, giving assistance and managing problem solving in ways which create effective learning and the development of cognitive skills is not an easy task.

Research shows that a major source of difficulty experienced by children in the problem solving process is transforming the written word into mathematical operations and the symbolization of these operations. Namely, children are required to disembed the information from the problem context, select the relevant values, and insert them into some formula. However, children are not very successful in transferring their abilities to solve problems to subsequent problems (Jonassen et al., 2003). Orton (1987) indicated that the most common difficulty of problem solving is failure to use known information. He also noted that in order to cope with this difficulty pupils should (1) write the problem in primitive form and sketch an accurate picture of the setup (where applicable), (2) transform the primitive statements to simpler language, and (3) translate verbal problems to more abstract mathematical statement(s) and figures, diagrams, charts and other similar representations.

## Multiple Representations

Recent approaches to mathematics instruction in the classroom emphasize mathematics as flexible, insightful problem solving that requires understanding that mathematics involves pattern seeking, experimentation, hypothesis testing, and active seeking of solutions. But children's beliefs about the nature of mathematics contrast with this emphasis. For example, Baroody (1987) asserts that due to an overemphasis on ‘the right answer’, children commonly believe that all problems must have a correct answer, that there is only one correct way to solve a problem and that inexact answers or procedures (such as estimates) are undesirable. In order to recognize that multiple solutions and different representations of problems are possible, children need to have higher order problem solving skills. Polya (1962) advocated that solvers should choose multiple representations when they begin to solve a problem. Jiang and Mcclintock (2000) also suggested that encouraging multiple solutions to problem solving plays an important role in facilitating students’ understanding of mathematical concepts and their grasp of methods of mathematical thinking. In this way, the National Council of Teachers of Mathematics (NCTM, 2000) states, “representations should be treated as essential elements in supporting students’ understanding of mathematical concepts and relationships; in communicating mathematical approaches, arguments, and understandings to one’s self and to others; in recognizing connections among related mathematical concepts; and in applying mathematics to realistic problem situations through modeling” (p. 67).

Representations are mainly divided into two categories. External representations are the knowledge and structure in the environment, as physical symbols, objects, or dimensions and as external rules, constraints, or relations embedded in physical configurations (Zhang, 1997, p. 180). Internal representations are retrieved from memory by cognitive processes. External and internal representations are particularly beneficial for learning when they are multiple. In most cases, learners have to process multiple representations, including graphics, symbols and audio. Classroom teaching has traditionally employed multiple external representations (MERs) in the pursuit of helping students learn. Teachers use MERs explicitly in order to make abstract situations more concrete.

Kaput (1992) proposed that multiple linked representations might allow learners to perceive complex ideas in a new way and to apply them more effectively. By providing a rich source of representations of a domain, one can supply learners with opportunities to build references across these representations. Such knowledge can be used to expose underlying structure in the domain represented. According to this view, mathematics knowledge can be characterized as the ability to construct and map across different representations.

## Computer-Based Multiple Representations

Computer environments have been gaining great importance in education. Numerical computation tools can be used by problem solvers to emphasize planning and interpretation of arithmetic operations. The existence of computer graphics tools can be used to help students understand abstract mathematical concepts, to create entirely new graphic oriented representations of traditional mathematical topics, or to provide alternative visual methods in mathematical problem solving. As Kaput (1992) states for the case of mathematics education, this entails that routine computations can be off-loaded to a machine, that new representational mechanisms only available on computers (such as programs as representations) become available, and that one can reify abstract concepts by means of computer simulations, making them more readily accessible for reflection and dialogue.

Fey (1989) asserts that the use of numerical, graphic and symbol manipulation is a powerful technique for mathematics teaching and learning.  He identified several ways in which computer-based representations of mathematical ideas are unique and especially promising as instructional and problem solving. First, computer representations of mathematical ideas and procedures can be made dynamic in ways that no text or chalkboard diagram can. Second, the computer makes it possible to offer individual students an environment for work with representations that are flexible, but at the same time, constrained to give corrective feedback to each individual user whenever appropriate. Third, the electronic representation plays a role in helping move students from concrete thinking about an idea or procedure to an ultimately more powerful abstract symbolic form. Fourth, the versatility of computer graphics has made it possible to give entirely new kinds of representations for mathematics-representation that can be created by each computer user to suit particular purposes. Finally, the machine accuracy of computer generated numerical, graphic, and symbolic representations make those computer representations available as powerful new tools for actually solving problems (p. 255).

## Designing the Interactive Learning

The use of multimedia technology has offered an alternative way of delivering instruction. The old text-based approach to learning is being superseded by an approach, which includes multisensory representations (Jonassen et al., 2003).  Interactive multimedia is one of the most promising technologies of the time and has the potential to revolutionize the way we work, learn, and communicate (Macromedia, 1992; Staub & Wertherbe, 1989). Interactive multimedia programs take the idea of learning and doing seriously. With interactive multimedia programs, the learning process is modified by the actions of the learners, thus changing the roles of both the learner and the teacher. Interactive multimedia learning is also a process, rather than a technology, that places new learning potential into the hands of users (Jonassen, 1999). The ideal interactive learning environment (ILE), then, is one where students are encouraged to undertake such activities and are provided with feedback as they do so.

Brooks (1993) stated that, with all the additional capabilities of the growing number of multimedia applications, the design of these applications has become a nightmare. He also pointed out the preponderance of ugly interfaces containing screens full of multiple fonts, insignificant boxes, irrelevant noises, and confusing webs of possible interactivity among the features of poorly designed multimedia packages. There are many requirements that must be checked while designing an interface such as screen design, learner control and navigation, use of feedback, student interactivity, and video and audio elements (Stemler, 1997). So, the design of the interface, which considers interactivity, is clearly important (Frye et al., 1988). Hence a properly designed interface should make the cognitive process transparent and externalized so as to support evaluation, reflection, and discussion and direct accessibility.

The following principles should be considered during the design of ILEs (Akpinar & Hartley, 1996).

The ILE should provide interactive objects and operators, which are visual and can be directly manipulated by pupils.

The ILE system should provide mechanisms for pupils to check the validity of their methods, and thus receive some feedback on the appropriateness of their actions in relation to task.

As the instruction aims to support links between the concrete and symbolic representation of word problems, the ILE should be able to display these forms so that the equivalence between is apparent. The system should also be able to move its presentation modes to the symbolic as students gain in competence.

The ILE should allow experimentation of concepts and procedures in ways that relate to the children’s experiences. In brief the ILE should be able to support guided discovery as well as directed methods of instruction.

The ILE should allow the learning to be conceptualized and procedural in its approach, and be capable of adjusting to the task needs of teachers.

### Interactive Learning Environment: LaborScale

The overall aim of this research was to investigate the design of the LaborScale ILE that can assist problem solving performance and understanding specifically mathematical work and pool problems. Problem solving requires the integration and utilization of multiple knowledge representations e.g. graphical, symbolic, and audio. Depending upon these factors, the design of the computer based learning environment must take into consideration students’ knowledge so that it can accommodate different levels of competence and be useful for varying modes of instruction in the classroom (Mayer 1985). The proposed design to realize these aims is LaborScale that provides a constructive environment based on direct manipulation, user-system interactions and available interface design.

The ILE should have all the features and components to develop children’s word problem solving skills. Hence, it should be designed with an object-oriented and direct-manipulation approach. In order to reach this objective, the instructional software (LaborScale) was developed and implemented by the researchers using an authoring tool, Asymetrix Toolbook II 5.0 and other related multimedia programs (Macromedia Flash 5.0, 3D Studio Max and Photoshop 5.0) to support Toolbook Application with videos, animations, audios and pictures. The user-friendliness of Toolbook interface and its accompanied object-oriented scripting language, Openscript, used to specify the functionality were well suited to the development and implementation of the prototype. Toolbook software is a development environment that provides tools to draw objects that can be made interactive using the Openscript programming language. Also the development can be carried out incrementally. Further, Toolbook is event-driven i.e. an application can respond to events such as mouse clicking whenever they occur. This is suitable for the ILE interface that is based on a direct-manipulation approach in addition to its ability to produce quality visual animation.

The user-interface of LaborScale has two-page design consisting of multiple viewers in which each viewer has a background and a foreground containing objects such as fields, buttons, graphics and text. The user interface has two units: a curriculum-manager unit and a student-working unit.

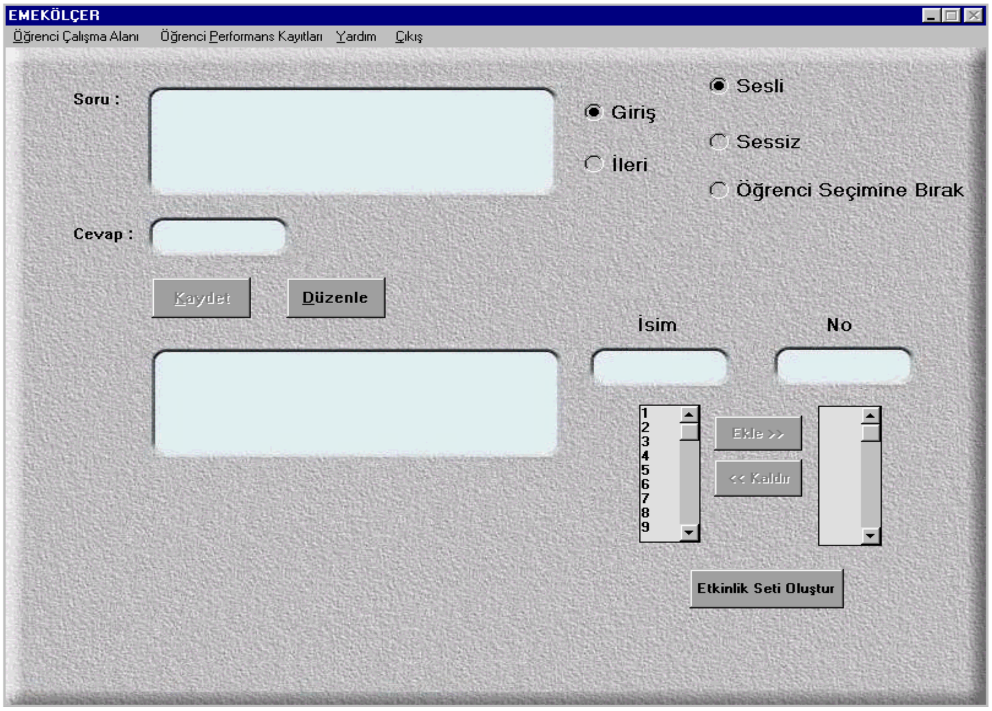
### Curriculum Manager Unit

Curriculum Manager Unit (CMU) is one of the main windows of the LaborScale (Figure 1). This is the place where teachers set problems and customize environments for students. Each problem specification will need to provide context information, and the concepts based on the activity sets. Hence, the purpose of the problem specification is to provide contexts familiar to the students.

The CMU has been designed to manage the specification of activity sets that contains the problem content, specification of problems, and types of representation. In order to form a new activity set for any student, teachers can use two methods. One has two steps, which are pre-storing problems and their answers, and specification of the problems depending on the level of the students. The other is only specification of problems, which are saved to the system previously. In brief, teachers can manage the following tasks by using CMU:

- Forming problem sets including simple and advanced level problems of two types, work and pool, by saving problems to the systems,
- Setting audio environment of student-working unit,
- Preparing an activity set with respect to the students' level,
- Looking at the performances of the students who finish their activity sets,
- Viewing the activity set in the student-working unit.

Figure 1. A screen of curriculum manager unit

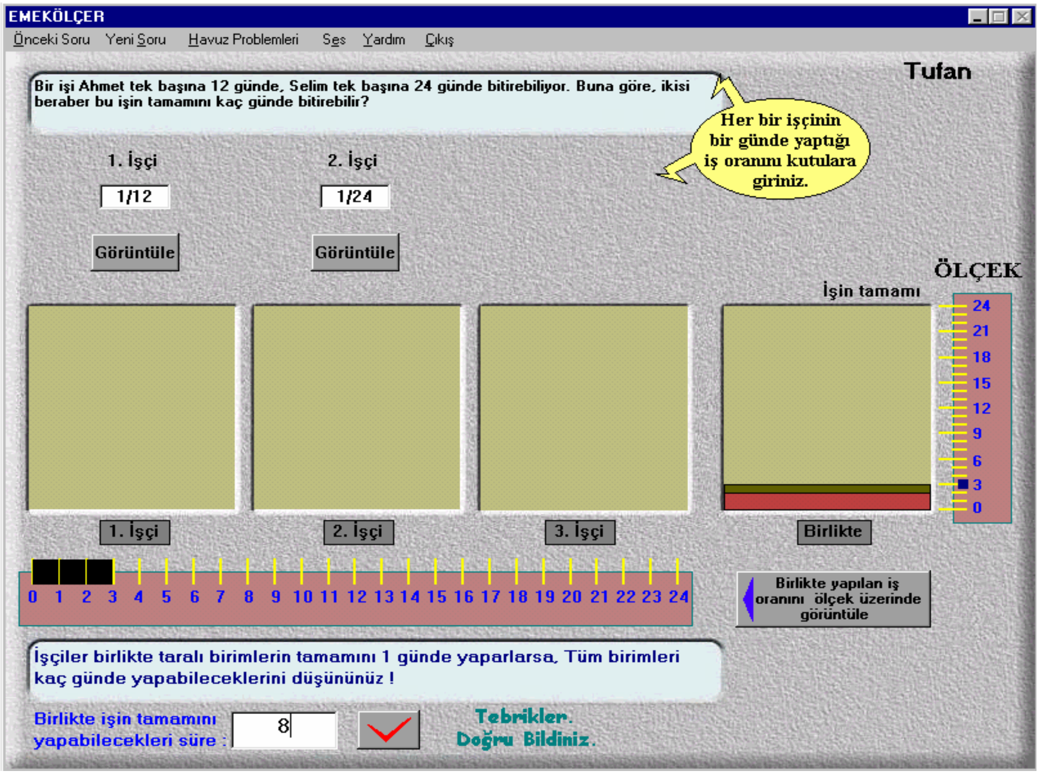



**Student Working Unit**

The student working window (Figure 2), the learner mode of the LaborScale, is the second main window of the LaborScale. The Curriculum-Manager Unit passes the sequence of problems to the ILE controller that is to manage the interactions with students and to keep records of their progress. Hence a principal consideration in the design of this unit was the user-system interface in which these interactions take place. LaborScale is based on a high degree of graphical and symbolic object manipulation, and with the interface users are able to directly manipulate the LaborScale objects, for example by giving the values symbolically, dragging and dropping of picture of these values, and combining the representations of them to reach a solution. To outline, students can manage the following tasks in this unit:

- Displaying ratios they entered in the problems,
- Dragging and dropping the displayed objects and displaying a vertical scale as a result of this,
- Reaching right answers of the problems by analyzing a horizontal scale depending on the vertical scale,
- Setting audio environment,
- Transition to other problems.

Figure 2. A screen of student working unit




**Evaluation studies**

The validation of LaborScale was carried out during last week of May and first week of June 2001. The method of the research was pretest and posttest group design. The sample of the study was selected from seventh grade students of two different schools (Public school, school A and private school, school B) that have a computer laboratory. The subjects were selected by using clustering sample technique, namely, one class was selected from each school. The validation experiment was performed as a pretest of the work and pool problems. The pre-test was administered to 80 students (59 from public school and 21 from private school). Their average age was 14 and 40 of them were girls and 40 of them were boys. For the application and post-test, convenient students were chosen from each class by considering their teacher's opinions and number of computers in the computer laboratories of both schools. Students were chosen according to their achievements for each mode of the pre-test, namely, numerical solutions, symbolic and graphic representations of solutions. The students' actions in LaborScale were recorded by the system and notes were taken by the researcher as well as the pre and posttest differences in performance.

The instructor organized software for 27 students to run in their laboratories. The reason for choosing only 27 students was that there were 28 computers in the computer laboratory of School A, but 17 of them were available to run the software. There were 13 computers in the computer laboratory of School B, but 10 of them were available to run the software. Five problems randomly chosen from nine problems were assigned to these students for both work and pool problems respectively by regarding the pre-test scores of the students. Pool problems were given to them at the second week of the application to allow students to manage problems at ease and meaningfully. For low-achievers, three of the problems were simple and two of them were advanced. For intermediate students and high achievers, two of the problems were simple and three of them were advanced.

Before the application of the software in both schools, the researcher provided students with an orientation session at which the students received explanations and were experienced on how they will use the program by presenting worked examples for solving different type of problems. This session lasted about 20 minutes. Since the students in both schools had a regular computer course, they had no difficulty in controlling and manipulating the environment during the instruction.

After an orientation session, all groups received computer-assisted treatment for two hours without any break for two weeks respectively. During the instruction, students were left alone and they only interacted with computers. They solved their own problems about the program by themselves except system problems by using the help and information modes of the software. Therefore, the researcher behaved like an observer in the application.

The time that the students completed their activity sets changed between 30 and 65 minutes for work problems, however, the instruction on pool problems lasted between 20 and 45 minutes.

At the end of the instruction the performance test (PT) was conducted to all subjects as a post-test. After all, the questionnaire about the software evaluation was applied to the teachers involved in the study to obtain their criticisms.

In order to analyze the differences between the pre and post tests mean scores of the whole group and School A obtained from each mode of PT, paired sampled t-test was used, and Wilcoxon test was used for school B since the numbers of subjects in the groups were too small.

The pre and posttests results showed significant improvements in students' performances for each mode that pointed to the benefits of LaborScale ILE (See Table 1, Table 2, and Table 3). When the schools were analyzed separately, there was a significant increase in all modes of the tests for each school. Looking at the posttest results of each mode, significant improvements were also observed (for more details see Adiguzel, 2001).

Table 1 Differences between pre-post test scores of numerical solutions to PT

| Groups | N | Pre-test Num. Sol. Mean | Pre-test Num. Sol. Std. Dev. | Post-test Num. Sol. Mean | Post-test Num. Sol. Std. Dev. | t | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|
| Total | 27 | 22.85 | 27.28 | 85.78 | 21.70 | 10.997* | .000 |
| School A | 17 | 18.47 | 25.36 | 88.35 | 24.43 | 9.036* | .000 |
| | | | | | | z | |
| School B | 10 | 30.30 | 30.16 | 81.40 | 16.29 | 2.805* | .005 |

*p < .05.

## Conclusion

Studies formed a base for using computers featuring multiple linked representations to assist students with the transition from concrete experiences to abstract mathematical ideas, with the practice of skills, and with the process of problem solving, like in the LaborScale ILE, namely, beginning with the concrete representations and reaching the symbolic representations by using visual components supported by audio developed seventh grade students' performance on work and pool problems.

Table 2 Differences between pre-post test scores of symbolic mode of PT

| Groups | N | Pre-test Symbolic Mean | Pre-test Symbolic Std. Dev. | Post-test Symbolic Mean | Post-test Symbolic Std. Dev. | t | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|
| Total | 27 | 2.74 | 8.86 | 92.37 | 11.27 | 36.443* | .000 |
| School A | 17 | 2.47 | 9.68 | 96.59 | 5.49 | 37.343* | .000 |
| | | | | | | z | |
| School B | 10 | 3.20 | 7.73 | 85.20 | 14.92 | 2.807* | .005 |

*p < .05.

Table 3 Differences between pre-post test scores of graphic mode of PT

| Groups | N | Pre-test Graphic Mean | Pre-test Graphic Std. Dev. | Post-test Graphic Mean | Post-test Graphic Std. Dev. | t | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|
| Total | 27 | 18.67 | 18.62 | 82.26 | 31.25 | 10.380* | .000 |
| School A | 17 | 21.65 | 14.71 | 95.00 | 10.90 | 16.858* | .000 |
| | | | | | | z | |
| School B | 10 | 13.60 | 23.92 | 60.60 | 42.21 | 2.499* | .012 |

*p < .05.

In the post-test, students had different graphical representations of solutions. The results showed that they were affected from the visual components of the LaborScale ILE, namely, some of them drew a box, meant whole work, for each worker and they indicated the results by the graph corresponding these related graphs. Some of them drew a vertical scale whose pointer's location showed the values of work done in a day for each worker and the result. The rest of the students drew a horizontal scale, similar to the number line, whose pointer's location also represented the values of work done in a day for each worker and the result. This proves that if the students are given more visual representations, they will use and connect them to the symbolic representation of these and they will grasp the meaning of the word problem solving by concretizing them.

The increase in the symbolic mode was more than the other modes. This proves that multiple linked representations relating the symbolic representation to graphic representation allow learners to perceive complex ideas in a new way and to apply them more effectively. However, the increase in the graphical mode was significant but less than the other modes. The reason for this may be that since text-based books were dominant in the curriculum, children have not developed to present problems graphically. However, the graphical representations need to be well constructed and be capable of representing the information in a problem to enable the processing capabilities of the human visual system to be exploited, so that perceptual features and judgments can be developed and related to a more abstract symbolic understanding (Cox & Brna, 1995). Also, graphical representations are effective problem solving and learning tools because they reduce the space of applicable operations and they are more specific than the other representations. Relating with the theory, good performance on finding and presenting a graphic representation of a solution raised the performance on grasping symbolic representation of the solution in the study.

A similar result to the findings of this research was the outcome of ANIMATE software (Nathan, 1991). However, the potentials and facilities of ANIMATE differ from the LaborScale. Though Nathan's ANIMATE can not generalize the solution method into an algebraic formula, LaborScale can help students to build up algebraic formula that may be generalized and employed in a wide variety of problems

During the application, the time at which students finished each activity set was recorded by the researcher. According to the results, students spent longer time period on the first question of the activity set of the work problems than the other questions of the activity set since they were adapted to the system in the first question. After they gained an experience on the work problems, they acted carefully and swiftly on the pool problems since the application of the pool problems was applied to them one week later.

Performance recording unit of the program stored two main functions of the students: three trials on the values that are work done in a day for each worker and the answer of the problem for each trial. According to the records obtained from this unit, all students had tried at least three times on the advanced level problems and problems requiring complex calculation to reach a right answer. The reason for this was the greatness of the least common multiple related with the value of denominator of the work done in one day and that because of the big unit differences in the scale students could not grasp net measurement. However, they usually solved these problems after they tried at least three times. The main thing in this part is requiring the students to grasp the values from the problem. As a result, students' problem solving skills significantly improved by the help of instructional software, LaborScale.

The rationale of the development of the LaborScale was to base students' problem solving on multiple representations. This should aid understanding, conform to problem solving as an investigatory and creative activity. While LaborScale was successful in fulfilling many of these claims in its design and conception, there are further requirements to complement or supplement its current facilities and strengths.

In conclusion, the LaborScale software and validation studies have given some support to the design principles of ILEs in which the aim is to produce user-system interfaces that release students' knowledge and stimulate active and investigatory methods of learning. The suggested further work could re-illuminate design principles for multi-representational interfaces. And, since the research was concluded successfully and significant results were obtained, hopefully it should be adapted for other domains of mathematics.

**References**


Adiguzel, T. (2001). Developing school children's word problem solving skills through computer based multiple representations. Unpublished master's thesis, Bogazici University, Turkey.

Akpınar, Y., & Hartley, J. R. (1996). Designing interactive learning environments. Journal of Computer Assisted Learning, 12(1), 33-46.

Baroody, A.J. (1987). Children's mathematical thinking: A developmental framework for preschool, primary, and special education teachers. New York: Teachers College Press.

Brooks, R. M. (1993). Principles for effective hypermedia design. Technical Communication, 40(3), 422-428.

Cox, R., & Brna, P. (1995). Supporting the use of external representations in problem solving: The need for flexible learning environments. Journal of Artificial Intelligence in Education, 6(2), 239-302.

Fey, J. T. (1989). Technology and mathematics education: A survey of recent developments and important problems. Educational Studies in Mathematics, 20, 237-272.

Frye D., Littman D., & Soloway E. (1988). The next wave of problems in ITS: Confronting the "user issues" of interface design and system evaluation. In J. Psotka, D. L. Massey, and S. A. Mutter (Eds.) Intelligent tutoring systems: Lessons learned. Lawrence Erlbaum. Hillsdale, NJ.

Gagne, R. M. (1985). The conditions of learning and theory of instruction. New York: CBS College Publishing.

Jiang, Z., & McClintock, E. (2000). Multiple approaches to problem solving and the use of technology. Journal of Computers in Mathematics and Science Teaching, 19(1), 7-20.

Jonassen, D. H. (1999). Designing constructivist learning environments. In C. M. Reigeluth (Ed.), Instructional-design theories and models: A new paradigm of instructional theory (pp. 215-239). Mahwah, NJ: Lawrence Erlbaum Associates.

Jonassen, D. H., Howland, J., Moore, J., & Marra, R. M. (2003). Learning to solve problems with technology: A constructivist perspective. Pearson Education Inc.

Kaput, J. (1992). Technology and mathematics education. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 515-556). New York: Macmillan.

Macromedia, Inc. (1992). Action! User guide. San Francisco, CA.

Mayer, R. (1985). Implications of cognitive psychology for instruction in mathematical problem solving. In E. A. Silver (Ed.), Teaching and learning mathematical problem solving: Mulitiple research perspectives (pp. 123-138). Hillsdale, NJ: Lawrence Erlbaum Associates.

Nathan, J. M. (1991). A theory of word algebra problem comprehension and its implications for the design of computer-based learning environment. Unpublished Ph.D. Dissertation, University of Colorado.

National Council of Teacher of Mathematics (2000). Principles and standards for school mathematics. Reston, VA: NCTM.

Orton, A. (1987). Learning mathematics: Issues, theory and classroom practice. London: Cassell.

Polya, G. (1962). Mathematical discovery. New York: John Wiley & Sons.

Staub, D.W., & Wetherbe, J.C. (1989). Information technologies for the 1990s: An organizational impact perspective. Communications of the ACM, 32(11), 1328-1339.
Stemler, L. K. (1997). Educational characteristics of multimedia: A literature review. Journal of Educational Multimedia and Hypermedia, 6(3/4), 339-359.
Zhang, J. (1997). The nature of external representations in problem solving. Cognitive Science, 21(2), 179-217.

# Investigating the Relationships Among Instructional Strategies and Learning Styles in Online Environments

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**Abstract**

*Researchers investigated differences in learner preferences for different types of instructional strategies and learning styles in online environments. Results suggested that matches between students' learning styles and instructional strategies did not affect their perception of their own learning outcomes, level of effort and involvement, and level of interactions in the course. Data also indicated that no single instructional strategy, among three instructional strategies tested, emerged as superior for high and low field dependent online students.*

**Introduction**

The Internet has taken center stage today as a preferred medium for the delivery of distance education. Many universities offer online courses that respond to the diverse distance and time needs of today's learners. These universities provide course instructors with online tools to manage course participation and facilitate learning. Instructors can continuously monitor student progress, provide learners with time to reflect on content and feedback before participating, prompt active participation with content and peers, and offers instructional modules that are designed to appeal to a variety of learning styles and preferences (Hamilton-Pennell, 2002).

Learning style can be thought of as the combination of the learners' motivation, task engagement, and information-processing habits (Aragon, Johnson, & Shaik, 2002). Each learner can have different preferences as to how s/he receives, processes, and recalls information during instruction. Many researchers however, have not controlled for students' characteristics in their analyses of students' satisfaction of online instruction (Thurmond, Wambach, & Connors, 2002). Understanding the relationships among learning styles and instructional preferences holds great promise for enhancing educational practice (Claxton & Murrell, 1987).

The primary purpose of this exploratory pilot study was to investigate the relationships among learning styles, defined as high and low field dependence, and preferences for, and evaluation of, instructional strategies used in an online course. Field dependence describes the degree to which a learner's perception or comprehension of information is affected by the surrounding contextual field (Jonassen & Grabowski, 1993). Learning styles are useful because they provide information about individual differences from a cognitive and information-processing standpoint (Smith & Ragan, 1999). Field dependent individuals are more likely to succeed at learning tasks that engage them in:

- Group oriented and collaborative work situations
- Situations where individuals have to follow standardized pattern of performance
- Tests requiring individuals to recall information in the form or structure that it was presented (Jonassen & Grabowski, 1993).

High-field dependent individuals have more difficulty locating the information they are looking for than low field dependent individuals. Low field dependent individuals are more likely to excel at learning tasks involving identification of important aspects of information from a poorly organized body of information. High field dependent individuals tend to accept the information without reorganizing it from the way it was presented to them so low field dependent individuals are likely to reorganize information to fit their own perceptions. Muir (2001) recommends teaching methods that match instructional strategies to field dependence-independence style.

Instructional strategies represent a set of decision that result in plan, method, or series of activities aimed at obtaining a specific goal (Jonassen, Grabinger, & Harris, 1990). Instructional strategies are the activities used to engage learners in the learning process. Many types of instructional strategies are used to engage learner in different ways such as reading, collecting, thinking, etc. Expository strategies may include providing learners with lecture notes. Explanations are often kept simple and direct. Students usually use lecture notes to complete learning activities or respond to posed questions. Collaborative and group work instructional strategies require individuals, often at various levels, to work together to achieve a common goal. Individuals are prompted to analyze, synthesize, and evaluate their ideas collaboratively. Inquisitive (discovery learning) instructional strategies require individuals to formulate investigative questions, obtain factual information, and build knowledge, which reflects their answer to the original question. Students develop several questions, which eventually lead them to answer the original question, use extensive resources to gather data, and answer the original question.

The characteristics of high field dependent individuals appear to match with expository (presentation), and collaborative (group work) types of strategies because these types of instructional strategies require learners to complete learning activities that are usually kept simple, and sometimes require learners to work together. The characteristics of low field dependent individuals suggest a match with inquisitive type of strategies because low field dependent individuals prefer generating their own hypothesis and testing their hypothesis. Table 1 illustrates the suggested match and mismatch of learning style and instructional strategy for this study.

Table 1. Match and Mismatch of Learning Style and Instructional Strategy

| | Expository | Collaborative | Discovery |
|---|---|---|---|
| High Field Dependent | Match | Match | Mismatch |
| Low Field Dependent | Mismatch | Mismatch | Match |

Abraham (1985) found that matching instructional styles to students' field-dependent or independent style improved students' performance in the course. In the study, researchers used two computer-assisted instruction lessons, one rule oriented, and the other deemphasizing rules, to test whether a teaching approach that did not emphasize rules would be of greater benefit to field-dependent students in an English as a second language class. The results of the study showed that field-independent students performed better with rule oriented approach whereas field-dependent students performed better with the approach deemphasizing rules. There has also been research that was contradictory to these results. Macneil (1980) found that learning did not increase when students categorized as field dependent and field independent receive instruction oriented to their style. In the study, researchers used discovery and expository approaches to test whether randomly assigned field dependent students learn more from the discovery approach and field independent students learn more from expository approach. Results of the study revealed that achievement of field dependent and field independent students did not vary as a function of style. The question remains can matching learning styles and instructional strategies in distance education better support student learning. This study was designed to address the following research questions:

- Is there a difference in perceived learning outcomes for students whose learning style matches with the instructional strategy?
- Is there a difference in students' effort and involvement for students whose learning style matches with the instructional strategy?
- Is there a difference in students' perceived level of interaction for students whose learning style matches with the instructional strategy?
- Is there a difference in perceived learning outcomes for low field dependent learners in match and mismatch instructional strategy situations?
- Is there a difference in perceived learning outcomes for high field dependent learners in match and mismatch instructional strategy situations?

## Method

### Instructional Context

The pilot study was conducted at a private university located in the northeastern United States with graduate students enrolled in an online graduate course entitled Design and Management of Distance Education. This investigation focused on determining if students who were classified as low or high field dependent perceived different types of instructional strategies differently in an online instructional environment. Specifically, students would be queried about their perceptions of learning outcomes, their effort and involvement in the activities, and their level of interaction during the course.

The Design and Management of Distance Education course consisted of three modules. Each module was delivered online using a different instructional strategy including, expository (presentation), collaborative (group work), and inquisitive (discovery learning). All three units were experiential and generative in nature, requiring learners to interact in different ways with the content to facilitate learning. On average, each unit was completed over a four-week period.

Expository type of instructional strategy was utilized primarily to present module one content. Each student read the assigned chapters in the course text, specified web pages, and power point slides regarding the growth and development of the field of distance education. Students were then required to participate asynchronous discussions responding to initial question posted by course professor and at least two other postings from their peers supporting their responses with references from readings. Finally students were required to write a reflection journal and complete content quizzes.

Module two was presented using collaborative group work. Four teams of 3 to 4 students were established. A case scenario was presented and each team was asked to design a prototype distance education course based on specified criteria. A private discussion forum and workspace was made available to each team to support their collaboration while completing the module. Throughout the module, each team was expected to submit status reports, and a final instructional design report. Quality of the deliverables and level of participation were used as evaluation criteria.

Inquisitive (discovery learning) types of strategies were used to present module three. Students were prompted to explore methods, media, and materials in distance education, to identify most important points of their implementation, and to prepare a mini presentation describing benefits and challenges of each. In addition to the course text, and additional web links, students were expected to utilize other resources to prepare the mini presentation. Then, students were expected to participate in a bulletin board discussion, write a reflection journal describing the at least five web sources helping them to better understand on hot topic in distance education related to methods, media, or materials. For example, if a student was curious about copyright s/he would explore the topic and report findings back to class. Ultimately, students were prompted to respond to inquiries into, and learn about distance education by investigating a variety of distance education areas of their own choice, and share their findings with the class.

**Subjects**

The subjects included twelve graduate students registered for this course. Sixty-six percent of the students were doctoral students and others were master degree students. Four students reported their technical skill as advanced. The other eight studied described their technical skills as intermediate. Sixty-six percent of the students had taken at least one online course before enrolling in this course. The results of the Psychological Differentiation Inventory showed that 25% of the students were high field dependent and others were low field dependent students.

**Instruments**

In order to conduct this research a valid and reliable measure of learning style had to be secured that could be implemented online. One such measure used for decades to study learning styles is the Group Embedded Figures Test (GEFT) (Witkin et al., 1971). The GEFT is used for measuring field dependence and independence. However, the use of this instrument is problematic for online environments because of the requirement to time participant responses and because participants have to draw responses in a given booklet. Given that distributed nature of students, the reliability of each participant completing the instrument per instruction is questionable. Therefore, the investigator searched for a version of the instrument that could be implemented online. The Psychological Differentiation Inventory (PDI), a questionnaire measure of field dependence was reconstructed as an online questionnaire for this study and used to measure high field dependence and low field dependence of participating learners. The PDI has good test-retest reliability (.69) and correlates (r = 0. 46 – 0.76) with Embedded Figure Test which is frequently used as a single measure of field dependence (Evans, 1969).

In this research the evaluation system used to assess students' achievements in each module included three components. These components were (1) self-assessment of outcome, (2) individual effort and involvement, and (3) interaction and feedback between and among the instructor and students (Robles & Braathen, 2002). The modified version of Student Instructional Report II developed by John A. Centra in 1998 was used with permission to assess components 1 and 2. This instrument contains five items for assessing perceived unit outcome of students, and three items for assessing student effort and involvement. Returns indicated the student's perception of the effectiveness of each aspect of a unit to the same aspects in other units using a five-point scale. A rubric developed by Roblyer & Wiencke in 2003 was used to assess the level of interactivity in each module by having students evaluate elements of interactions including social goals, instructional goals, types and uses of technology, and impact of interactivity-changes in learner behaviors.

**Procedure**

The Design and Management of Distance Education course consisted of three modules. Each module had to be completed in order, and in a given time frame by all students. Data were collected after each unit was completed. The online unit evaluation form at the end of each unit measured learner satisfaction and involvement with the instruction specifically through (1) perceived unit outcomes, (2) student perception of effort and involvement in the unit, and (3) student perception of interaction and feedback levels between and among the instructor and students during the unit (Roblyer & Wiencke, 2003; Centra, 1998). A java script was written for the online unit evaluation form to ensure that students answered all questions before submitting it. Using java script eliminated the risk of missing question response. Upon completing the online unit evaluation form, the data were automatically emailed to the researchers.

Students also had to complete the online questionnaire version of the Psychological Differentiation Inventory to measure their level of field dependence. A java script was also written for the online questionnaire version of the Psychological Differentiation Inventory to ensure that students answered all questions on the inventory. Researchers also received the results of the Psychological Differentiation Inventory through email.

## Analysis

All data were ported into a statistical analysis package (Stata version 8.0) for later analysis. One way analysis of variance was used to test the hypotheses that there were differences in students perceived learning outcomes, students effort and involvement, and students' perceived level of interaction when students learning style matches with the instructional strategy, and to test whether one instructional strategy emerges with higher perceived learning outcomes for online students who are categorized as high field dependent and low field dependent. All statistical analysis reported in this research were conducted with a significant level of .05.

## Results

### Learning style

The results of the online questionnaire version the Psychological Differentiation Inventory revealed that nine students were low field dependent and three students were high field dependents. The mean score for students categorized as low field dependent was 19.55 (S.D. = 3.53) while the mean score for students categorized as high field dependent was 26.33 (S.D. = 0.57) (see Table 2).

Table 2. Means and Standard Deviations for Students Categorized as Low Field Dependent and High Field Dependent

| Categories | N | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|---|
| Low Field Dependent | 9 | 19.55 | 3.53 | 14 | 23 |
| High Field Dependent | 3 | 26.33 | 0.57 | 26 | 27 |

### Matching Learning Style with Instructional Strategy

The first hypothesis stated that there would be no significant difference in the perceived learning outcomes of students whose learning style matched the instructional strategy. The results of the one-way analysis of variance supported this null hypothesis, $F(2,18) = 0.11$, $p = 0.89$ (see Table 3). No significant difference was found in the perceived learning outcomes of students whose learning style matched the instructional strategy. Both low and high field dependent students perceived learning outcomes in the three instructional strategies the same. Table 4 shows the descriptive statistics for perceived learning outcomes of students whose learning style matched the instructional strategy.

Table 3. Results of One-way Analysis of Variance for Perceived Learning Outcomes of Students whose Learning Style Matched the Instructional Strategy Used to Present the Online Course Module

| Source | Sum of Squares | D.F. | Mean Squares | F ratio | F Prob. |
|---|---|---|---|---|---|
| Between groups | .18031733 | 2 | .090158665 | 0.11 | 0.8947 |
| Within groups | 14.4977771 | 18 | .805432064 | | |
| Total | 14.6780945 | 20 | .733904724 | | |

Table 4. The Descriptive Statistics for Perceived Learning Outcomes of Students whose Learning Style Matched the Instructional Strategy

| Matched Group | Instructional Strategy | Mean | N | S.D. | Min | Max |
|---|---|---|---|---|---|---|
| Low Field Dependent | Expository | 3.71 | 9 | 0.85 | 2 | 5 |
| Low Field Dependent | Collaborative | 3.55 | 9 | 0.88 | 2 | 5 |
| High Field Dependent | Discovery | 3.46 | 3 | 1.1 | 2.4 | 4.6 |

The second hypothesis stated that there would be no significant difference in the effort and involvement of students whose learning style matched the instructional strategy used to present the online course module. The results of the one way analysis of variance supported this null hypothesis, $F(2,18) = 1.02$, $p = 0.37$ (see Table 5). No significant difference was found in the effort and involvement of students whose learning style matched the instructional strategy used to present the online course module. When low and high field dependent students' learning styles matched three types of instructional strategies used in the study, low and high field dependent students reported they put equal effort and involvement to instructional activities. Table 6 shows the descriptive statistics for the effort and involvement of students whose learning style matched the instructional strategy.

Table 5. Results of One way Analysis of Variance for Effort and Involvement of Students whose Learning Style Matched the Instructional Strategy Used to Present the Online Course Module

| Source | Sum of Squares | D.F. | Mean Squares | F ratio | F Prob. |
|---|---|---|---|---|---|
| Between groups | 1.06779522 | 2 | .533897609 | 1.02 | 0.3795 |
| Within groups | 9.39358058 | 18 | .521865588 | | |
| Total | 10.4613758 | 20 | .52306879 | | |

Table 6. The Descriptive Statistics for the Effort and Involvement of Students whose Learning Style Matched the Instructional Strategy

| Matched Group | Instructional Strategy | Mean | N | S.D. | Min | Max |
|---|---|---|---|---|---|---|
| Low Field Dependent | Expository | 3.71 | 9 | 0. 5 | 3 | 4.4 |
| Low Field Dependent | Collaborative | 3.81 | 9 | 0.64 | 3 | 5 |
| High Field Dependent | Discovery | 3.13 | 3 | 1.41 | 1.6 | 4.4 |

The third null hypothesis stated that there would be no significant difference in the perceived level of interaction of students whose learning style matched the instructional strategy. The results of the one way analysis of variance supported this hypothesis, $F(2,18) = 0.03$, $p = 0.97$ (see Table 7). No significant difference was found in the perceived level of interaction of students whose learning style matched the instructional strategy. Low and high field dependent students perceived their level of interactivity same for all three types of instructional strategies used in these modules. Table 8 shows the descriptive statistics for the level of interaction perceived by students whose learning style matched the instructional strategies.

Table 7. Results of One-way Analysis of Variance for Perceived Level of Interaction of Students whose Learning Style Matched the Instructional Strategy Used to Present the Online Course Module

| Source | Sum of Squares | D.F. | Mean Squares | F ratio | F Prob. |
|---|---|---|---|---|---|
| Between groups | .054603198 | 2 | .027301599 | 0.03 | 0.9703 |
| Within groups | 16.2755553 | 18 | .904197518 | | |
| Total | 16.3301585 | 20 | .816507926 | | |

Table 8. The Descriptive Statistics for the Level of Interaction Perceived by Students whose Learning Style Matched the Instructional Strategies

| Matched Group | Instructional Strategy | Mean | N | S.D. | Min | Max |
|---|---|---|---|---|---|---|
| Low Field Dependent | Expository | 3.82 | 9 | 0.92 | 2.6 | 5 |
| Low Field Dependent | Collaborative | 3.77 | 9 | 0.95 | 2.66 | 5 |
| High Field Dependent | Discovery | 3.66 | 3 | 1.0 | 2.6 | 4.6 |

**One Superior Instructional Strategy**

The fourth null hypothesis stated that there would be no significant difference in the perceived learning outcomes for low-field-dependent learners in match and mismatch instructional strategy situations. The results of the one way analysis of variance supported this null hypothesis, $F(2,24) = 0.19$, $p = 0.82$ (see Table 9). No significant difference was found in the perceived learning outcomes of low-field-dependent students who completed three online course modules. The characteristics of low field dependent students showed match with expository and collaborative type of instructional strategies, and mismatch with discovery type of instructional strategies. Statistical analysis showed no significant difference in the perceived learning outcomes of low field dependent students in match and mismatch instructional strategy situations. Table 10 shows the descriptive statistics for the perceived learning outcomes for low field dependent learners in match and mismatch instructional strategy situations.

Table 9. Results of One-way Analysis of Variance for Perceived Learning Outcomes of Low-Field-Dependent Students in Match and Mismatch Instructional Strategy Situations

| Source | Sum of Squares | D.F. | Mean Squares | F ratio | F Prob. |
|---|---|---|---|---|---|
| Between groups | .234073991 | 2 | .117036996 | 0.19 | 0.8286 |
| Within groups | 14.8266668 | 24 | .617777781 | | |
| Total | 15.0607407 | 26 | .579259259 | | |

Table 10. The Descriptive Statistics for the Perceived Learning Outcomes for Low Field Dependent Learners in Match and Mismatch Instructional Strategy Situations

| Low Field Dependent Learners Match and Mismatch Situations | Instructional Strategy | Mean | N | S.D. | Min | Max |
|---|---|---|---|---|---|---|
| Match | Expository | 3.71 | 9 | 0.85 | 2 | 5 |
| Match | Collaborative | 3.55 | 9 | 0.88 | 2 | 5 |
| Mismatch | Discovery | 3.77 | 9 | 0.58 | 3 | 4.8 |

The last null hypothesis stated that there would be no significant difference in the perceived learning outcomes for high-field-dependent learners in match and mismatch instructional strategy situations. The results of the one way analysis of variance supported this null hypothesis, $F(2,6) = 0.13$, $p = 0.88$ (see Table 11). No significant difference was found in the perceived learning outcomes of high-field-dependent students who completed three online course modules each of which used different instructional strategy. Perceived learning outcomes of high field dependent students did not change when they were taught with different instructional strategies matching and mismatching their characteristics. Table 12 shows the descriptive statistics for the perceived learning outcomes for high field dependent learners in match and mismatch instructional strategy situations.

Table 11. Results of One-way Analysis of Variance for Perceived Learning Outcomes of High-Field-Dependent Students in Match and Mismatch Instructional Strategy Situations

| Source | Sum of Squares | D.F. | Mean Squares | F ratio | F Prob. |
|---|---|---|---|---|---|
| Between groups | .267654316 | 2 | .133827158 | 0.13 | 0.8824 |
| Within groups | 6.28740728 | 6 | 1.04790121 | | |
| Total | 6.5550616 | 8 | .8193827 | | |

Table 12. The Descriptive Statistics for the Perceived Learning Outcomes for High Field Dependent Learners in Match and Mismatch Instructional Strategy Situations

| High Field Dependent Learners Match and Mismatch Situations | Instructional Strategy | Mean | N | S.D. | Min | Max |
|---|---|---|---|---|---|---|
| Mismatch | Expository | 3.66 | 3 | 0.94 | 2.6 | 4.4 |
| Mismatch | Collaborative | 3.88 | 3 | 1.01 | 3 | 5 |
| Match | Discovery | 3.46 | 3 | 1.1 | 2.4 | 4.6 |

## Discussion and Conclusion

Delivering instruction on the Internet has become very popular in recent years. Often face-to-face courses are converted to online course activities and materials with little thought of learners' preferences for instruction. Understanding the effects that learning styles and learners' perceptions of engagement in online environments have potential to improve the planning, producing, and implementing of online educational experiences. Thus, learning styles can be utilized to enhance students' learning, retention, and retrieval (Federico, 2000). This study provides insight into the relationships among learning style and instructional strategies used in online environments.

The statistical analysis revealed no significant differences among three match situations for low and high field dependent students. When the characteristics of low and high field dependent students matched with instructional strategies, match groups did not show any statistically significant difference in their perceived learning outcomes, their perceived effort and involvement in units, and level of interactivity that they perceived during the unit. This result showed that when low and high field dependent students receive instruction utilizing instructional strategies matching their characteristics, they gain equal learning benefits from the instruction. Using expository and collaborative type of instructional strategies for high field dependent students, and using discovery type of instructional strategies for low field dependent students in online courses provided equal benefits for students in terms of their perceived learning outcomes, their perceived effort and involvement, and level of interactivity that they perceived in the class. However, considering the fact that mean scores of students for match situations were more than the average score, matching instructional strategies with low and high field dependent learners appears to show some positive effect on student learning. Online course instructors may utilize expository and collaborative types of instructional strategies for high field dependent students, and discovery types of instructional strategies for low field dependent students to make the instruction more appealing and effective. Ultimately online students may gain more learning benefits from the course in terms of their perceived learning outcome, their effort and involvement, and level of activity that they perceive in the online class.

The results also revealed that there is no single superior instructional strategy for high and low field dependent students among the three types of instructional strategy used in the study. The characteristics of low field dependent students matched expository and collaborative instructional strategies and mismatched discovery type of instructional strategies. When low field dependent student groups were statistically compared, no significant differences were detected for three constructs used in the study. Matching and mismatching instructional strategies for low field dependent students did not affect students' perceived learning outcome, their perceived effort and involvement in units, and level of interactivity that they perceived during the unit. Similar statistical analysis was conducted for high field dependent students whose characteristics matched discovery type of instructional strategies and mismatched expository and collaborative type of instructional strategies. However, statistically no significant results were found for high field dependent students as well. Results of this study showed that utilizing expository, collaborative, and discovery types of instructional strategies to design online courses provided almost equal learning benefits for low and high field dependent students.

Although, this pilot study provided valuable information on gathering learner style information from online learners, results of the study should be interpreted with caution. These findings may have been due to a number of factors. Finding no significant results could have been due to small number of subjects. Considering the fact that there were twelve-subjects involved to the study and only three subjects were categorized as high-field dependent individuals, more subjects are required to validate the results of this pilot study. There appears to be other factors that may have affected the results of the study. Existing course structure may not have provided pure experiences in different instructional strategies. Furthermore, the time allocated to complete units was not same so it may have influenced the experiences of students in three units. Finally the content of units were different so the content may have influenced the level of effort that each student put into completing units.

Future researchers should consider testing environments that do strictly follow instructional strategy guidelines to confirm these findings. Researchers should also consider testing other learning style instruments and instructional strategies in their future research. Although no significant differences were identified in this study, there is much to learn about how individuals interact and learn in online environments.

**References**


Abraham, R. (1985). Field Independence-Dependence and the Teaching of Grammar. TESOL Quarterly, 2. 689-702.

Aragon, S. R., Johnson, S. D., & Shaik, N. (2002). The influence of learning style preferences on student success in online versus face-to-face environments. American Journal of Distance Education, 16, 227-244.

Centra, J. (1998). The development of student instructional report II. Educational Testing Service.

Claxton, C. S. & Murrell, P. H. (1987). Learning Styles: Implications for improving educational practices. ASHE-ERIC Higher Education Report No.4. Washington, D.C.: Association for the Study of Higher Education.

Evan, F. (1969). The Psychological Differentiation Inventory: A questionnaire measure of field dependence. A Paper presented at the Eastern Psychological Association, Philadelphia, PA., April 1969

Federico, P. (2000). Learning styles and student attitudes toward various aspects of network-based instruction. Computers in Human Behavior, 16, 359-379.

Hamilton-Pennell, C. (2002). Getting Ahead by Getting Online. Library Journal, 127, 32-35.

Jonassen, D. H., Grabinger, R. S., & Harris, N. D. C. (1990). Analyzing instructional strategies and tactics. Performance and Instruction Quarterly, 3, 29-45.

Jonassen, D. H. & Grabowski, B. L. (1993). Handbook of individual differences, learning, and instruction. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Locatis, C. & Weisberg, M. (1997). Distributed learning and the internet. Contemporary Education, 68, 100-103.

Macneil, R. (1980). The relationship of cognitive style and instructional style to the learning performance of undergraduate students. Journal of Educational Research, 73, 354-359.
Muir, D. J. (2001). Adapting online education to different learning styles. National Educational Computing Conference, Chicago, IL.
Robles, M. & Braathen, S. (2002). Online Assessment Techniques. The Delta Pi Epsilon Journal, 44, 39-49.
Roblyer, M.D. & Wiencke, W. R. (2003). Design and use of a rubric to assess and encourage interactive qualities in distance courses. The American Journal of Distance Education, 17, 77-98.
Smith, P. L.& Ragan, T. J. (1999). Instructional Design. New York, N.Y.: John Wiley & Sons Inc.
Thurmond, V. A., Wambach, K. & Connors, H. R. (2002). Evaluation of student satisfaction: Determining the impact of a WBE by controlling for student characteristics. American Journal of Distance Education, 16, 169-189.
Witkin, H. A., Oltman, P. T., Raskin, E. and Karp, S. A., (1971). Group Embedded Figures Test Manual. Palo Alto: Consulting Psychologists Press.

# Capturing Rehearsals to Facilitate Reflection

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## Introduction

Many learning environments involve rituals for rehearsal and reflection. Musicians, for instance, spend countless hours practicing scales and adjusting their bodies to increase their skills. But they do more than simply practice: They also play for instructors and others who can provide valuable critiques of their performances. Architectural design studios encourage students to create designs and share them with experts and peers in organized "crit" sessions that point out good and bad aspects of their work. Athletic coaches often watch videos of games with their players to reflect on issues for improvement. In all cases, there is a cycle of skill rehearsal followed by periods of critical reflection to understand successes and failures, ultimately to improve future performance.

Much of reflection is about making tacit knowledge and routines explicit so they can be analyzed and promote self-awareness or "knowledge-in-action" (Lin et al., 1999; Schon, 1983). In the above examples, these reflections are partially facilitated through concrete artifacts that capture aspects of past performance. Musical sessions can be recorded to tape, architecture students create drawings and models, and athletes use video when reflecting on their skills. Otherwise transient actions and performances are captured and made explicit as concrete artifacts for reflective thinking and learning.

Our research considers the importance of making actions into artifacts for reflective thinking. In particular, we will describe ongoing efforts to develop computer-based visualizations for diabetes health management. Approximately 17 million American suffer from diabetes (NIDDK, 1998), and those numbers continue to increase. The disease cannot be cured, but it can be managed through insulin and oral medications and changes in diet and exercise habits. We are focused on the latter part of diabetes self-management, the regulation of daily routines to prevent abnormal blood sugar levels that could lead to future health complications.

Most diabetics carry and use glucose meters, small, handheld devices that measure and report current blood sugar levels. These technologies are critical to diabetic lifestyles, as they present physiological data to help people see how they are dealing with the disease. Our research tries to add additional information to glucose meters by helping diabetics explore questions about why their sugar levels are normal or abnormal during the day. Specifically, we developed a computer-based visualization for displaying glucose meter data that makes patterns of regularity (or irregularity) explicit to its users. The hallmark of these visualizations is the use of color to provide global overviews of high, low, and normal blood sugars over extended periods of time.

Beyond visualizing physiological data, we have diabetics take photographs of their daily activities, focusing on things that might impact their blood sugar levels. These images are integrated into the computer visualizations to contextualize the numerical data. Our hypothesis was that diabetics could begin to engage in reflective thinking around their health practices when provided with visualizations that point out potential correlations between blood sugar levels (captured by glucose meters) and behaviors (captured in photographs). We will report results from a recent study of the use of visualizations of behavioral and physiological data to enhance the aspects of reflection stated in findings

## Definitions of Reflection

Reflection has been defined differently by different people. Before analyzing our study data we considered the following definitions.

In a chapter in How We Think (1997), entitled "What is Thought?". Dewey defines and emphasizes the importance of reflective thought. Reflective thought is one of the four senses of thought: the process of accepting a belief after deliberately seeking and examining its grounds. Reflection involves the consequences of ideas rather than merely a sequence of ideas. Each created idea is a link in a chain of ideas. The important consequences of beliefs or behaviors might force one to consider the reasons for these and come to a "reasoned conclusion". Reflective thought is the "active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends" (Dewey, p. 6). Reflective thinking has two elements or subprocesses: "a state of perplexity, hesitation, doubt" and an investigation to confirm or refute the further facts (Dewey, p. 9). In other words reflective thinking starts with facing a problem or questioning and then continues with efforts at solving the problem by reasoning. The process ends with a reasoned conclusion which would be the start of another reflective thinking process. Dewey concludes that reflective thinking "… means judgment suspended during further inquiry; and suspense is likely to be somewhat painful." (1997, p. 13)

Schon's definition of reflection comes with the following terms: knowing-in-action, reflection-in-action and reflection on action-in-action. Knowing-in-action refers to the kind of knowing that is revealed in our intelligent action while executing a spontaneous performance (Schon, 1987). This is a kind of action that cannot be verbalized. The knowing occurs in the action as a response to an unexpected outcome. The unexpected outcome can be result of anything that does not happen as a part of routine. Further knowing-in-action may help us to reflect on the unexpected outcomes of daily routine and take an in action. For example, automatically steering a bicycle to the left in order to maintain balance whenever the bicycle tilts to the left is an example of reflection-in action, The action which occurs in that present moment as a response to the unexpected results from and demonstrates knowing-in-action. During an action, we still can make a change to the situation and our thinking serves to reshape what we are doing while we are doing. In cases like this, we reflect-in-action, "thinking on our feet" (Schon, 1983, p. 54). For example one bikes to the left naturally when the bike tilts to the left at the moment of in-action. When we think back to see how our knowing-in-action helped us respond to the unexpected situation, then we are reflecting on action. Reflection on action can help reveal our own theories as well. When one finds himself experiencing puzzlement, or confusion in an uncertain or unique situation, "he reflects on the phenomena before him, and on the prior understandings which have been implicit in his behavior (Schon, 1983, p. 68). This experience results in generating "both a new understanding of the phenomena and a change in the situation" (Schon, 1983, p. 68).

Self-reflection and reflection are the terms defined as a part of self-regulated learning (SRL) by Zimmerman and Pintrich (Puustinen & Pulkkinen, 2001). Zimmerman (1998) defines self-regulated learning as a cyclical process which has three components: forethought, performance and self-reflection. Each of these components support each other in a sequence. Further more specifically self-reflection has four types of processes: self-evaluation, attributions, self-reactions and adaptivity. As one of the initial processes during self-evaluation, one compares self-monitored information with a goal. Self-evaluation leads one to attributions of reasoned conclusions. Attributions lead one to self-reaction and also to adaptation to the performance. Similarly, Pintrich's SRL definition has reflection as one of the four phases, whereas the first three are forethought, monitoring, control and reflection (Puustinen & Pulkkinen, 2001). More "reflection includes cognitive judgments, affective reactions, making choices and task and context evaluation".(Puustinen & Pulkkinen, p. 274)"

**Study described**

Specifically, our study involved six type I diabetics and one type II diabetic. This group took photographs of their everyday activities for a month and met with us weekly to discuss their health, using their visualized data as a conversational prop (Brinck & Gomez, 1992; Roschelle, 1992) for reflection.

They were given small digital cameras and asked to take pictures of diabetes-related behaviors. The diabetics were free to decide what they would take pictures of. We suggested that they might take pictures of their meals and exercise activities. In their daily activities they were testing and monitoring glucose results by using a digital glucose tester.

Before each weekly meeting, we uploaded the glucose data and the pictures to the computer. Then we displayed the data with software which was created for this purpose (see Figure 1 and 2). With this interface we could see the glucose results and diabetes-related activities, captured in pictures, accompanied by a record of the time and day. For the glucose results, color codes were used in order to facilitate an easy and quick grasp of glucose patterns. The colors represented ranges of blood sugar levels as follows:

- Dark blue: 0-39
- Lighter blue: 40-80
- Gray: 81-120
- Red: 121-140
- Dark Red: 141 and higher

The data for the entire period were displayed and then we posed questions to facilitate reflection. When necessary, the pictures were magnified (see Figure 3).

What follows is a discussion, based on preliminary data analysis, of the experience of the participants and how it helped them reflect.

**Findings**

Schon claims that his examples of a baseball pitcher who reflects on "winning habits" and a jazz musician who reflects on the experience of making music, show that "reflection tends to focus interactively on the outcomes of action, the action itself, and the intuitive knowing implicit in action" (1983, p. 56). In our study, participants were invited to focus on the outcomes of activities related to being diabetic, activities by themselves and the intuitive knowing implicit in activity. Before taking photos of activities they had to focus on the outcomes of the activities related to diabetes. For example, how does this exercise affect my glucose? Most of them took pictures of their meals and exercise activities such as walking and weight-lifting. In the process of capturing activities the participant experiences the intuitive knowing implicit in the activity. The participant makes this implicit knowledge explicit in two ways. The participant makes the knowledge explicit by communicating via visual representations of captured activities, photos and also by talking about them later on during the interviews. The knowledge is received by two parties: the participant and the interviewer who in some cases could be a health care person or physician.

Following we will introduce our preliminary data results associated with these phases. Participants' awareness about what to do was extremely variable. Most of the participants know what to do in general for their health care. P108, who was an athletic, had already come to an understanding through past experience of what affects her blood sugar and how to deal with it by correlating her eating and exercise. She had been exercising couple of times per a week since her childhood. She kept log books recording of what she ate and what she did for exercise. She thinks she does not have room to improve much. In other words, she does not have much confusion in her diabetes-related life. However she still is not sure about some blood sugar changes that specifically occur due to exercise. She still has not found the reasons of this. This is still a puzzle to her. When we asked what she learned about herself during the study, she answered:

"…I don't think I learned anything new…because I am an athlete and I have been at least recently really looking at my diabetics what affects it and how to change it, kind of understanding myself more what the exercise does to my health aham I think I have already gone that process but if maybe the other people haven't aham that they don't really understand what affects it as much it might help them for a better understanding. Since I wrote down everything I eat what insulin I take, I can sort of already look back and see what affects more…I have a basic understanding but some things are still different like I said exercise will kick in at strange times, some times directly after sometimes later which I am still trying to figure out…for some reason one day my body would kick in earlier or later" (P108, interview4, conscious, 1:36)

On the other hand some of the participants still did not know what causes what. They were still in confusion or hesitation. And knowing the reasons for changes could be helpful for P106.

"…I hope to see what it is causing me to get high blood sugar…but if I see what is causing me that would definitely be direction…" (P106, interview1, conscious, 20:03)

Even though they know, what they do or they do not do to manage their diabetes has already become part of their daily routine. They may not be thinking about their diabetics-related experiences enough because they have become repetitive practices embedded in their daily routines. For example, Schon (1983, p. 61) mentions that when practice becomes more repetitive and routine, knowing becomes sufficiently implicit and natural that the practitioner may miss important opportunities of careful consideration of what he is doing. By asking participants to capture their diabetes-related behaviors, we invited them stand outside of their routine lives and think actively, persistently and carefully about what they are doing for their health care as they are doing it (thinking on their feet). As a result of experiencing their lives out of their routine by wearing different lenses which comes with the study requirement, capturing behaviors, they could reveal their knowing-in-action and then reflect in-action.

For example P109 was not sure about the reasons for his high glucose measures and he was having suspended judgment:

"…I think with this really high one I had a big dinner that evening that could have been of the causes of that…aham I know for most of the high ones they come after meals…that could be something to do with eating a meal right before that that could be why they are high…" (P109, interview1, conscious, 24:58)

and he was reflecting-in-action by facing the problem that needs to be fixed but not having the solution/ response yet:

"…I think now looking at the blood sugars that there are a lot of higher ones which something needs to be fixed…" (P109, interview1, conscious, 27:02)

While monitoring the two-week data on our second interview, he continues reflection-in-action, advantageously, this time he realizes some patterns on his high glucose results in the mornings and questions the reason. He wants to know the reason. This is still reflection-in-action, investigation, since there is an inquiry but he does not respond to the problem yet.

"…I think I need to trying get my blood sugar under control especially in the mornings. I have to figure out what is causing that." (P109, interview2, conscious, 56:37)

P107 started living a different life when she left home and became a college student. This new life brought her some perplexity and suspended judgment regarding her diabetes management. We can see her experience of four phases at the same time: doubt, context evaluation, making choices and changes.

"…(her doctor) said they should have nutrition facts up there stuff, they do have that for a lot stuff but I eat a lot at the salad bar and they don't have that stuff up so unless I go and bug somebody in. I tried to looking up on the Internet…now just trying judging…now I am trying…I better go low then high but it is hard to the fact that at home I think I could manage my diabetes better…here my schedule I mean everything is so different every day is different and I am walking everywhere so that's why it is much easier to control at home…" (P107, interview 1, as a student-nutrition, 16:29)

"…I have been a lot more conscious about how to cover my meals…they don't have carbs in the dining hall…so I am trying to guess and it is the reason why sometimes it is high or low…so I have been trying to eat more regular salad dressing not fat-free" (P107, interview1, conscious, 04:17)

Choosing the regular salad dressing shows her solution. She has a problem and responds to that problem while it is occurring. She is reflecting-in-action and also making choices and changes.

Monitoring the glucose data and captured activities supported the participants on their investigation. For example both P109 also P110 observe how their eating amounts affect their blood sugars by monitoring the patterns on the visualized and color-coded data. They noticed that their glucose level was high in the mornings as well. More, some of them stated some new understandings of their life:

"..It was interesting to see what kind of habits I have. Maybe I realized what I should do a little bit more…Like I really never thought about sleeping how it affects my sugar…" (P105, interview4, conscious, 36:27)

"…this is interesting because I don't usually view as stress affecting me much but you guys said anything affect my blood sugar level that I could feel it…like affecting me and I don't usually give that much" (P106, interview1, conscious, 10:14)

"…I just became more aware like at the gym…this is first time I kept a log book for a long time it kind of helps seeing the pattern…"(P107, interview3, conscious, 12:21)

Monitoring also helped for realizing some habits, self-evaluation and followed with confirming the fact:

"…I took a picture of glucose tablets…aham let me see…geez I don't why I ate glucose tablets. I just eat them sometimes when I feel low…well that's even normal to deal with …we (then he sees the pictures and says) yeah I am actually starting to remember this day I ate a lot…I ate what ever I want…then I try to compensate with extra insulin which is not good idea I am trying to learn more on that, me myself…" (P106, interview3, conscious, 30:30)

After investigation confirmation emerged. Some participants noticed or confirmed that different kinds of exercising such as walking versus weight lifting affects blood sugar drops differently. For example P108 mentioned that weight lifting kind of activities affect later rather than just immediate after. She already had an awareness of that. On the other hand P109 was not sure of this and had an idea about that when questions prompted him to see a correlation:

"…maybe weight lifting is affecting the next day more than the same day…" (P109, interview4, conscious, 45:47)

"…I think we saw a connection between exercise and the next day blood sugar seems to be lower in the morning the day after exercise. I think it is one pattern that we saw. Seems that if I have a big dinner I don't know how to adjust (?)…"(P109, interview4, conscious, 51:05)

When asked to provide the reasons for the fluctuations by monitoring the data, one participant responded,

"…Aham there could be a lot of different reasons of that. For instance if I am taking the insulin or I am taking too much insulin or eating I have noticed depending on what eat has different effects. like if I eat pizza or something the effects of that don't really impact me until like two hours later." (P111, interview 3, measures-fluctuations, 36:46)

In the fourth interview when the color-coded data viewed P111 realizes changes:

"…I see a significant improvement in the back last five days…"

and then he comes to some conclusions when he is asked to see the connection between his exercise and blood glucose data:

Interviewer 1: "…when you look all overall this data and do you see connection between your exercise and blood glucose data?"

P111: "definitely"

Interviewer 1: "how?"

"…aham I think (?) last week (?) shows and from when I work as well shows that my blood glucoses decreases dramatically so if it doesn't decrease dramatically immediately if it doesn't immediate effect like from running or something aham symptoms of it will definitely show up in the morning rather than at night and from I think from work since work is usually a longer period than a few hours you see the results of working of when I finish working my work I test my blood and you see the results…" (P111, interview 4, reflection-on, 22:48)

Ultimately, some participants reported some changes or considerations of changes in their life. After they responded to the problem and then reflected on that. Some participants increased their exercise with more walking or decreased eating non-recommended food. For example P111 stated that he stopped eating ice cream, or P110 tried to increase his exercise (walking) and decided not to eat late at night. P111 is talking on the experience of the study: "…it was definitely a positive experience just because of the fact that I just had to be consciously aware of yeah I need to take picture of this and sometimes it is a horrible (deter?) but sometimes I think that 'do I really need to eat this?'because I am gonna take picture of it. I think it it definitely helped just making me conscious of what I eat…" (P111, interview4, DPS-taking pictures-stops more eating, 31:19)

Interviewer 1 follows: "Do you think it affected your choices of eating?"

"…yeah a few times it did…like for instance this whole past last two months like I have not eaten any ice-cream which is very weird considering that I love ice-cream and I am in the Penn State (referring the popular ice-cream place)..." (P111, interview4, DPS-taking pictures-stops more eating, 31:19)

"…I have improved the numbers (blood results)…it is definitely worked a lot…" (P106, interview4, conscious, 43:31)

Interviewer 1 asks: "This experience have helped your health?"

"…this just made me realize I am pretty out (?) of control now…so many little things make big differences…I am trying to get under control I guess…" (P107, interview4, conscious, 4:00)

## Limitations and Conclusion

One of the limitations was the interviewers' lack of expertise on the content. The interviewers were not health experts, so that could have decreased their ability to see the correlations between the data and the disease. Further, some questions asked by the interviewers to facilitate seeing the impact and correlation could affect the statements given by the participants. More the tendency of pictures on the subjects of eating and exercise could have been the result of examples given by the researchers at the beginning of the study. In addition to these, we had some technology-related limitations. The camera was forgotten or inconvenient to carry for some participants. One participant mentioned that it would be better to have camera and the monitor together in one tool, since she already has to carry the monitor. Also a few comments were made about how difficult it is to communicate everything by taking pictures. One participant found writing log books easier while some others found taking pictures easier.

Further applications and research of this study might be in various areas for various purposes. In general, this could be used for reflection processes as a path to improvement. Facilitating active, persistent and careful consideration of lived experiences by thinking about captured and monitored activities might help one to improve. We can see applications in health for complex disease diagnosis, adaptation and management. The study also has broader educational applications because it describes and evaluates a form of self-regulated learning.

## References


Brinck, T. & Gomez, L.M. (1992). A collaborative medium for the support of conversational props. In *Conference Proceedings on Computer-Supported Collaborative Work* (pp. 171-178), New York: ACM Press.

Dewey, J. (1997). *How We Think.* Dover Publications, Inc.

Lin, X., Hmelo, C., Kinzer, C.K., & Secules, T.J. (1999). Designing technology to support reflection. *Educational Technology Research and Development, 47*(3), 43-62.

NIDDK. (1998). *Diabetes Overview* (NIH Publication No. 96-3873). Bethesda, MD: National Institutes of Health.

Puustinen, M., & Pulkkinen, L. (2001). Models of Self-regulated Learning: a review. *Scandinavian Journal of Educational Research, 45*(3), 269-286.

Roschelle, J. (1992). Learning by collaboration: Convergent conceptual change. *The Journal of the Learning Sciences, 2*, 235-276.

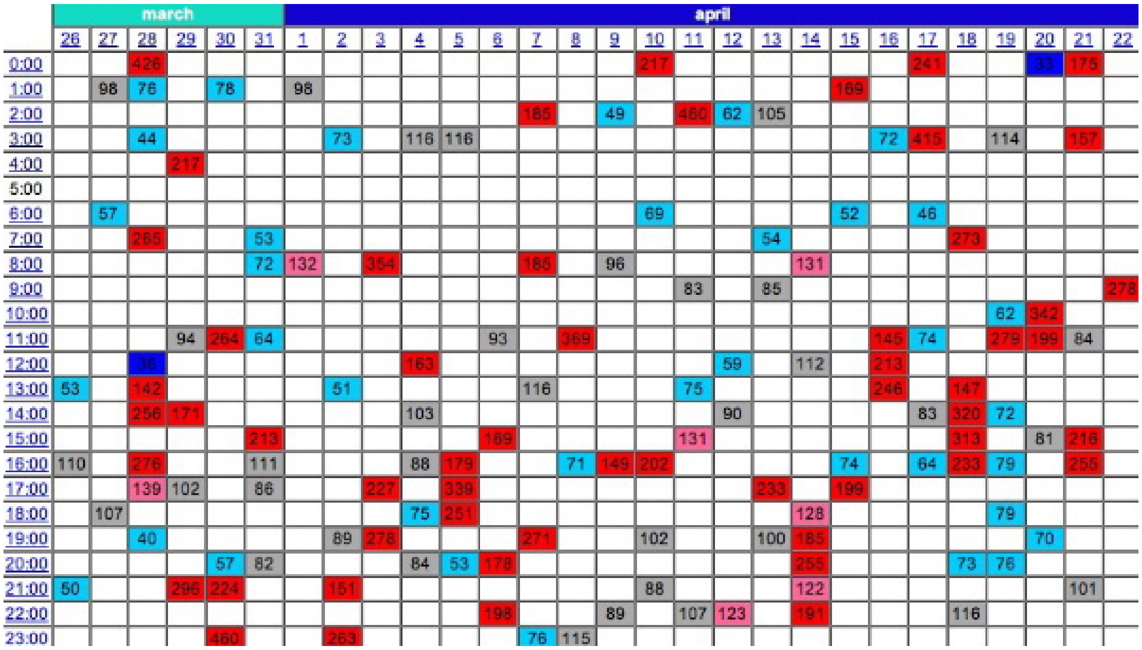
Schon, D.A. (1983). *The Reflective Practitioner: How Professionals Think in Action*. New York: Basic Books.

Schon, D. A. (1987). *Educating the Reflective Practitioner: Towards New Design for Teaching and Learning in the Professions*: Jossey-Bass Inc., Publishers 350 Sansome Street San Francisco, CA.

Zimmerman, B. J. (1998). *Self-regulated learning : from teaching to self-reflective practice*. New York: Guilford Press.

**Graphics**

Figure 1: Glucose results on color-coded chart



| | march | | | | | | april | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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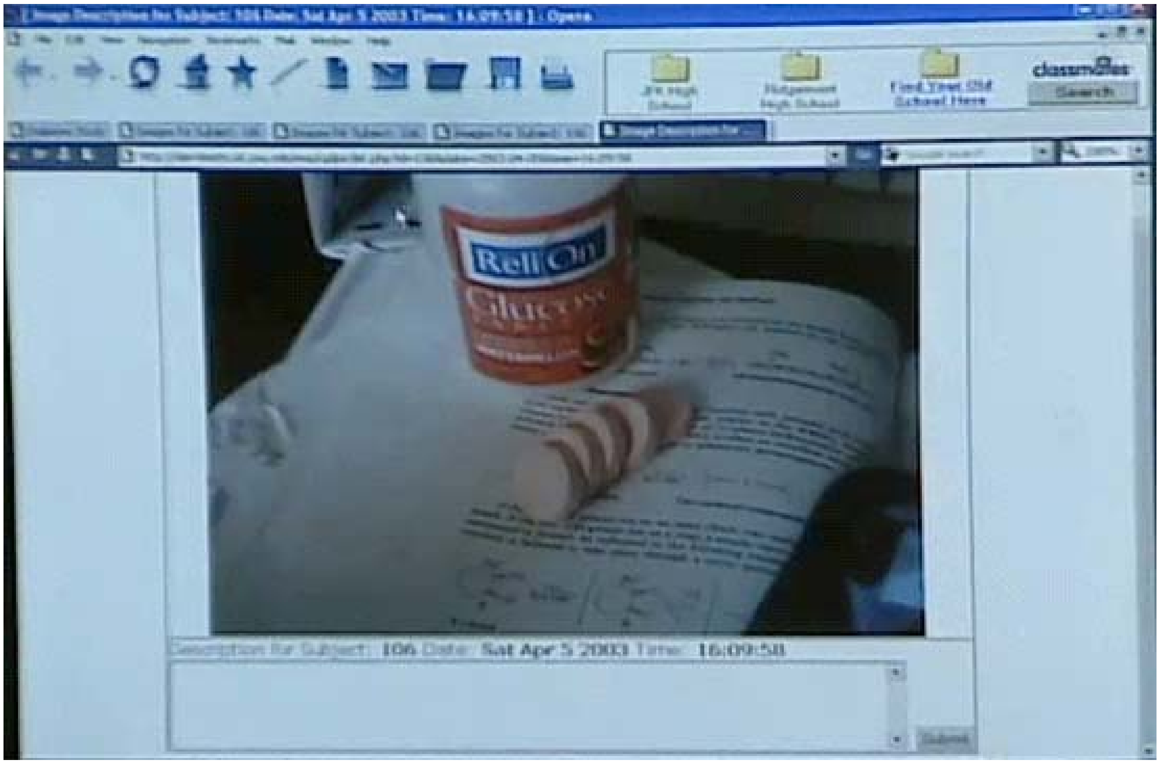
| 0:00 | | | 426 | | | | | | | | | | | | | 217 | | | | | | | 241 | | | 33 | 175 | |
| 1:00 | | 98 | 76 | | 78 | | 98 | | | | | | | | | | | | | | 169 | | | | | | | |
| 2:00 | | | | | | | | | | | | | 185 | | 49 | | 460 | 62 | 105 | | | | | | | | | |
| 3:00 | | | 44 | | | | | 73 | | 116 | 116 | | | | | | | | | | | 72 | 415 | | 114 | | 157 | |
| 4:00 | | | | 217 | | | | | | | | | | | | | | | | | | | | | | | | |
| 5:00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6:00 | | 57 | | | | | | | | | | | | | | 69 | | | | | 52 | | 46 | | | | | |
| 7:00 | | | 265 | | | 53 | | | | | | | | | | | | | 54 | | | | | 273 | | | | |
| 8:00 | | | | | | 72 | 132 | | 354 | | | | 185 | | 96 | | | | | 131 | | | | | | | | |
| 9:00 | | | | | | | | | | | | | | | | | 83 | | 85 | | | | | | | | | 278 |
| 10:00 | | | | | | | | | | | | | | | | | | | | | | | | | 62 | 342 | | |
| 11:00 | | | | 94 | 264 | 64 | | | | | | 93 | | 369 | | | | | | | | 145 | 74 | | 279 | 199 | 84 | |
| 12:00 | | | 36 | | | | | | | 163 | | | | | | | | 59 | | 112 | | 213 | | | | | | |
| 13:00 | 53 | | 142 | | | | | 51 | | | | | 116 | | | | 75 | | | | | 246 | | 147 | | | | |
| 14:00 | | | 256 | 171 | | | | | | 103 | | | | | | | | 90 | | | | | 83 | 320 | 72 | | | |
| 15:00 | | | | | | 213 | | | | | | 169 | | | | | 131 | | | | | | | 313 | | 81 | 216 | |
| 16:00 | 110 | | 276 | | | 111 | | | | 88 | 179 | | | 71 | 149 | 202 | | | | | 74 | | 64 | 233 | 79 | | 255 | |
| 17:00 | | | 139 | 102 | | 86 | | | 227 | | 339 | | | | | | | | 233 | | 199 | | | | | | | |
| 18:00 | | 107 | | | | | | | | 75 | 251 | | | | | | | | | 128 | | | | | 79 | | | |
| 19:00 | | | 40 | | | | | 89 | 278 | | | | 271 | | | 102 | | | 100 | 185 | | | | | | 70 | | |
| 20:00 | | | | | 57 | 82 | | | | 84 | 53 | 178 | | | | | | | | 255 | | | | 73 | 76 | | | |
| 21:00 | 50 | | | 296 | 224 | | | 151 | | | | | | | | 88 | | | | 122 | | | | | | | 101 | |
| 22:00 | | | | | | | | | | | | 198 | | | 89 | | 107 | 123 | | 191 | | | | 116 | | | | |
| 23:00 | | | | | 460 | | | 263 | | | | | 76 | 115 | | | | | | | | | | | | | | |

Figure 2: Glucose results and pictures taken

Figure 3: A magnified view of a picture



# Communities of Practice as Organizational Knowledge Networks

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**Abstract**

*As the amount of critical information in companies continues to burgeon and employees' knowledge is heralded as an organization's key competitive advantage, knowledge management has become a compelling workplace topic of discussion. Communities of practice have recently been recognized as effective means for organizations to manage their knowledge. In order to determine how virtual communities of practice serve as knowledge management vehicles, the authors of this paper conducted a study on virtual communities of practice within twelve large, international companies by interviewing virtual community of practice builders and leaders within these organizations. This paper reveals the study's findings. It outlines specific ways that organizations can benefit from sponsoring virtual communities of practice. It also identifies factors that community builders and leaders can influence to ensure a VCoP's success as a knowledge management vehicle.*

## Introduction

In our current age where information and knowledge are recognized as key ingredients for success and competitive advantage (Goldwassar, 2001), employees' knowledge, skills, and ideas are often considered to be companies' most valuable assets (Schwen, Kalman, Hara, & Kisling, 1998; Stewart, 1997). As the pressure to manage knowledge has become more and more pronounced, companies are undertaking major initiatives to protect and preserve it (Wenger, 1998). Accordingly, much literature has been dedicated to knowledge management (Blunt, 2001; Davenport & Prusak, 1998; Hamel & Prahalad, 1994; Kelly, 1998; Schwen et al., 1998; Sharp, 1997; Pfeffer & Sutton, 2000; Wenger & Snyder, 2000).

Proponents of knowledge management primarily recommend two ways of capturing and managing an organization's knowledge (Hansen, Nohria, & Tierney, 2001; Schwen et al., 1998). One recommended way to manage knowledge is to codify, index, and warehouse the information (Davenport & Prusak, 1997; Davenport & Prusak, 1998; Nonaka & Takeuchi, 1995; Schwen et al., 1998). This method is known as the codification means of managing knowledge (Hansen et al., 2001). Another recommended way to manage knowledge is to have the people who generate, refine, share, distribute, and use the knowledge actively manage it (Brown & Gray, 1995; Davenport & Prusak, 1998; Pfeffer & Sutton, 2000; Wenger, 2000). This method is known as the personalization means of managing knowledge (Hansen et al., 2001). A number of individuals who promote actively managing knowledge via people recommend using informal workplace learning networks, like communities of practice as knowledge management vehicles (Masterson, 2002; Pfeffer & Sutton, 2000).

This paper describes and discusses the findings of a study that reveals specific ways that virtual communities of practice can benefit individuals and organizations by helping them manage their knowledge more efficiently. To place the research in context, communities of practice are first introduced and discussed as knowledge management vehicles. An account of the research methodology follows, along with a general description of the study findings. The findings are then discussed in detail in terms of gains that individuals and organizations realize from participating in and sponsoring VCoPs. The paper concludes with suggestions of how this research contributes to the field.

## Communities of Practice as Knowledge Management Vehicles

Communities of practice (CoPs) are comprised of members who communicate one with another to generate and share knowledge and expertise. They function as an interdependent network over an extended period of time, with the shared goal of furthering their 'practice' or doing their work better (Wenger, 1998). Many CoPs operate virtually because community members live and work around the globe, relying on various technological means to communicate with one another. These CoPs are often called virtual communities of practice (VCoPs).

Existing research on communities of practice indicates that they have been found to help employees acculturate themselves into an organization (Chao, 2001; Gregory, 1993) develop a work-associated identity (Hara, 2000; Yi, 1999), teach them skills to get their work done more efficiently (Brown & Gray, 1995; Sharp, 1997), motivate them to do their work (Barab & Duffy, 2000; Bradsher & Hagan, 1995), and improve their individual job performance (Allen, 2003). However, literature relating the individual and organizational impact of CoPs to knowledge management is limited.

Wenger and Snyder (2000) reported that CoPs have helped several organizations improve their overall performance, enhance their communication structure, and support their goals. However, beyond a few individual case studies and Wenger and Snyder's case study synthesis, little research focuses on the ways that CoPs facilitate knowledge management within organizations. In order to learn more about the ways that CoPs, and particularly VCoPs, help organizations and individual VCoP members manage their knowledge, a study was conducted on VCoPs within large corporations, government organizations, and educational institutions.

## Research Methodology

The research team utilized interviews as the primary research data source because they are a key means of gathering qualitative case study data (Stake, 1995; Yin, 1994). They used a survey as a secondary research data source. The researchers collected the study data in two phases. They interviewed VCoP builders and leaders in phase one. During phase two, the researchers collected data from VCoP participants via a web-based survey. Prior to starting each phase, the researchers pilot tested and validated the data collection instruments with a small group of selected potential participants to ensure that the collected data would be reliable and valid.

The research participants involved in phase one consisted of twenty-five builders and leaders of virtual communities of practice from thirteen organizations. These organizations were primarily large, global companies who provide a wide range of products and services, such as financial services, microprocessor chips, technology services, training, health care services, consumer products, and insurance. The interviewees were carefully screened before they were interviewed to ensure that the virtual communities of practice they lead or built adhered to the theory and practices of community of practices. Once the VCoPs' legitimacy was established, formal interviews were conducted via 60-90 minute telephone conversations. These interviews were recorded and later transcribed The interviews addressed all aspects of VCoPs in order to gain a holistic understanding of their utilization. Some interview questions focused around discovering why VCoPs exist within organizations, what kind of "work" they do, and how they get started. Other questions attempted to ascertain how VCoPs impact the flow of data, information, and knowledge throughout their organizations. For example, interviewees were asked to identify and explain how the communities of practice served as forums to create and disseminate knowledge throughout their organizations.

During the second phase, the research team used the data gathered in phase one to create a web-based survey that was distributed via e-mail to participants of VCoPs in forty organizations. Approximately 150 virtual community of practice members responded to the web-based survey. The survey respondents worked for financial institutions, microprocessor chip manufacturers, technology services companies, training providers, health care providers, consumer product developers and distributors, insurance providers, and various other corporations. The survey questions focused around discovering why participants join and participate in VCoPs, what factors contribute to a VCoP's success or failure, what learning medium participants prefer for various types of learning and information exchange, and how learning in VCoPs compares to learning via more formal training methods. The web-based survey software automatically captured the participants' responses.

## Findings

In general, the findings indicate that individuals and organizations can receive substantial knowledge management-related benefits from participating in and sponsoring VCoPs. The interviews with VCoP builders and leaders and survey responses uncovered a wide range of explicit and tacit knowledge about virtual communities of practice. The interviewees articulated how the VCoPs actually perform in applied contexts and explained the benefits they provide to their members and to the organizations that sponsor them. The survey data revealed ways that members believe VCoPs can significantly help individuals learn, manage their knowledge, and perform their jobs better.

### Ways that VCoPs Benefit Individual Members

During the course of the study, the data provided both by VCoP builders and participants suggest that VCoPs benefit members by helping them do their jobs better, support their learning process, and extend or share their knowledge with one another. In their interview responses, builders of various virtual communities explained how VCoPs support their members' learning processes. For example, one VCoP builder stated:

[VCoPs] form because that's how people actually learn. That's how they share information, share resources… ask questions, get answers to those questions, and so forth. This is how people really do work and we in the training world, since that is where I'm coming from, we often look from an educational training perspective that most learning goes on in the classroom, but the reality is obviously that it doesn't. Most of it goes on in the workplace… most of the real critical learning goes on in the workplace.

In general, the study data suggest that VCoPs help employees learn by situating learning in the workplace, providing just-in-time and context-specific solutions to problems, and increasing employee interaction.

**VCoPs Situate Learning in the Workplace**

Recent research shows that employees often learn more in the workplace than they do in formal training environments because they fail to transfer and implement formal training into their jobs (Gilbert, 1978; Mager, 1992; Sorohan, 1993; Stolovitch & Keeps, 1999). VCoPs are valuable on-the-job learning environments because they are situated in employees' immediate work setting. One VCoP builder stated that "a community of practice is a better vessel even to do training [than formal training environments] because it's done within the situation of the work [they're] doing."

**VCoPs Provide Just-in-time Solutions to Problems**

VCoPs also provide a context where individual members gain access to people and resources that can help them solve their problems by viewing their problem from multiple perspectives and generating numerous problem-solving ideas. In other words, VCoPs provide a way for members to discover solutions to problems when they are most needed – just in time and in their own unique context. This significantly increases employees' performance capabilities.

As part of the web-based survey, VCoP members were asked to identify the benefits they personally gain from participating in virtual communities. In response to this question, 99% of participant responded that "job skills and knowledge" were the most important benefits. Approximately 84% of participants also indicated that VCoPs provide "excellent problem solving resources." The percentages of these responses clearly suggest that people join and participate in VCoPs to "gain knowledge and skills" and to "access resources" that will empower them to make better decisions.

**VCoPs Increase Employee Interaction**

VCoPs also benefit individual members because the group structure of VCoPs allows members to share information and engage in learning activities with peers. The increased peer interaction then leads to an increase in the members' knowledge retention and stronger relationships across the organization. This is particularly true when VCoPs involve people from across the organization, around the world, and different job descriptions and specializations. Because of these variations, the input and connections made by VCoP members unite employees and help them gain a sense of purpose and awareness that their individual efforts contribute to organization-wide strategies. In this way, community participation and interaction reduces both hierarchical and geographical boundaries and increases employee unification.

In a related survey question, VCoP participants selected their top three reasons for participating in virtual communities. Participants selected their reasons from a variety of responses related to relationship building, productivity, status, and motives. In response to this question, the participants indicated that developing "professional relationships with other community members" is their top reason for participating in VCoPs. This response specifically relates to knowledge management because developing professional relationships with other VCoP members is a key step in transferring knowledge among members. Also, when members exchange information and aid one another in solving problems, the overall productivity of the community increases. This increase in job-performance implies that employees are learning how to do their jobs better.

The benefits of situating learning in the workplace, providing just-in-time and context-specific solutions to problems, and increasing employee interaction were reinforced by a final question from the web-based survey, which asked VCoP members to identify whether VCoPs, web-based/computer-based training, instructor-led training, or mentor/apprentice learning environments best help them accomplish certain aspects of their jobs. In response to this survey question, VCoP members indicated that participating in VCoPs helps them do the following six specified job aspects better:

- Providing for an efficient idea exchange
- Generating a broad perspective on solving problems
- Providing greater access to experts
- Increasing members' knowledge
- Increasing members' motivation to learn
- Effectively helping others learn

Additionally, VCoPs ranked second in conjunction with "providing a more direct solution to a problem" and "impacting people's attitude about their jobs." These responses suggest that VCoP members view VCoPs as a learning environment that helps them manage their knowledge and better perform on the job.

**Ways that VCoPs Benefit Organizations**

Organizations also gain key knowledge management-related benefits from supporting virtual communities of practice. As previously indicated, knowledge management initiatives revolve around moving data, information, and knowledge effectively throughout an organization. The general goal is to decrease the communication barriers that exist in nearly every organization between individuals due to divisions, levels within the organization, and physical locations. In their interviews, all of the virtual community of practice builders and leaders stated that VCoPs improve their organization's knowledge management initiatives via either direct or indirect means. They indicated that virtual communities of practice facilitate a greater flow of information across organizations by breaking down many of the existing barriers. They also indicated that VCoPs increase the networking and communication opportunities available to VCoP members across organizations by providing increased interaction between organizational units where communication was previously impossible, increasing exchanges between management and employees, extending discussions that occur in face-to-face meetings, and creating a written repository of best practices that VCoP members have ongoing access to. VCoPs also appear to increase the informal training that occurs within the organization, foster innovation, and instigate cost savings. Each of these benefits is elaborated upon below.

**VCoPs Increase Interaction Among the Best Minds**

Before VCoPs existed, employees that spanned geographic borders or time zones were limited in their ability to effectively share data, information, and knowledge with one another. Virtual communities of practice overcome time and physical boundary limitations. Thus, they grant community members access to the best and brightest human resources throughout an organization, no matter what business unit or country they reside in. One community builder explained this benefit when he stated, "a virtual community of practice expands the quality of the skill base that we're able to draw from… it helps us get the best quality people… by not being constrained by physical location."

By granting open access to the knowledge and expertise of a collective whole, VCoPs increase their members' power and ability to function effectively and efficiently. For example, VCoP members often help individuals solve problems that they couldn't solve on their own in a relatively short period of time. By posing a problem to VCoP members around the globe, these individuals can get a variety of contextualized solutions to their exact problem or recommendations based on similar problems that other VCoP participants have experienced very quickly. One VCoP builder emphasized the problem-solving benefit of VCoPs in the following statement:

There is no time barrier, no geographic barrier, no culture barrier keeping you from solving your problem…. If you are in the middle of Kalimantan, or in the middle of the Borneo Islands, you have the company's [virtual community members] and with that, you have the support of everywhere in the world helping you resolve your problem.

**VCoPs Increase Communication between Employees and Management**

Another way that VCoPs boost an organization's data, information, and knowledge flow is increasing the communication between management and employees. VCoPs do this by providing a means for employees to safely voice opinions and concerns and introducing a channel through which management can solicit individual employee input and feedback. The exchange both directions helps to break down the hierarchies that separate management from front line employees. For example, many community builders indicated that individual VCoP members who hesitate to voice their opinion, share their ideas, and help create new processes on their own will engage in these activities within their virtual communities. The results of these exchanges can be shared directly with members of the company's management if they are VCoP members. If not, the VCoP members are able to discuss the issue(s) raised among themselves, and then pass their collective, and usually improved opinions, ideas, and recommendations on to company management from the collective community membership instead of a single individual. In that situation, VCoP members' feedback and recommendations often have more credence with management because it is collective, rather than feedback from a single individual.

In the same manner that VCoPs provide members with a safe vehicle to communicate with management, VCoPs provide managers with a non-invasive mechanism to inform employees of new developments, influence policy and solicit feedback. In her interview, one VCoP builder indicated that her management actively uses VCoPs to gather input from employees in remote locations, especially when they are building new programs that will impact those employees. She said that the VCoPs provide an easy way to get feedback on new programs or policies from people across their organization instead of only receiving input from employees in the corporate office as they did in the past. In addition to facilitating the creation of better policies and programs, VCoPs inadvertently increase employee buy-because they have opportunities to voice their opinion about those policies and programs. Additionally, virtual communities of practice establish a forum for company management and employees to collectively establish standards across geographic and culture boundaries.

**VCoPs Extend Communication Between Face-to-Face Meetings**

VCoPs also increase the information flow between employees by extending communication that occurs in face-to-face meetings. Members of VCoPs who meet physically on a regular basis often use the virtual component of their communities to interact with one another between these meetings. As an example, one VCoP leader said that the virtual communication channel between members of his virtual community allows them to follow up on issues and stay abreast of concerns facing their organization, divisions, or product lines when they are not physically present. It also gives community members the chance to jointly work on unresolved issues and action items assigned during face-to-face meetings before the next meeting takes place. For example, one VCoP builder commented that the addition of a virtual component to a co-located community of practice greatly increased communication between community members because they were able to discuss items and follow up on tasks that they had previously forgotten between face-to-face meetings. This made both the face-to-face meetings and the period of time between those meetings more productive.

**VCoPs Codify Best Practices and Solutions to Problems**

Another positive VCoP outcome related to knowledge management is the manner in which the information is captured. Since most of the communication and information exchange originating in virtual communities of practice occurs electronically, the questions, solutions, and best practices exchanged can be captured, organized, and archived for reference at a later date, in addition to being shared among community members immediately. This practice positively impacts an organization's knowledge management initiative from both the codification and personalization knowledge management perspectives introduced at the beginning of this paper. Through VCoPs, information is shared between people in relation to a specific context; thus it is personalized. Additionally, because it is digitally captured, it is also codified to that others can benefit from the exchange in the future.

One example of such a beneficial exchange occurred in a VCoP hosted by a multi-national insurance provider. In this instance when individuals in a Canadian office said, "Boy we've got a problem with…" members of the VCoP were able to say, "Oh, the Midwest office has already figured it out and they've already got the solution implemented. Talk to them and look at the information in the community archives to see what they did." In that single instance, the VCoP provided both the personal contacts and the repository of information that saved the Canadian office countless hours of duplicate effort and a large amount of money.

**VCoPs Facilitate Informal and Formal Training**

Due to the nature of the communication that occurs in VCoPs, these communities regularly facilitate informal training. In many ways, the questions that VCoP participants pose to one another and their calls for problem solving assistance serve as informal training requests because one VCoP member is seeking information from peers or experts to perform his or her job better. If community interaction is viewed in this light, whenever VCoP members answer one another's questions or provide advice, they are filling those informal training requests with impromptu training experiences. As a result, virtual communities of practice act as informal training networks and they provide constant informal training and mentoring opportunities. VCoP leaders indicated that community members also impact and influence formal training opportunities by identifying where collective knowledge gaps exist and requesting formal training for VCoP members in order to fill those gaps.

**VCoPs Foster Innovation**

Virtual communities of practice also benefit their sponsoring organizations by fostering innovation. VCoP builders and leaders indicate that VCoPs tend to foster innovation and refine organizational processes because the members examine problems and processes from multiple perspectives in a non-threatening, non-hierarchical, non-constrained environment and often create new processes or streamline existing processes. One VCoP expert focused in on this organizational benefit in her interview when she said, "If you bring the right people together and help them share their tasks and knowledge and collaborate on problem solving, you have innovation… so a community of practice is a perfect structure to engender innovation." Other VCoP builders echoed this expert's assertion when they told us that their VCoP members generally get excited about having opportunities to innovate and take advantage of those opportunities.

**VCoPs Help Organizations Reduce Costs**

Virtual communities of practice can help companies reduce their bottom line in a variety of ways. VCoP builders and leaders indicated that by sponsoring virtual communities of practice they were able to reduce the need for travel, decrease their overall training budget, reduce duplicated efforts, and minimize the time it takes to communicate with VCoP members across the world. In particular, several community builders noted that by utilizing virtual communities of practice as a training and collaboration tool, they have been able to significantly decrease the overall training expenses for their organization. For example, one VCoP builder of a worldwide oil product company indicated that his organization saves $35,000-$40,000 every month because members of a specific community of practice discuss and work on issues that they used to discuss in a monthly face-to-face meeting through the VCoP. This builder said that even though VCoPs require specific software and other technology to communicate, the costs associated with that technology are substantially less than paying for all the community members to meet physically on a regular basis so he happily provides the needed software, hardware, and server space needed by the VCoP to operate effectively.

Several community builders also noted that sponsoring virtual communities can help organizations reduce costs incurred by duplicating efforts. One VCoP builder stated that VCoPs "help out the bottom line" as they start to reduce redundancies and eliminate duplicated efforts. Another VCoP leader quantified the costs savings achieved by a particular community in terms of his personal time savings. He commented that he is able to achieve the same gains by relaying a message to members of this community virtually in a couple of hours as he did when he traveled for two or three days to relay the same message with community members physically.

## Conclusion

The research data indicate that virtual communities of practice benefit the knowledge management initiatives of the organizations that sponsor them. The interviewees' comments evidence the fact that the interaction between VCoP members increases the amount of data, information, and knowledge that is exchanged throughout an organization and heightens employees' awareness of what others are doing. The information exchange mutually benefits community members throughout organizations and the organizations themselves. The data also indicate that VCoPs increase opportunities for training and innovation, and help to reduce costs. These combined benefits lead to improved management of an organization's knowledge because they facilitate knowledge generation, knowledge codification and coordination, and knowledge transfer throughout organizations (Davenport & Prusak, 2000).

This study's findings contribute to the growing body of knowledge about virtual communities of practice by identifying specific ways that organizations benefit from sponsoring VCoPs and by revealing critical factors that organizations can influence to strengthen the likelihood that these communities will succeed. As a result, the data are valuable for organizations who desire to strengthen their ability to manage their collective employees' knowledge and utilize virtual communities of practice in that endeavor. The VCoP builders and leaders who participated in the study collectively articulated that greater information and communication flow, increased opportunities for training and innovation, better utilization of global resources, and reduced costs are benefits that organizations can realize from supporting virtual communities of practice. These benefits directly lead to improved knowledge management on both the individual and organizational level because the virtual communities of practice serve as organizational networks where knowledge is created, disseminated, and transferred throughout organizations.

## References


Allen, S. (2003) "No formal training required: How an informal community of practice helps its members improve their individual performance", Unpublished doctoral dissertation, Utah State University.

Barab, S.A. & Duffy, T.M. (20009 "From practice fields to communities of practice', in Jonassen, D. & Land, S. (Eds.), Theoretical foundations of learning environments, Erlbaum, Mahwah, NJ, pp. 25-56.

Benson, G. (1997) "Informal training takes off", Training & Development, Vol 51 No 5, pp. 93-94.

Blunt, R. (2001) Knowledge Management in the new economy. Writers Club Press, Lincoln, NE.

Bradsher, M. & Hagan, L. (1995) "The kids network: Student-scientists pool resources", Educational Leadership, Vol 53 No 2, pp. 38-43.

Brown, J.S. & Gray, E.S. (1995) "The people are the company", Fast Company, viewed 20 August 2002, <http://www.fastcompany.com/online/01/people.html>.

Chao, C.A. (2001) "Workplace learning as legitimate peripheral participation: A case study of newcomers in a management consulting organization", Unpublished doctoral dissertation, Indiana University.

Davenport, T.H. & Prusak, L. (1997) Information ecology: Managing the information and knowledge environment, Oxford University Press, New York.

Davenport, T.H. & Prusak, L. (1998) Working knowledge: How organizations manage what they know, Harvard Business School Press, Boston
Gilbert, T. F. (1978). Human competence: Engineering worthy performance. New York, NY: McGraw-Hill.
Goldwasser, D. (2001)“Me a trainer?”, Training, Vol 28 No 4, pp. 61-66.
Gregory, T. (1993) “Community of teachers”, Technical document, Indiana University.
Hamal, G. & Prahalad, C.K. (1994) Competing for the future, Harvard Business School Press, Boston.
Hansen, M.T., Nohria, N. & Tierney, T. (2001) “What’s your strategy for managing knowledge?” inHarvard Business Review on Organizational Learning, Harvard Business School Press, Boston, pp. 61-86.
Hara, N. (2000) ‘Social construction of knowledge in professional communities of practice: Tales in courtrooms’, Unpublished doctoral dissertation, Indiana University.
Kelly, K. (1998) New Rules for the New Economy: 10 Radical Strategies for a Connected World, Viking Press, New York.
Lave, J. & Wenger, E. (1991) Situated learning: Legitimate peripheral participation, Cambridge University Press, New York.
Mager, R. F. (1992). What every manager should know about training: or “I’ve got a training problem”… and other odd ideas. Atlanta, GA: Center for Effective Performance.
Masterson, K.T. (2002) “Communities of practice: A bridge to knowledge management success”, LawNet, Inc., viewed 13 December 2002, <http://www.peertopeer.org/papers.html>.
Nonaka, I. & Takeuchi, H. (1995) The knowledge creating company: How Japanese companies create the dynamics of innovation. Oxford University Press, New York.
O’Driscoll, T. (2003) “Improving Knowledge Worker Performance”, Performance Improvement, Vol 42 No 4, pp. 5-11.
Pfeffer, J., & Sutton, R. I. (2000). The knowing-doing gap: How smart companies turn knowledge into action. Boston, MA: Harvard Business School Press.
Saint-Onge, H. & Wallace, D. (2003) Leveraging communities of practice for strategic advantage, Butterworth-Heinemann, Burlington, MA.
Schwen, T.C., Kalman, H.K., Hara, N. & Kisling, E.L. (1998) “Potential knowledge management contributions to human performance technology research and practice”, Educational Technology Research and Development, Vol 46 No 4, pp. 73-89.
Sharp, J. (1997)“Communities of practice: A review of the literature”, viewed 20 May 2002, <http://www.tfriend.com/cop.htm>.
Sorohan, E. G. (1993). We do; therefore we learn. Training & Development, 47(10), 47-55.
Stake, R.E. (1995) The art of case study research, Sage, Thousand Oaks, CA.
Stewart, T.A. (1997) Intellectual Capital, Doubleday/Currency Publishers, Inc., New York.
Stolovitch, H. D., & Keeps, E. J. (1999). What is human performance technology? In H. D. Stolovitch & E. J. Keeps (Eds.), Handbook of human performance technology: Improving individual and organizational performance worldwide (2 ed., pp. 3-23). San Francisco, CA: Jossey-Bass.
Wenger, E. (1998) Communities of practice: Learning, meaning, and identity, Cambridge University Press, Cambridge.
Wenger, E. (2000) “Communities of practice: Stewarding knowledge” in Despres, C. & Chauvel, D. (Eds.), Knowledge horizons: The present and the promise of knowledge, Butterworth-Heinemann, Boston, pp. 205-224.
Wenger, E. & Snyder, W.M. (2000) “Communities of practice: The organizational frontier”, Harvard Business Review, Vol 78 No 1, pp. 139-145.
Yi, J.Q. (2000) “Supporting business by facilitating organizational learning and knowledge creation in the MOT community of practice (CoP)”, Unpublished doctoral dissertation, Indiana University.
Yin, R.K. (1994) Case study research: Design and methods, Sage, Thousand Oaks, CA.

# The Digital Divide: Focused Research Results On Peer Mentoring, Scalability and Occupational Self Efficacy In a Home-Based Technology Integration Program

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**Introduction**

The existence of a "digital divide" in which portions of society do not have sufficient access to technology, nor to the information and skills that technology use imparts, was of concern for educators and policy makers even before home computers were easily connected to the Internet (NTIA 1995, 1998, 1999, 2000; Resmer, Mingle & Oblinger, 1995; Riley, 1996; Annie E. Casey Foundation, 1998). As new technologies (such as broadband Internet access), and new uses for technology (such as interactive websites for homework) are developed, new levels of the divide will appear, certainly to the extent that children in low income homes do not gain access to the same level of information at the same rate as other children (c.f. Hundt, 2003; Digital Divide Network, 2003). In an era in which funding may be difficult to obtain, the development of tested, scalable, affordable solutions should therefore be a mandate for educators.

Research in the digital divide field is still in the critical early stages; consequently, much of the research has focused on demographic information and on documentation of participant benefits (cf. Chow, Ellis, Walker & Wise, 2000). As it is now well established that participants do benefit, and that those who would not otherwise have access to technology do take advantage of such opportunities, more focused research is called for. In addition, much early digital divide research has been based on solutions developed in conjunction with community technology centers (Chow, Ellis, Walker & Wise, 2000); the notable exceptions (e.g. Apple Classroom of Tomorrow, 1995; Pinkett, 2000, 2002) were largely based on partnerships with specific institutions and on highly funded pilot programs, so that conclusions drawn may be limited in the extent to which they can be used to plan larger programs and fiscally reasonable solutions. Moreover, as Secretary of Education Rod Paige has pointed out (US Dept. of Ed., 2003a, 2003b, 2003c), access in schools and in other institutions such as libraries does not substitute for access to home computers with Internet connectivity. Projects designed to test home-based technology programs are thus seen to be a priority (Andrews, DiGangi, & Jannasch-Pennell, 1999, 2000; Stock, 2001).

This paper reports on a seven-year project that was specifically designed to generate scalable and affordable solutions to the digital divide in a participatory research setting, and on a briefer study based on the project; one year was allocated to data collection in the study, and a second year was devoted to completing the analysis. The paper offers an overview of results of the study, and of the means by which the results were obtained. While more detailed papers are planned, it is hoped that this overview will draw attention not only to the divide, but also to some solutions, and to the efficacy of a grassroots-oriented means of generating such solutions.

In the seven-year project, computers were placed in low income homes as well as in non-standard dwelling places (e.g. shelters and vehicles) via a participant-led grassroots technology program, Floaters.org. Outcomes regarding disposition and use of the computers were tracked largely via a peer mentoring process in which previous recipients introduced new members to the computers. Mentors in particular, and mentees as well, were invited to bring their experiences and suggestions to a participant research group and in so doing to serve as a bridge to trained researchers. The participant research group met weekly and functioned as a consensus-based decision-making body with regard to the evolution of the project. Participants thus shaped the program to their needs in an exemplary participatory action research project (c.f. Moser, 1977; Fals Borda, 1995; Sohng, 1996).

Five years into the project, a mixed-method study was begun that would focus on specific aspects of home-based technology integration. Methods were chosen, with participant input, to maximize the amount of information gained. Thus, discourse analysis was selected as the appropriate method to examine transcripts of taped peer mentoring sessions; grounded theory was used to identify changes to the program that emerged as the program was scaled up in size; and a standard self-efficacy scale was used to examine participant self efficacy with regard to technology occupations. Finally, the program looked back at itself via the process of participatory action research, used in the project in order to generate and evaluate digital divide solutions from the bottom up, that is, with maximum input from the people most affected.

## Purposes of the Project and Study, and Research Questions for the Study

Participant-chosen goals for the project, and therefore for the participatory aspect of the study as well, were to investigate how best technology could be integrated into the homes and lives of low income populations; and, consequently, how technology could be used to improve these lives. From the beginning, the project sought not only demographic information and information about participant benefits, but also information about how those benefits could be accomplished.

Goals of the study, as contrasted with those of the project, were chosen in participant-driven focus groups in which members learned research methods. These goals focused specifically on a set of particular research questions:

What took place with regard to teaching and learning in the peer mentoring sessions?

How did the structure of the program, designed over time by participants, change further as the program was scaled up in size?

Did participant self efficacy change during the study with regard to occupations, especially with regard to technology occupations?

## About the Floaters.org Project

Working with university researchers, a community group designed and implemented the Floaters.org project, in which older computers were and are recycled into low-income homes and then monitored. The Floaters.org project itself is a participatory action research project, wherein all participants have an equal voice and goals are set by group members working together. The project was designed to integrate technology with those who are least likely to otherwise attain it: specifically, those living in poverty, those who have been homeless and later, people with disabilities who could not otherwise afford technology. The project simultaneously was designed to identify and put into practice the highest pedagogical and research practices. This does not imply that mistakes were not made, but rather that learning from mistakes was a built-in part of the process.

An examination of the nature of the project, undertaken as the two year study began, showed that participants took on three roles: peer mentors or mentees; shapers of the program; and co-researchers. Each role corresponds to one of the research questions stated above.

The monitored study was designed with input from participants, and participant approval was gained for all aspects of the study. As part of their work as co-researchers, participants learned about ethics standards, including the right to withdraw from the study without having to withdraw from the program. Each participant chose a screen name or alias, and data were recorded for these aliases. Where privacy dictated, the academic researcher occasionally chose to use an additional naming convention as well. Those participants who did leave the study have given their permission to continue using their data.

## Discourse Analysis

Discourse analysis, a qualitative research method used to examine the peer mentoring sessions, consists of a number of approaches to analysis of verbal interactions. Discourse analysis was agreed upon as a method for the study by the participants, who saw this method as a means of investigating empowerment. This view is consistent with the literature: in Language and Power, Fairclough (1989) invited both researchers and lay people to investigate the uses of discourse strategies to take and consolidate power.

It is the branch of discourse analysis known as conversation analysis, or CA, that was primarily used in this study. In conversation analysis, audio or video recordings are transcribed, and the transcriptions then analyzed, with structural details taking precedence over content. That is, rather than interpreting data and assigning motives, conversation analysts seek information about the structure of the conversation. Intonations, pauses, interruptions and grammatical structures are among the features typically coded for.

Conversation analysis was pioneered by sociologist Harvey Sacks in the 1960’s; his work, edited by Gail Jefferson and Emmanuel Schegloff, was not published until 1992, as the Lectures on Conversation (Sacks, 1992). However, long before this publication date, Sacks, Jefferson, and Schegloff had began a collaboration that resulted in a series of works that defined conversation analysis. These works included the Semiotica article "Opening up Closings" in which Schegloff and Sacks proposed the concept of the adjacency pair to explain conversational structures such as questions and answers (Schegloff & Sacks, 1973) as well as the Language article, "A Simplest Systematics for the Organization of Turn-Taking for Conversation" (Sacks, Schegloff and Jefferson, 1974). Working with Sacks' material, Gail Jefferson originated a set of notations for marking up text that was published with the 1974 article, and that has remained standard among conversation analysts.

In addition to Sacks' pioneering work, Sacks, Schlegloff and Jefferson built on the work of Harold Garfinkel, founder of the ethnomethodology school of sociology. Ethnomethodology focuses on the study of everyday actions, including language use, and takes for granted that ordinary people understand what they are doing; thus it is by nature well suited to a participatory action research project in which participants are co-researchers. Garfinkel presented the principles of his approach in Studies in Ethnomethodology, citing transcripts of conversations to show how people organize their shared realities using "common understandings" (Garfinkel, 1967, p. 38). In other words, ordinary people can and do understand their own actions. Like the conversation analysts, Garfinkel relied on observable data, using only as much context as was necessary to understand the data and expressing a belief that only those involved could understand the whole situation (Garfinkel, 1967).

Also related is the work of Erving Goffmann. In The Presentation of Self in Everyday Life, Goffman showed how, whether consciously or not, conversationalists act out roles and create a "front"–"that part of the individual's performance which regularly functions in a general and fixed fashion to define the situation for those who observe the performance" (Goffman, 1959, p.22). Conversation analysis draws from the work of Goffmann in that both reveal the ways in which relationships are constructed and roles created.

Transcription in itself has come to be viewed as a theoretical process, a viewpoint introduced by Elinor Ochs in "Transcription as Theory" (1979) and by Carole Edelsky, in "Who's Got the Floor?" (1981). Central here are the realizations that the raw data are not the same as the transcribed data; that, rather, the transcription is a representation of the data; and that the infinite multitude of decisions made during transcription are actually theoretical decisions reflecting the relative importance of particular discourse features. Two researchers working independently would not make the same theoretical decisions; and a single researcher, writing about the same text at different times, may make different coding decisions.

It cannot, therefore, be assumed that reliance on observable data over inference in conversation analysis implies that the data are wholly objective. The ongoing development of software applications that can be brought to bear on the transcription process (for example, software that measures pauses) does not change this, as researchers will continue to make the important decisions: for example, pauses in a technology mentoring session may have to do not with hesitation but with mentee concentration on a technology task. Where there is reason, a second researcher may separately transcribe audio or video recordings, and the two versions can be compared; or, a group of researchers working together may listen/view and transcribe as a group, as is recommended procedure in ethnographic inquiry and interaction analysis (Jordan & Henderson, 1995). However, neither process is necessarily indicated if it is accepted that transcription decisions are properly the domain of the researcher (c.f. Ochs, 1979; Edelsky, 1981; Lemke, 1998).

A second branch of discourse analysis useful in a participatory action research study is critical discourse analysis, or CDA, in which discourse is examined for underlying relationships of power. In the European countries, Foucault is thought of as the father of discourse analysis (e.g. Fricke, 1999; Diaz-Bone, 2003), in part for work published in his Archeology of Knowledge and in his Discourse on Language, published together in English in 1972. Elsewhere, Foucault might be thought of at least as the godfather of critical discourse analysis: Foucault began the Archeology of Knowledge by declaring that in order to understand any discourse it would be necessary first to get rid of all preconceived ideas in order to begin anew, and then to examine relations, including relations of power.

The Floaters.org study is closer in its approach to another critical discourse analyst, Norman Fairclough. Fairclough's use of close readings of text resembles that of conversation analysis, although his intention is to identify and uncover power relations. In Language and Power (1989), Fairclough not only identified discourse structures that give and take power, but invited others (including those with no prior academic background) to do so as well.

**Participatory Action Research**

The term "action research" has several meanings. In educational research, action research might be classified into two major branches, practitioner research and participatory action research or PAR. In both, research is carried on at least in part by people who have not been formally trained as researchers, but who have the advantage of being directly within the research situation and so have access to an unusually high level of information. Practitioner research in education rests on the belief that teachers ("practitioners") can participate in research, generally via self study, rather than being consumers of research only. In "participatory action research" on the other hand, the object is goal-oriented social justice, as guided by those affected. In PAR, a researcher or researchers may enter the situation with the intent of forming a participatory research group. The Floaters.org study utilizes the PAR approach: the initial impulse came from a researcher, who invited a counterpart in an affected community to join together in investigating technology integration by distributing donated computers.

Further confusion as to the nature of action research arises because participatory investigation or participatory action research has been used widely by such entities as the World Bank (Narayan, Patel, Schafft, Rademacher & Koch-Schulte, 2000). Such entities generally have an a priori interest in showing immediate financial gains for participants, whereas true participatory action research centers on the identification of participant values prior to the taking of action (Fals Borda, 1995; Sohng, 1996).

Participatory action research has been used in the United States in the establishment of support groups for sufferers from AIDS (Glasser & Bridgman, 1999) and in the investigation of the efficacy of prison education. (Fine, Boudin, Bowen, Clark, Hylton, Migdalia, Missy, Rivera, Robers, Smart, Torre & Upegui, 2001). In education, the work of Paolo Freire can also be seen as participatory action research, in that Freire mobilized participants to take control of their education (Freire, 1970, 1994, 1998).

In participatory action research, participants are co-researchers, with an equal voice in all decisions. The method itself therefore is also open to further refinement. Before the Floaters.org study began, five years' of group work on the project had resulted in three principles against which all decisions were tested: equality of voice; consensus-based decision making; and revolving authority, in which those who are expert in a particular area may step forward and take charge, so long as those who are interested in the area may also participate.

In interactions outside of the group, "Nothing about us without us" is the credo of grassroots participatory action research, as documented on the Homeless People's Network, the sister website and mailing list for the Floaters.org project (c.f. also Charlton, 2000). "Speak truth to power," is a related imperative, implying that participants must at every step of the way open to stating their opinion rather than, for example, avoiding the situation (Carey et al, 1955; Kennedy Cuomo & Adams, 2004).

With these guiding principles in participatory action research, project members take an ethical stance that is every bit as difficult to implement as the most rigorous of quantitative methods; in both, at the end of the study, the researchers know that their findings are trustworthy to the extent that the method has been properly followed.

**Self Efficacy**

"Perceived self efficacy" refers to people's optimistic beliefs about their ability to reach their goals (Bandura, 1977, 2001). Hackett and Betz have stated that one of the most useful concepts in modern psychology is Albert Bandura's concept of self-efficacy expectations, for self efficacy has been shown to affect human development (Hackett & Betz, 1981; Betz & Hackett, 1981; Bandura, 1977; Bandura, 2001). Changes in self efficacy have four sources, according to Bandura: mastery experiences, vicarious experiences modeled by others, verbal persuasion, and people's own physiological indicators or somatic and emotional states resulting from the attempt to achieve. Investigating these four sources, Bandura found, for example, that verbal dissuasion is easier to accomplish than verbal persuasion; that both positive and negative moods may affect self efficacy, as can pain; and that, in a learning environment, teacher self efficacy can negatively or positively impact student self efficacy (Bandura, 1994, 1995, 1997, 2001). Bandura's work with self efficacy was a part of his pioneering work that made a place for cognition, rather than adhering to the older "black box" theories of psychology. In thus allowing for the thought processes of the individual, Bandura created a concept which is more appropriate to grassroots PAR investigation, which also places emphasis on the individual participant, than earlier theories.

Self efficacy is domain specific. Bandura states in his Guide to the Construction of Self-Efficacy Scales (2001) that is important to use a domain-specific measure rather than a general measure of efficacy, as general measures are too ambiguous to be meaningful. Self efficacy can transfer across domains, and powerful experiences, in particular, can effect changes across many domains (Bandura, 1994, 1995, 1997, 2001).

With regard to the study of self efficacy with low income populations, early research conducted by CTCNet (CTCNet, acc. 2003) identified a number of benefits to users, one of which was personal efficacy (Mark, Cornebise & Wahl, 1997). In subsequent CTCNet studies, this benefit was dropped as a concept of interest (Chow et. al., 2000), but a more domain-specific self-efficacy concept may be worth a closer examination.

While career goals are not the only objective of technology integration, they are a concept of interest among the Floaters.org population, as determined by the participatory research group. "Work self efficacy" or "Occupational self efficacy" refers to the belief that one can succeed in a particular job. The concept of occupational self efficacy itself was introduced in pioneering work published in 1981 by Gail Hackett and Nancy Betz (Hackett & Betz, 1981; Betz & Hackett, 1981). In these works, Betz and Hackett applied the concept of self efficacy to career counseling and discovered gender differences among with regard to traditionally gendered occupations, in particular, men had much stronger self efficacy scores for traditionally male careers (Betz & Hackett, 1981; Hackett & Betz, 1981.)

Following Bandura's model, Hackett and Betz created the Occupational Self-Efficacy Scale (OSES) in the form of a Likert scale from one to ten for 20 occupations; respondents were asked to select their answers based first on how certain they were of being able to complete the education or training for each occupation, and then on how certain they were of being able to carry out the job duties (Betz & Hackett, 1998). A revised version of their 1981

Manual for the Occupational Self-Efficacy Scale was made available online in 1998 (Betz & Hackett, 1998). Typically the scale is revised by the researcher to offer relevant occupations for the population of interest (Hackett, personal communications, 2001, 2003); in this PAR study, the participants themselves chose the relevant occupations. The scale can be administered in terms of the training aspect, in terms of the job duties aspect, or with both aspects included.

## Method

### Participants

Participants in the group (n=184 at the time of the study) comprise a "snowball" sample (Babbie, 1998) in that new participants were recruited by project members, each of whom was asked to choose someone else to teach. For the study, 37 primary participants were lent recycled computers, standardized to the extent possible. Data were collected over the course of a year for each of the 37. Each primary participant represented a different family except where there were two or more computers in a family; in these cases, each primary user of a computer was also a primary participant in the study. All of the 37 volunteered for the project, and all were over the age of eighteen. Each section of the study drew on a different subset of participants as appropriate:

Fourteen of the 37 took part in the taped peer mentoring sessions. The taped sessions used for the study were theoretically sampled, that is, they were chosen in order to provide as wide a range as possible in terms of age, level of experience in the program, gender, and level of education.

All participants were invited to optional weekly research meetings, where data were collected in the form of field notes and observations regarding changes in the structure of the Floaters.org project during the study.

Twenty-two members agreed to take part in the self efficacy portion of the study; of these, seventeen took part in both administrations of the self-efficacy scale, at approximately four-month intervals, while five took part only in the first administration. The 22 were self-selected from the 37 primary participants.

While research decisions (e.g. aspects studied and methods) were made by the participants after group study of research methods, and while participants took part in other aspects of the research as appropriate (e.g., participants selected the careers to appear on the Occupational Self Efficacy Scale), a trained researcher conducted the analysis, with constant member checks wherein participants were asked to comment on portions of the analysis.

### Data Sources

Data sources included the following:

- Records of the computers and the work done with them
- Field notes, observations, and qualitative memos
- Eight videotaped mentoring sessions, theoretically sampled so as to provide the widest possible variety of mentors and mentees
- Field notes and observations from focus group sessions
- Scores from the two administrations of the Occupational Self Efficacy Scale

Responses to followup questions asked of those who took part in the mentoring study

### Procedure

Recycled Macintosh computers with a standard set of applications were distributed to thirty-seven primary participants, along with self-study materials and resources for feedback.

Eight peer mentoring sessions, theoretically sampled to provide the widest possible range in education, experience, age, and gender, were videotaped by the researcher.

The Occupational Self-Efficacy Scale was administered at approximately four-month intervals to a subset of twenty-two self-selected mentors and mentees in order to determine any changes in attitude towards computer-related jobs. Seventeen of the twenty-two were available to take the self-efficacy instrument a second time; five took it only once.

Weekly focus group sessions/research group sessions were held, and follow-up interviews were scheduled during the last three months.

Figure 1. Timeline for the study. The equivalent of the recommended year for ethnographic data collection was allotted to data collection for the study, along with a second, also recommended, year for analysis and writing.

## Analysis

### Peer Mentoring Sessions: A Discourse Analysis

The first of the three aspects studied was that of the mentor/mentee relationship. For the discourse analysis portion of the study, eight theoretically sampled peer mentoring sessions were taped, transcribed, and coded for discourse features in order to examine the participant roles of mentor and mentee. The sessions were selected via the theoretical sampling process in order to provide as wide a range as possible regarding age, level of experience in the program, gender, and level of education. The mentoring pairs were videotaped during sessions, and the sessions were transcribed and marked up, then coded, using modified conventions based on the work of Gail Jefferson (Sacks, Schegloff & Jefferson, 1974; Jefferson, 1984). It is standard practice for the researcher to adjust the transcription conventions to the requirements of the researcher's interests and of the text at hand, so the conventions given here vary from those originated in 1974. Data were coded line by line, in constant comparison analysis (Glesne & Peshkin) until categories were found and then saturated, that is, until all new data fit into already discovered categories. Transcription conventions used for marking up the text can be found in Appendix A.

### Scalability/Changes to the Program

The second aspect studied was that of scalability of the project. At the beginning of the study, the project was scaled up in size. Rather than accepting new members one at a time as mentors became available, twenty new families were accepted at once. As the program was modified in order to accomplish this expansion of the program and to provide ways to collect data, the opportunity arose to track answering changes produced by the participants responsible for the program structure. Most important of these changes was the establishment of a weekly focus group that any participant (n=184) could attend and that served as a means of communicating concerns as well as to continue the work of shaping the program. Field notes of these focus group meetings were collected by the researcher and analyzed, again via coding and constant comparative analysis, in order to investigate how the role of shaper and developer of the program played out during this time.

### Occupational Self Efficacy

To examine occupational self-efficacy, the Occupational Self-Efficacy Scale or OSES was revised in accordance with guidelines set by Bandura (2001) and advice given by Hackett (personal communications, 2001, 2003). The OSES is typically revised by the researcher, who selects occupations that are relevant to the group under study; here, the participants were asked to choose the occupations. Rather than limit the list of occupations, they chose to use them all, adding eight more technology occupations and the occupation of President.

For this aspect of the study, four smaller questions were formulated:

1. Will there be a significant difference between means for technology-related occupations and non-technology related occupations within the first administration of the instrument?
2. Will there be a significant difference between means of technology-related occupations and non-technology related occupations within the second administration of the instrument?
3. Will there be a significant difference between means of non-technology occupations, between the two administrations of the instrument?
4. Will there be a significant difference between means of technology-related occupations, between the two administrations of the instrument?

Scores on the self-efficacy scales were analyzed for each of the four smaller research questions by running a paired samples t-test to test for difference of means. Follow-up questions were generated based on a pattern analysis of the results, and participants were contacted and interviewed.

## Results

### Peer Mentoring Sessions: A Discourse Analysis

Analysis of the peer mentoring sessions showed that peer mentors developed and used sophisticated teaching strategies and that these strategies were similar among experienced mentors, regardless of education levels. Coding yielded two sets of mentor discourse strategies that had to do with verbal contributions of the mentee to the session. Differences were found in the use of these strategies between experienced and beginning mentor discourse: expert mentors alternated the two types of strategies, thereby encouraging mentee contributions while advancing the instruction. On the other hand, features found in the discourse of experienced mentors were similar regardless of educational level: members with and without a high school diploma were equally expert in mentoring if they had an equal amount of mentoring experience.

One set of strategies encouraged mentee participation: these strategies included such features as questions, problem statements, and off-topic remarks. This problem statement by the mentor, for example, is followed by a mentee response:

→Mentor: 30. I've never seen the mouse
31. connected to the cord before.
Mentee 32. (.) Then nobody can steal them.

The second set of strategies included such discourse features as interrupting, ignoring mentee contributions, and speeding up the rate of mentor speech. Here, the mentor interrupts, thereby retaining control of the instruction:

→ Mentee: 23. Let me show [you ( )
→ Mentor: 24. [And then you can, now if you want to do.
25. ˚ Let me show you.˚

### Scalability/Changes to the Program

Participants modified the Floaters.org program further during the study, primarily increasing communication opportunities. The first modification, in which participants requested that the focus and research group meet weekly, and that it be immediately opened to mentors and mentees alike, provided a regular opportunity for participants to bring up their concerns and to suggest changes. Participants successfully maintained the basic premises of the program (equality of voice, consensus-based decision making, and revolving authority) throughout the mixed method study: no mean feat, for as the group learned, in a research situation methods can easily deviate from grassroots principles unless there is constant attention to the principles. A second major modification was that of the addition of a fourth principle to group interactions: speaking truth to power within the group (as well as outside of it) rather than walking away. This addition to the internal principles of participatory action research was needed since many participants (as documented in the self efficacy interviews) perceived of their power as limited in some senses, but strong in that they stated that they could always walk away from a situation in which they were not being treated fairly. Encouragement to speak out in the group over perceived slights was the solution to losing participants over such problems.

### Occupational Self Efficacy

Results of the self-efficacy questionnaire were inconclusive, though a major history effect may have had some impact on these results. The study was interrupted by the events of September 11, 2001, and in follow-up interviews as well as in focus group observations, some participants indicated that these events had changed their opinions.

One significant difference was found, for the exploratory question, Will there be a significant difference between means for technology-related occupations and non-technology related occupations within the first administration of the instrument?

For the difference between means of technical and non-technical occupations in the first administration of the OSES, the p value was .047. As the sample size is small, a non-parametric test, the Wilcoxon Signed Ranks test was also run, and here the p value was .049, leading to the same conclusion.

This difference disappeared in the second administration of the OSES, where scores for non-technology occupations rose, although not significantly. Standard deviations for technology-related occupations, particularly in the second administration, were higher than for non-technology-related occupations:

Table 1 Standard Deviations

| Non-technology 1 | Technology 1 | Non-technology 2 | Technology 2 |
|---|---|---|---|
| 1.6949 | 1.8254 | 1.6474 | 2.0261 |

These results are somewhat counter-intuitive as it might have been expected that technology self efficacy would increase after participants received their computers. In order to investigate this further, responses to the scale were first graphed and patterns of responses were analyzed, in order to generate follow-up questions. Open-ended follow-up qualitative interviews were then held.

Three types of typical patterns were found: one subset reached the ceiling in technology self-efficacy either in the second administration, or in both administrations: these scores either rose, or stayed the same.

Statements from this group in follow-up interviews indicated that these participants wished to make it clear that they could do anything if they had the opportunities for education and success that others have. These members felt that they were capable of completing the education for occupations requiring high levels of education, but felt others in society were unaware of their ability.

In another subset, scores fell, sometimes radically. Interviews with this group indicated that after September 11, some participants lost interest in their work with the computer, and some lost faith in their ability to prepare for computer-related jobs.

With a third group, response levels varied based on the specific type of computer career, either in both administrations or in the second, That is, a participant might score high on a career involving computer art, but low on a career involving programming. In follow-up interviews, these participants indicated that their greater understanding of technology careers had led them to give more precise answers, sometimes resulting in an overall lower score.

**Looking at the Participatory Process**

With regard to participant goals, localized best practices were found regarding technology integration. Financial goals remained problematic, but other goals defined by participants as pertaining to a better life were met to a degree. As one participant stated, “I will stay as long as it feeds my spirit.”

Also documented in the focus group sessions and noted in the Changes to the Program section is the refinement of the participatory action research process over the course of the study.

Participatory studies may more commonly limit methods to ethnography: in this study, other methods were used as well, but introduced with care and always with participant understanding and consent. For example, the research group voiced concerns that quantitative methods would be disempowering, and a discourse analysis has been proposed to determine if the self-efficacy scale is less empowering with this population than an open-ended questionnaire.

As a method, discourse analysis was not seen as disempowering, as the group was introduced to it via Fairclough’s call for lay attention to discourse as a means of taking power (Fairclough, 1989.) The origins of conversation analysis being to some extent in ethnomethodology, a field in which ordinary people are seen as able to understand their own discourse, further makes this method approachable to discourse analysis. Finally, the place of self efficacy in psychology as introducing the importance of cognition makes this concept also appropriate.

## Discussion and Future Research

Generalizability in the traditional meaning of the word is not the purpose of a study that takes a qualitative perspective; instead, theory is generated in the form of hypotheses based directly on data. In such a study, sufficient detail is ideally presented for readers to be able to make the decision as to whether or not the findings may also generalize to particular situations with which the researcher is familiar. Such detail adds to the credibility of the study. In this brief paper, detail is necessarily necessity limited: further papers are planned, and in the meantime it is hoped that the detailed presentation here of the participatory process as used in this study will encourage the reader to entertain the assumption that the rest of the study may likewise be credible.

It is also important for credibility that rapport and “buy-in” on the part of participants can be shown. This study sought such rapport and buy-in by following participatory action research principles. As all participants are co-researchers with an equal voice in decision making, rapport was a natural outcome.

Credibility is further enhanced by triangulation, or the use of multiple methods and/or data sources, especially when the findings of the methods and sources converge, as they do here. In terms of the purposes of the project and of the study, a project using specific means of technology integration (participatory research, peer mentoring, focus groups, home-based technology integration) was examined in differing ways (discourse analysis, field notes, and a self-efficacy scale) to yield converging results.

The results point to the usefulness and potential for success of peer mentoring, a process that is eminently affordable as a means of instruction. The discourse strategies can be studied further; one next step for this project will be to incorporate the strategies into mentor training.

Within the participatory process, it is interesting to note that grassroots participants, after five years of work with the process, were able to transform the project to meet the challenges of scalability and indeed to further refine the participatory process. Further study of the nature of power and empowerment for such a group appears to be in order.

As mentioned earlier, participants themselves have suggested a close look at the discourse of those who are taking the OSES, in order to determine if the OSES is empowering or disempowering as an educational experience

Another direction for study, and currently underway, is the further development of the OSES in the direction of a Technology Occupational Self-Efficacy Scale, Important here will be the identification of sets of related technology occupations that are of varying difficulty, so as to satisfy Bandura's requirement that items on the scale present varying levels of challenges (Bandura, 2001). To take an example from the current version of the scale, "video game tester" and "video game designer" require varying levels of training or education. Since technology-related occupations exist across various subdomains–programming, networking, and art, for example–it will be important to identify the various technology-related domains. A related avenue of future research will be the further development of an instructional intervention that describes the technology domains.

## Appendix A

Transcription Conventions Used in the Floaters.org Study

Markup is based on the work of Gail Jefferson (1974, 1984).

| Markup | | Definition/Samples |
|---|---|---|
| [ | | Left bracket: beginning of overlap or interruption |
| | S. | Yah I was in one of those technology classes [or |
| | A. | [Computer class? |
| ] | | Right bracket (optional): end of overlap or interruption |
| = | | Equal signs: no break or pause. |

== Two equal signs indicate no break between the lines. One equal sign may be lined up above the other; or, one may appear at the end of one line and one at the beginning of the next.

A. one day=
S. =yah (.)
T.

\- Dash: speech is cut off.

A. All in the box. It all stays in the box-
no ! Get out! Can anybody hear me?

yah Underscoring denotes a louder voice or other stress, as in a slight rising inflection.

U. Yea::h, Pe:te!

**dit** Bolded text denotes an even louder voice or other form of exaggeration:

P. **dit dit dit dit**

F. That said it closed down (.) i:m properly=

:: Colons indicate prolongation of the prior sound. The longer the colon row, the longer the prolongation.

N. She lo::ves using the computer.

< Angle brackets (carets, greater than signs) surrounding text and pointing inward: speech is said more quickly relative to other utterances.

S. >very cool very cool<

<> Angle brackets (carets, greater than signs) surrounding text and pointing outward: speech is said more slowly relative to other utterances.

<and you ca::n't kill it>

( ) Empty parentheses or with the word "inaudible" indicate something not heard by the transcriber.

(yah?) Parenthesized words are guesses on the part of the transcriber.

° ° Degree signs indicate something said very quietly.

F. °Let me show you.°

{} Curly brackets indicate context.

{Context: mentor is looking at computer.}

(( )) Doubled parentheses contain descriptions of sounds other than speech.

Pauses are measured approximately.

New lines and micropauses (.) are about .1 second.
A number within parentheses, such as (2.5), is also approximate.
Some pauses were the result of engagement with the computer. Where this engagement was audible, it was transcribed with an explanation in double parentheses, as for example ((clicking)).
Silences longer than a few seconds were coded by approximate length or by an explanation within double parentheses: ((extended silence)).

**References**


Andrews, S. S., DiGangi, S. A., & Jannasch-Pennell, A. (1999). Technology and the homeless/formerly homeless. Paper presented at the Annual Convention of the Association for Educational Communications and Technology, Los Angeles, California.

Andrews, S. S., DiGangi, S. A., Jannasch-Pennell, A., Wright, B., & Boland, T. (2000). Bridging the digital divide with art and technology. Paper presented at the Biannual Meeting of the United States Society for Education through Art, Tempe, AZ.

Annie E. Casey Foundation. (1998). Computer and communications use in low-income communities: Models for the neighborhood transformation and family development initiative. Newton, MA: Education Development Center, Inc.

Apple Classroom of Tomorrow. (1995). Changing the conversation About teaching, learning & technology: A report on 10 years of ACOT research. Cupertino, CA: Apple Computer. Retrieved November 18, 2003, from http://www.apple.com/education/k12/leadership/acot/library.html

Babbie, E. (1998). The practice of social research. NY: Wadsworth.

Bandura, A. (1971). Social learning theory. New York: General Learning Press.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review, 84(2), 191-215.

Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1994). Self-Efficacy. In V. S. Ramachaudran (Ed.), Encyclopedia of human behavior (Vol. 4, pp. 71-81). NY: Academic Press.

Bandura, A. (1995). Guide for constructing self-efficacy scales.

Bandura, A. (1997). Self-efficacy: The exercise of control. NY: W.H. Freeman.

Bandura, A. (2001). Guide for constructing self-efficacy scales. (2nd ed.).

Betz, N. E., & Hackett, G. (1981). The relationship of career-related self-efficacy expectations to perceived career options in college women and men. Journal of Counseling Psychology, 28, 399-410.

Betz, N. E., & Hackett, G. (1998 [rev.]). Manual for the occupational self-efficacy scale Retrieved November 27, 2003, from http://seamonkey.ed.asu.edu/~gail/occse1.htm

Cary, S.G., Bristol, J.E., Chakravarty, A., Chalmers, A.B., Edgerton, W.B., Freeman, H.A. & Gilmore, R.(1955). Speak truth to power: A Quaker search for an alternative to violence. Washington, DC: American Friends Service Committee. Retrieved October 4, 2004, from http://www.quaker.org/sttp.html

Charlton, J.I. (2000). Nothing about us without us: Disability empowerment and oppression. Los Angeles: University of California Press.

Chow, C., Ellis, J., Walker, G., & Wise, B. (2000). Who goes there? Longitudinal case studies of twelve users of community technology centers. Newton, MA: CTCNet Research and Evaluation Team, Education Development Center, Inc.

CTCNet. (n.d.). Community Technology Centers' Network (CTCNet). Retrieved Jan. 25, 2003 from http://ctcnet.org

Diaz-Bone, R. (2003). Entwicklung im Feld der foucaultschen Diskursanalyse [Developments in the field of Foucauldian discourse analysis]. Forum Qualitative Sozialforschung/Forum: Qualitative Social Research [On-line Journal]. 4(3), Retrieved November 18, 2003, from http://www.qualitative-research.net/fqs-texte/3-03/03-03review-diazbone-d.htm

Digital Divide Network. (n. d.). Access. Retrieved July 30, 2003, from http://digitaldividenetwork.org/content/sections/index.cfm?key=3

Edelsky, C. (1981). Who's got the floor? Language in Society, 10, 383-421.

Fairclough, N. (1989). Language and Power. NY: Longman.

Fals Borda, O. (1995, April 8). Research for social justice: Some North-South convergences. Paper presented at the Plenary address at the Southern Sociological Society Meeting, Atlanta, GA.
Fine, M., Boudin, K., Bowen, I., Clark, J., Hylton, D., Migdalia, M., Missy, Rivera, M., Robers, R. A., Smart, P., Torre, M. E., & Upegui, D. (2001, June 22-24). Participatory action research: From within and beyond prison bars. Paper presented at the Bridging the Gap: Feminisms and Participatory Action Research Conference, Boston College, MA. Retrieved Oct. 10, 2003 from http://www.wnum.org/gap/fine.htm.
Foucault, M. (1972). The archeology of knowledge; and, The discourse on language (A. M. S. Smith & R. Swyer, Trans.). NY: Pantheon.
Freire, P. (1970, 1993, 2000 [with new introduction by Donaldo Macedo]). Pedagogy of the oppressed. NY: Continuum.
Freire, P. (1994). Pedagogy of hope. NY: Continuum.
Freire, P. (1998). Pedagogy of the heart. NY: Continuum.
Fricke, M. (1999). Diskussion neuerer Foucault-basierter Verfahren der Diskursanalyse anhand von empirischen Analysen von Printmedientexten. [Discussion of recent Foucault-based practices in discourse analysis with regard to empirical analyses of printed media texts]. Unpublished dissertation. University of Oldenburg, Oldenburg, Germany.
Garfinkel, H. (1967). Studies in ethnomethodology. Englewood Cliffs, NJ: Prentice Hall.
Glassner, I., & Bridgman, R. (1999). Braving the street: The anthropology of homelessness. NY: Berghahn.
Glesne, C., & Peshkin, A. (1992). Becoming qualitative researchers: An introduction. White Plains, NY: Longman.
Goffman, E. (1959). The presentation of self in everyday life. Garden City, NY: Doubleday.
Hackett, G. & Betz, N. E. (1981). A self-efficacy approach to the career development of women. Journal of Vocational Behavior, 18(3), 321-339.
Homeless People's Network. (1997-2003). Archives. Arizona State University. Retrieved Aug. 4, 2003, from http://aspin.asu.edu/hpn/
Hundt, R. (2003, July 8). The ineluctable modality of broadband. Unpublished manuscript, Washington, DC.
Jefferson, G. (1984). Transcript notation. In J. Heritage & J. M. Atkinson (Eds.), Structures of social action: Studies in conversation analysis. (pp. ix-xvi). Cambridge, UK: Cambridge University Press.
Jefferson, G. (1985). An exercise in the transcription and analysis of laughter. In T. van Dijk (Ed.), Handbook of discourse analysis: Volume 3/Discourse and dialogue (pp. 25-34). London: Academic Press.
Kennedy Cuomo, K. & Adams, E. (2004). Speak truth to power: Human rights defenders who are changing our world. NY: Umbrage.
Lemke, J. L. (1998). Analyzing verbal data: Principles, methods, and problems. In B. Fraser & K. Tobin (Eds.), The international handbook of science education. (pp. 1175-1189). Dordrecht: Kluwer.
Mark, J., Cornebise, J., & Wahl, E. (1997). Community technology centers: Impact on individual participants and their communities. Newton, MA: Education Development Center, Inc. Retrieved November 9. 2003 from http://www.ctcnet.org/eval.html.
Moser, H. (1977). Praxis der Aktionsforschung : Ein Arbeitsbuch. [The praxis of action research: A workbook.]. München: Koesel.
Narayan, D., Patel, R., Schafft, K., Rademacher, A., & Koch-Schulte, S. (2000). Voices of the poor: Can anyonehear us? NY: Oxford University Press.
National Telecommunications and Information Administration. (1995). Falling through the net: a survey of the "have nots" in rural and urban America. Washington, DC: Dept. of Commerce.
National Telecommunications and Information Administration. (1998). Falling through the net II: New data on the digital divide.. Washington, DC: Dept. of Commerce.
National Telecommunications and Information Administration. (1999). Falling through the net: Defining the digital divide. Washington, DC: Dept. of Commerce.
National Telecommunications and Information Administration. (2000). Falling through the net: Toward digital inclusion. Washington, DC: Dept. of Commerce.
National Telecommunications and Information Administration. (2002). A nation online: How Americans are expanding their use of the Internet. Washington, DC: Dept. of Commerce.
Ochs, E. (1979). Transcription as theory. In E. O. B. Schieffelin (Ed.), Developmental pragmatics. (pp. 43-72). NY: Academic Press.
Pinkett, R. D. (2000). Bridging the Digital Divide: Sociocultural constructionism and an asset-based approach to community technology and community building. Paper presented at the Paper presented at the 81st Annual Meeting of the American Educational Research Association (AERA), April 24-28, 2000, New Orleans, LA.

Pinkett, R. D. (2002). The Camfield Estates-MIT Creating Community Connections Project: High-technology in a low- to moderate-income community. In Lazar, J. (Ed.), Managing IT/Community Partnerships in the 21st Century. Hershey Park, PA: Idea Publishing Group.
Resmer, M., Mingle, J.R. & Oblinger, D. (1995). Computers for all students: A strategy for universal access to information resources. Denver: State Higher Education Executive Officers.
Riley, R. W. (2000, July 3). Keynote: Connecting at the crossroads. Paper presented at the National Educational Computing Conference, Atlanta, GA.
Sacks, H., Schegloff, E.A. & Jefferson, G. (1974). A simplest systematics for the organization of turn-taking for conversation. Language, 50, 696-735.
Sacks, H., Schegloff, E. & Jefferson, G. (1978 [1974]). A simplest systematics for the organization of turn-taking for conversation. In J. N. Schenkein (Ed.), Studies in the organization of conversational interaction (pp. 7-55). New York: Academic Press.
Sacks, H. (1992). Lectures on conversation (Vol. I). Oxford: Blackwell.
Schegloff, E. A., & Sacks, H. (1973). Opening up closings. Semiotica, 7, 289-327.
Sohng, S. S. (1996). Participatory research and community organizing. Journal of Sociology and Social Work, 23(4), 77-97.
Stock, E. (2001). Computers for youth: Why it makes sense to focus digital divide efforts on the home. Retrieved April 4, 2001, from http://www.benton.org/DigitalBeat/db022201.html
Stokrocki, M. (1997). Qualitative forms of research methods. In La Pierre, S. D. & Zimmerman, E. (Eds.), Research methods and methodologies for art education. Reston, VA: National Art Education Association.
United States Department of Education. (2003a, October 29). Press release. US Dept. of Education. Retrieved October 29, 2003, from http://www.ed.gov/news/pressreleases/2003/10/10292003a.html
United States Department of Education. (2003b). Internet access in U.S. public schools and classrooms: 1994-2002. Washington, DC: Institute of Education Sciences.
United States Department of Education. (2003c). Computer and Internet use by children and adolescents in 2001. Washington, DC: Institute of Education Sciences.

# Secondary School Students' Readiness for E-learning

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Computers and computer-based technologies have made an incredible impact on societies and cultures. This impact has made dramatic changes in the field of education as well. Today, computers are common tools in almost every school and are being used increasingly in all subject areas. Especially universities which offer distance education programs are using computers and online technologies as a main medium to deliver instruction. Also, primary and secondary schools offer computer related courses to their students to prepare them for higher education.

The purpose of this study is to reveal the extent of secondary education (Lycee) students' readiness for e-learning. E-learning as a form of distance education has become one of the essential movements in higher education. Almost all of the higher education institutions in Turkey as well as the rest of the world have been trying to offer e-learning opportunities for their students. However success in e-learning largely depends on learners' e-readiness. Literature provides tools and variables for measuring e-readiness. For instance, level of students' self-efficacy for online technologies can be used to predict their success in e-learning.

**Background**

Distance education is not a new approach in the world of education. For many years various types of courses and programs have been developed and delivered for the distance learners in the world. In Turkey, Anadolu University has been doing distance education for more than twenty years. The university, now, has around 1.000.000 distance students in its system. The student population is so big and will be much bigger in a near future because of the rapid growth of young population in Turkey who can not get higher scores from the university entrance exam and or want to be distance students for any other reasons.

In this system, the university has been using mainly a basic text based system to deliver information. In addition to the text based system, the university has been using television and radio programs (sometimes live, basically from the stored video and sound) to support the information basically given by the texts. The university has begun to use web supported information delivery systems to help the learners for better understanding the contents. Also, for more than three years (started in 2001); the university has some fully online degree programs for the distance students.

Use of the Internet for learning is a new issue in Turkish Educational System. There is a big need to know the students thoughts and attitudes before they enter to the system. Especially their readiness for e-learning is a big issue for instructional designers to develop effective and efficient courses and programs.

Bandura (1977) was the first user of the term self-efficacy. He has defined self-efficacy as "self-assessment of ability to master a task or achieve mastery over a specific situation or people's judgements of their capabilities. It is concerns not with the skills one has about a subject but with judgements of what one may do with whatever skills one possesses" (Bandura, 1986, p. 391). Therefore, the concept of self-efficacy was context specific.

The term self-efficacy has been extended to particular domains, including the use of computers or computer self-efficacy. According to Compeau and Higgins (1995), computer self-efficacy has a major impact on an individual's expectations towards using computers. In addition to this, Oliver and Shapiro (1993) said that an individual who did not see himself or herself as a good user were less likely to use computers. Computer self-efficacy and e-readiness may be connected in this context. If an individual feel comfortable himself or herself toward the computer, it could be said that the individual is ready to use computer or to deal with computer in a specified context.

According to Arani (2001), several research studies have investigated computer self-efficacy, using a variety of measures to study different subject groups. The computer self-efficacy scale created by Murphy et al. (1989) is used by many researchers. The Murphy scale was developed to measure individuals' self perceptions of accomplishments surrounding particular computer-related skills and knowledge. The 32-item scale is composed of three different levels of computing skills: Beginner's level, advanced level, and a level associated with mainframe computers. Miltiadou and Yu (1999) have been developed online technologies self-efficacy scale and tested to validate the scale on 330 college level students. The researchers indicated that the Cronbach's Coefficient Alpha for the instrument was 0.95. With minor modifications, items from Miltiadou and Yu scale was chosen and used to gather information regarding high school students' readiness for e-learning in this study to inform instructional designers endeavouring to create and design effective, efficient, appealing, and successful Internet-delivered courses for new generation students.

Wallace (1999), in his major study of computer self-efficacy, has argued that there were very few studies at the school level, and he suggested that it would be useful to conduct studies of computer-self efficacy in specific subject groups. The results of this research will indicate Turkish high school students' levels of e-readiness and the levels of self-efficacy toward the computer and online designed courses and programs. Peoples who are designing the university level courses and degree programs may get some benefit from the research.

The present study examined self-efficacy levels of secondary education (Lycee) students' toward online technologies to be able to measure their readiness for e-learning in higher education.

The study investigated the following research questions:

1. What is the current state of computer skills of students?
2. Do the students' characteristics (gender, grade level, school type) have any effect on their computer self-efficacy?

## Method

### Participants

Two hundred ninety two students from two different types of high school were the participants of the study. The majority of participants, 198 (67.8 percent), were from Anadolu high school that has selected students and was teaching intensively science related courses while the remaining 94 (32.2 percent) students were from ordinary high school that has normal (50 percent science, 50 percent literature and social courses) curriculum.

### Procedures

Data was collected in June, 2005. Survey was distributed and collected during normally scheduled class times and took 10 to 15 minutes to complete.

### Instrument

The instrument consisted of 30, 5-point Likert-scaled items. For each of them, students were asked to indicate their level of confidence from 1=not confident at all to 5=very confident. The 3.41 mean score identified as the expected level of confidence with the item while other responses enables the students to show higher or lover level of confidence. The 3.41 mean average was determined after identifying the critical level: 4 intervals/5 categories = 0.8. The instrument, also, has four subscales 1) Internet Competencies, 2) Synchronous Interaction, 3) Asynchronous Interaction I, and 4) Asynchronous Interaction II.

Table 1: Internet Competencies Subscale

| *I feel confident…* |
| --- |
| *1. Opening a web browser (e.g. Explorer or Netscape)* |
| *2. Reading text from a web browser* |
| *3. Clicking on a link to reach a specific web site* |
| *4. Accessing a specific web site by typing the address (URL)* |
| *5. Bookmarking a web site* |
| *6. Printing a web site* |
| *7. Conducting an Internet search using one or more keywords* |
| *8. Downloading (saving) an image from a web site to a disk* |
| *9. Copying a block of text from a web site and pasting it to a document in a word processor* |
| *10. Creating a simple web page with text, images, and links* |

Table 2: Synchronous Interaction Subscale

*I feel confident…*

*11. Providing a nickname within a synchronous chat system (if necessary)*

*12. Reading messages from one or more members of the synchronous chat system*

*13. Answering a message or providing my own message in a synchronous chat system (one-to-many interaction)*

*14. Interacting privately with one member of the synchronous chat system (one-to-one interaction)*

Table 3: Asynchronous Interaction Subscale I

*I feel confident…*

*15. Logging on and off an e-mail system*

*16. Sending an e-mail message to a specific person (one-to-one interaction)*

*17. Sending one e-mail message to more than one person at the same time*

*18. Replying to an e-mail message*

*19. Forwarding an e-mail message*

*20. Deleting messages received via e-mail*

*21. Creating an address book*

*22. Saving a file attached to an e-mail message to a local disk and then viewing the contents of that file*

*23. Attaching a file (image or text) to an e-mail message and then sending it off*

Table 4: Asynchronous Interaction Subscale II

*I feel confident…*

*24. Signing on and off an asynchronous conferencing system*

*25. Posting a new message to an synchronous conferencing system*

*26. Reading a message posted on an asynchronous conferencing system*

*27. Replying to a message posted on asynchronous conferencing system so that all members can view it (reply to all)*

*28. Replying to a message posted on asynchronous conferencing system so that only one member can view it (reply to sender)*

| | |
|---|---|
| | *29. Downloading a file from an asynchronous conferencing system to a local disk*<br><br>*30. Uploading (sending) a file to an asynchronous conferencing system* |

Table 5: Gender

| Gender | Frequency | Percent |
|---|---|---|
| Male | 139 | 47.6 |
| Female | 153 | 52.4 |
| *TOTAL* | *292* | *100* |

Table 6: School type

| School type | Frequency | Percent |
|---|---|---|
| Ordinary high school | 94 | 32.2 |
| Anadolu high school | 198 | 67.8 |
| *TOTAL* | *55* | *100* |

Table 7: Grade level

| Grade | Frequency | Percent |
|---|---|---|
| 9th grade | 180 | 61.6 |
| 10th grade | 112 | 38.4 |
| *TOTAL* | *55* | *100* |

The mean scores, standard deviations, and t-tests analysis were used to interpret the data gathered via the survey instrument. The Cronbach's Coefficent Alpha for the instrument was 0.95.

**Results and Discussions**

***What is the current state of computer skills of students?***

The first research question was about the current state of computer skills of students. Table 8 shows overall mean scores of the students' responses to each subscale. According to the findings, the students were confident with their computer skills on each subscale. First skill was about the Internet competencies ($M=3.86 > M_{els} = 3.41$). From this finding, it can be said that the students were feel themselves comfortable with the Internet options of computer. The second skill was about synchronous interaction on the net ($M=3.80 > M_{els} = 3.41$). From this finding, it can be said that the students were comfortable with the synchronous communication via the computer. The third skill was about asynchronous interaction on the net (M=3.92 >

$M_{els}$ = 3.41). From this finding, it can be said that the students were using e-mail regularly and comfortable with the asynchronous communication. The last skill was about asynchronous interaction also (M=3.46 > $M_{els}$ = 3.41). From this finding, it can be said that the students were using computer conferencing system, subscribe and unsubscribe from groups and felt comfortable themselves with the asynchronous communication. Overall, the students were good at communicating via the computer.

Table 8: Mean and standard deviation scores of confidence subscales

| Subscales | N | M | SD |
|---|---|---|---|
| Internet Competencies | 292 | 3.86 | .95 |
| Synchronous Interaction | 292 | 3.80 | 1.06 |
| Asynchronous Interaction I | 292 | 3.92 | 1.03 |
| Asynchronous Interaction II | 292 | 3.46 | 1.08 |

***Do the students' characteristics (gender, grade level, school type) have any effect on their computer self-efficacy?***

The second question of the study investigated the differences occur in the students' overall computer skills due to their characteristics such as gender, grade level, and school type. An independent sample t-test analysis has been conducted to see if gender makes any differences in the students' computer skills. The results of the analysis summarised in table 9.

According to the results male students scored higher than female students. Internet competencies subscale was significant (t= -2.18, DF=290, p=0.30) and asynchronous interaction II was significant also (t= -2.18, DF=290, p=0.30). For both subscales mean number gap between male and female students were higher than other subscales. Other computer skill types between females and males were not significant.

Table 9: t-test results for gender effect

| Subscales | Gender | N | M | SD | Df | Sig. (2-Tailed) |
|---|---|---|---|---|---|---|
| Internet Competencies | Female | 153 | 3.75 | .91 | 290 | .030* |
| | Male | 139 | 3.99 | .98 | | .031* |
| Synchronous Interaction | Female | 153 | 3.72 | .98 | 290 | .213 |
| | Male | 139 | 3.88 | 1.14 | | .216 |
| Asynchronous Interaction I | Female | 153 | 3.87 | .96 | 290 | .394 |
| | Male | 139 | 3.97 | 1.11 | | .398 |
| Asynchronous Interaction II | Female | 153 | 3.33 | 1.02 | 290 | .030* |
| | Male | 139 | 3.60 | 1.12 | | .031* |

An independent sample t-test analysis has been conducted to see if school types make any differences in the students' computer skills. The results of the analysis summarised in table 10.

According to the results asynchronous interaction II was significant (t= 2.51, DF=290, p=0.13). Other computer skill types between schools were not significant.

Table 10: t-test results for school type effect

| Subscales | School Type | N | M | SD | Df | Sig. (2-Tailed) |
|---|---|---|---|---|---|---|
| Internet Competencies | OHS | 94 | 3.85 | .91 | 290 | .850 |
| | AHS | 198 | 3.87 | .98 | | .836 |
| Synchronous Interaction | OHS | 94 | 3.87 | .98 | 290 | .417 |
| | AHS | 198 | 3.76 | 1.14 | | .370 |
| Asynchronous Interaction I | OHS | 94 | 3.84 | .96 | 290 | .388 |
| | AHS | 198 | 3.95 | 1.11 | | .337 |
| Asynchronous Interaction II | OHS | 94 | 3.69 | 1.02 | 290 | .013* |
| | AHS | 198 | 3.35 | 1.12 | | .007* |

OHS: Ordinary high school, AHS: Anadolu high school

An independent sample t-test analysis has also been conducted to see if grade level makes any differences in the students' computer skills. The results of the analysis summarised in table 11.

According to the results computer skill types between 9th and 10th grades were not significant. But the 10th graders scored higher than the 9th graders. The reason for this can be the older students have more experienced than the younger ones.

Table 11: t-test results for grade level effect

| Subscales | Grade Level | N | M | SD | Df | Sig. (2-Tailed) |
|---|---|---|---|---|---|---|
| Internet Competencies | 9th grade | 181 | 3.82 | .90 | 290 | .32 |
| | 10th grade | 111 | 3.93 | 1.02 | | .33 |
| Synchronous Interaction | 9th grade | 181 | 3.78 | .98 | 290 | .79 |
| | 10th grade | 111 | 3.82 | 1.18 | | .80 |
| Asynchronous Interaction I | 9th grade | 181 | 3.84 | .96 | 290 | .10 |
| | 10th grade | 111 | 4.04 | 1.13 | | .11 |
| Asynchronous Interaction II | 9th grade | 181 | 3.43 | 1.04 | 290 | .49 |
| | 10th grade | 111 | 3.51 | 1.14 | | .50 |

## Conclusions

This descriptive study reveals self-efficacy levels of secondary education (Lycee) students' toward online technologies to be able to measure their readiness for e-learning in higher education. This research is just a beginning to learn and understand the younger generations' skills on the computer technologies. According to findings, high school students' seems to be ready for online delivered education. As expected, high school students' confidences in their use of computers are quite high and there is no big gap between male and female students. But the pedagogical issues should be investigated in further researches. Online courses should be designed to deal with a wide range of student computer skills so as not to overwhelm low skill students with higher skill levels.

## References


Arani, O. K. (2001). Researching computer self-eficacy. International Education Journal, 2 (4).

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review, 84 (2), 191-215.

Bandura, A. (1986). Social Foundations of Thought and Action. NJ: Prentice Hall.

Compeau, D.R., & Higgins, C.A. (1995) Computer self-efficacy: Development of a measure and initial test. MIS Quarterly, 19 (2), 189-212.

Kim, C.Y. (2002). Teachers in digital knowledge-based society: New roles and vision. Asia Pacific Education Review, 3 (2), 144-148.

Miltiadou, M.,& Yu, C., (1999). Validation of the online technologies self-efficacy scale (OTSES). ERIC Document Reproduction Service No: ED445672).

Murphy, C.A., Coover, D., ve Owen, S.V. (1989). Development and validation of the computer self–efficacy scale. Educational and Psychological Measurement, 49, 893-899.

Newby, T.J., Stepich, D. A., Lehman, J.D., & Russell, J. D. (1996). Instructional technology for teaching and learning. New Jersey: Englewood Cliffs.

Oliver, T.A.,& Shapiro, F. (1993). Self-efficacy and computers. Journal of Computer Based Instruction, 20 (3), 81-85.

Owtson, R.D. (1997). The World Wide Web: A technology to enhance teaching and learning? Educational Researcher, 26 (2), 27-33.

Tapscott, D. (1997). The digital economy: Promise and peril in the age of networked intelligence. New York: McGraw-Hill.

Wallace,A.R. (1999). An exploratory study of the factors influencing the construction of computer self-efficacy. Unpublished doctoral thesis, Charles Sturt University.

# Modular Object-Oriented Dynamic Learning Environment: What Open Source Has To Offer

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Open source online learning environments have emerged and developed over the past 10 years. In this paper we will analyze the underlying philosophy and features of MOODLE based on the theoretical framework developed by Hannafin and Land (2000). Psychological, pedagogical, technological, cultural, and pragmatic foundations comprise the framework and represent the major points of our analysis. This paper is intended for instructional designers, distance education specialists, K-12 and college instructors who may want to add an online component to their courses.

> **As we enjoy great Advantages from the Inventions of others we should be glad of an Opportunity to serve others by any Invention of ours, and this we should do freely and generously.**
> ***~ Benjamin Franklin***

### Introduction

Benjamin Franklin's philosophy resonates in the recent advent of *open source* software. The term "open source" refers to computer programs or operating systems for which the source code is publicly available. (Johnson-Eilola, 2002) The definition further explains that inherent in the open source philosophy is the freedom of a distributed community of programmers to modify and improve the code (Perens, 1999).

Open source software promotes the use of technologically-neutral, non-proprietary tools and formats, which allow for wide-spread access. According to the Open Source Initiative website (2004), the major reasons for utilizing open source software include free distribution, freedom to modify the software to meet individual needs, cross-platform compatibility and universal accessibility, and active collaboration to improve design. These factors bear a special significance in an educational setting. As Terry Vessels (2004) puts it:

> …Educators have been called upon throughout history to combat censorship imposed by various powers over the flow of information. The censorship being applied today comes in the form of licenses that lock away the tools to build the information age and laws that limit fair use in ways that are unprecedented in the modern era (¶ 2).

The open source movement has already had a significant impact in the business world (Wheeler, 2003), and is now drawing the attention of educators around the globe. Distance education is at the forefront of using and creating open source applications in education.

Current advances in open source online learning environments are a response to the shortcomings of commercial products like WebCT and Blackboard. One such weakness is a lack of flexibility in designing and adding customized learning modules. With commercial products one can only include elements that the software designers deemed necessary when they developed the program. With an open source learning environment it is possible to download and use any learning module one might find on any open source software website. This opens almost limitless capabilities for the user to customize the application by choosing from a variety of options for e-mail, discussion boards, chat, online quizzes, and all the other elements one might want to include.

Further, as the open source definition suggests, the actual code can be modified and improved to meet individual needs. So, if the user decides that an open source module he or she found is *almost* perfect, the code can be modified to meet his or her needs. Look, feel and functionality can all be changed since the code can be easily accessed and modified.

As to pricing of commercial products, “companies are moving toward selling campuswide access to software, and toward setting prices based on the number of students each college enrolls.” (Young, 2002) According to Young, “… the company's [WebCT] current software costs $3,000 to $30,000 annually, depending on the size of the institution and the level of use of the software.” This is particularly important with seemingly continual decreases in federal and state appropriations for higher education. All open source software, on the other hand, is available free of charge to anyone who wants to use it.

Shortcomings of commercial distance education software have prompted the development of a number of open source online learning environments such as MOODLE, EduCreate, Covidia, and LogiCampus. Concurrently, the open source concept has developed to the point that even the tools used to create such systems are open source. For example, most of this software is written in Hypertext Preprocessor (PHP)  an open source alternative to commercial scripting languages and make use of open source relational database systems like MySQL. They can be installed on almost any web server—the most popular being Apache (again, open source). One open source online learning environment, Modular Object-Oriented Dynamic Learning Environment (MOODLE) is a highly usable, reliable, and functional alternative to popular commercial products like WebCT and Blackboard. Developed by Martin Dougiamas, a PhD student in Computer Science and Education at Curtin University of Technology, Australia, this learning environment provides the considerable flexibility inherent in open source software for designing and administering Web-based courses to meet the individual needs of online educators. It was specifically developed to address the aforementioned shortcomings of commercial online learning environments—which he had used and supported in his own teaching and as a technician working with faculty. In his own words:

> … It started in the 90's when I was a webmaster at Curtin University of Technology and a system administrator of their WebCT installation. I encountered many frustrations with the WebCT beast and developed an itch that needed scratching – there had to be a better way (no, not Blackboard :) (Dougiamas, 2004, ¶ 2).

**Analysis of MOODLE**

Dougiamas decided to create his own online learning environment in the open source format and allow the open source community to help develop and refine his ideas. MOODLE was designed to support and promote users interested in developing constructivist, student-centered learning environments (Dougiamas, 2004). To examine this claim, we conducted an analysis of MOODLE using a framework developed by Land and Hannafin (2000) which was initially designed as a guide for developing constructivist learning environments.  According to the authors, “Learning environments, directed as well as constructivist, are rooted in five core foundations: psychological, pedagogical, technological, cultural, and pragmatic” (Hannafin & Land, 1997). Figure 1 highlights the five components of these core foundations as applied to the design of student-centered learning environments.

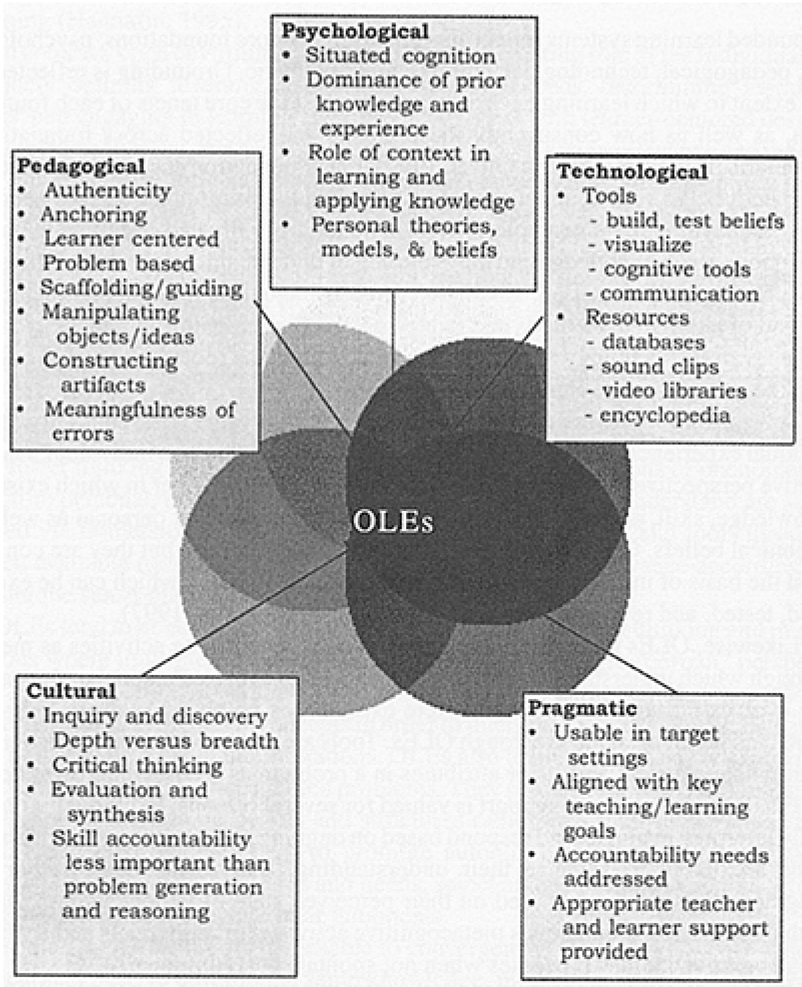


*Figure 1:* Five core foundations of student-centered learning environments (Hannafin & Land, 1997)

In the remainder of the paper we will relate each of Hannafin and Land's core foundations to the underlying philosophy and principles that guided the development of MOODLE.

**Psychological Foundations**

Psychological foundations address research, theory and practice associated with how people think and learn. Our examination of the program shell and standard MOODLE learning modules reflect the designers' use of several important considerations from cognitive psychology:

Situated cognition suggests effective learning should involve immersing students in authentic activity and culture in a real-world learning context. (Brown, Collins, & Duguid, 1989). Relevance is enhanced through interconnected, embedded engagement with interesting and complex tasks situated in an authentic context. Situated learning integrates four critical factors that maximize student learning potential: content, context, community, and participation (Stein, 1998). MOODLE learning modules allow instructors to set up complex, ill-defined and authentic tasks in real-life contexts, and assign roles for students to assume in the solution of these problems. For example, the *Workshop* module allows students to collaborate on the design of possible solutions to an authentic problem and peer assess the suggested solutions. The instructor might decide to have students work individually or in groups to determine where to build an alternate route to help alleviate traffic accidents at a specific intersection. In the *Resource* module the instructor can scaffold the activity by providing area maps, different perspectives on the problem (e.g. interviews with Department of Transportation experts), and sample solutions devised by other states or counties. Students can brainstorm possible solutions in *Chat* or *Discussion* forums, then present their alternate routes via the *Workshop* module, which allows for peer assessment. Thus, learners will compare and contrast their solutions and select the best one based on the group discussions.

Cognitive flexibility is defined as “the ability to adaptively re-assemble diverse elements of knowledge to fit the particular needs of a given understanding or problem-solving situation” (Spiro & Jehng, 1990). This theory focuses on learning in complex and ill-structured domains—which represent many real-life situations. “A central claim of cognitive theory is that revisiting the same material, at different times, in rearranged contexts, for different purposes, and from different conceptual perspectives is essential for attaining the goals of advanced knowledge acquisition” (Spiro, Feltovich, Jacobson, & Coulson, 1991). One of the major metaphors employed by the theory is that of a “… criss-crossed landscape, with its suggestion of a non-linear and multi-dimensional traversal of complex subject matter, returning to the same place in the conceptual landscape on different occasions, coming from different directions” (Spiro, Vispoel, Schmitz, Samarapungavan, & Boerger 1987; Wittgenstein, 1953). MOODLE supports the “criss-crossing of the conceptual landscape” through the Glossary learning module–a unique feature that allows users (both students and instructors) to create an online hypertext-based dictionary that is created on the fly and updates automatically to all content in the course or even throughout the entire portal. This module allows users to consult the glossary dynamically while navigating through the lesson content, assignments, or even discussion postings, but, perhaps more importantly, students take ownership for their learning as they actively construct a richer, more complex and sophisticated learning environment.

**Pedagogical Foundations**

Pedagogical foundations include the instructional practices that the designers use. They are grounded in theories of learning and reflect the teaching strategies with which they are aligned. MOODLE developers have explicitly stated that the design of the software is grounded in constructivist and constructionist instructional principles. In the following paragraph, Dougiamas (2004) discusses the importance of pedagogy and encourages educators to adopt the constructivist methodology:

> Once you are thinking about all these [pedagogical] issues, it helps you to focus on the experiences that would be best for learning from the learner's point of view, rather than just publishing and assessing the information you think they need to know. It can also help you realise how each participant in a course can be a teacher as well as a learner. Your job as a 'teacher' can change from being 'the source of knowledge' to being an influencer and role model of class culture, connecting with students in a personal way that addresses their own learning needs, and moderating discussions and activities in a way that collectively leads students towards the learning goals of the class. (¶ 13)

Constructivism implies that the learner links new information with existing and future-oriented knowledge in unique and meaningful ways (McCombs & Whisler, 1997). Social constructivism, a branch of this theory, emphasizes the value of knowledge that is built socially in a learning community. Pioneered by theorists like Vygotsky (1978), this paradigm argues for the importance of culture and context in forming understanding. Learning is not a purely internal process, nor is it a passive shaping of behaviors. Vygotsky favored a concept of learning as a social construct which is mediated by language via social discourse.

MOODLE promotes social discourse in learning through the synchronous and asynchronous communication modules described above. Internal support for introducing groups within a class of students in the learning environment is built into the program. Students can form cohorts themselves or the instructor can moderate this process. Within a cohort students work cooperatively and engage in a more individualized interaction with one another. Later, cohorts can share their perspectives in a whole class discussion and continue the learning process as a unified group. Although the program supports this type of instruction, the art of combining individual activities with cohort-based or whole-class activities is one of the factors that reflect the teaching skills of the instructor. An instructor may choose to integrate a discussion forum, chat or even a private two-way dialogue into any learning activity of the course. *Wiki* is the module that gives students and instructors the opportunity to collaborate on the design of hypertext that represents the knowledge constructed socially by the learning community of an individual class. A community of graduate students, for example, can thus work together on a literature review for a specific topic. The document is started when a student makes the first text entry. Other students modify this document to develop the ideas for the literature review. The system keeps track of each modifications and both students and instructor have the opportunity to see how the document developed over time, and who and how each person contributed. Younger learners might enter and revise class notes in a group *Wiki*, compare and revise the notes as a class, and create a useful resource for each other and for future students.

Constructionism (as opposed to Constructivism) asserts that that knowledge acquisition is particularly effective when constructing something for others to experience. Papert (1991), who started developing this concept in the 1980s, asserts that constructionism "…shares constructivism's connotation of learning as "building knowledge structures" irrespective of the circumstances of the learning. It then adds the idea that this happens especially felicitously in a context where the learner is consciously engaged in constructing a public entity, whether it's a sand castle on the beach or a theory of the universe." Constructionism stresses the importance of building external artifacts as a means to more effectively construct and represent the inner knowledge structures. The importance of learning through design is supported by the research on children's development of strategies and collaboration in video game design, building and learning with programmable bricks (Kafai & Resnick, 1996). In addition to the *Glossary* and *Wiki* examples provided earlier, MOODLE supports the construction of artifacts by allowing learners to present and share their knowledge in a variety of different formats, including multimedia and hypertext. These products can then be shared with others through *Discussion Forum*, *Resource* or *Assignment* modules. Further, as described above, the *Workshop* module promotes social construction of knowledge artifacts by allowing students to collaborate on the possible solutions to ill-structured real-world problems and evaluate them in the peer assessment activity.

**Technological Foundations**

Technological foundations affect how media can support, limit, or improve the pedagogy of the learning environment. According to Land and Hannafin (2000), "… technology can control the pacing and chunking of information where cognitive load limitations are assumed…"

MOODLE supports the pedagogy of the learning environment through its interactive, collaborative and reflective modules. For example, the Journal module allows the instructor to ask the students to reflect on a particular topic, and edit and refine their answer over time. This activity promotes self-assessment, critical thinking, and metacogntition. Learning journals entice students to think in unconventional ways (Fulwiler 1987) and provide an opportunity to both develop and capture reflection in the learning process (Moon, 1999).

Although the flexibility of hypertext systems is powerful, it may result in disorientation problems (Theng, 1997) and information overload (Niederhauser, Reynolds, Salmen & Skolmoski, 2000). The MOODLE shell provides a framework for presenting modules that accounts for these potential problems. It allows to structure and control the presentation of the learning material and decrease the risk of the "lost in hyperspace" problem (Boyle & Encarnacion, 1994). For example, each page of the portal has a quick-jump drop-down menu that allows users to navigate the system more efficiently. Users may also use the personalized navigation bar at the top of each page, which tracks and shows the history of previously viewed pages for each specific user. Extraneous cognitive load often occurs when instructional materials require learners to use cognitive resources to search for specific information without providing any scaffolds or quick and easy access to relevant resources (van Merrienboer, Kirschner, Kester, 2003). Information overload of learners is reduced through built-in support for adaptive hypertext navigation (Hook, 1997). Navigation in MOODLE is further enhanced via the use of the *Latest News* section, which allows instant access to the most recent discussion postings, news entries and assignments. A similar function is performed by the Calendar module that highlights the upcoming events, due dates and other information through simple mouse rollovers.

A major strength of using MOODLE lies in the inherent nature of open source software which promotes customization. With only a basic knowledge of web scripting one can add almost any open source stand-alone application to customize an online learning environment to meet individual needs. For example, more than half of the modules, visual themes, and administration features available in the current version of the program have been added by different members of the open source community. This brings us to the discussion of another important foundation of learning environments – the cultural aspect of design.

**Cultural Foundations**

Cultural foundations tend to reflect the prevailing values of a learning community. For instance, one might find particular values such as back to basics, interdisciplinary learning, or global society in a given learning environment. (Land & Hannafin, 2000)

The central ideas in the MOODLE culture are collaboration, sharing and community. They are represented in Dougiamas' (2004) discussion of social constructivism, one of the four major concepts in the underlying philosophy of MOODLE:

> [social constructivism] extends the above ideas into a social group constructing things for one another, collaboratively creating a small culture of shared artifacts with shared meanings. When one is immersed within a culture like this, one is learning all the time about how to be a part of that culture, on many levels. (¶ 9)

Virtual community is defined as a community of people sharing common interests, ideas, and feelings over the Internet or other collaborative networks (Rheingold, 2000). Members of a learning community also share the meanings that they make of the learning material. Social exchanges by individual students are an important part of the group interaction and learning. They help build a sense of trust and respect among community members (Lally & Barrett, 1999). Students in the MOODLE learning environment form a cultural community by interacting in synchronous and asynchronous discussion modules, *Journal* and the collaboration tools like *Workshop*, *Wiki* and *Glossary* discussed earlier.

Another aspect of community building associated with MOODLE involves those who are working to develop, refine, and support advancement of the program. The collaborative nature of designing and supporting open source applications like MOODLE reflects the important social aspect of software development and knowledge construction by integrating the diverse perspectives and expertise of the members of the international community working together to improve the quality of the software. The community of MOODLE developers and users bring multiple perspectives and skills and share their views on online learning in MOODLE discussion forums. This international collaborative effort results in a truly socially constructed design process, which enhances the quality of the software from both the pedagogical and technological perspective. For example, Williams Castillo, "a curious developer" from Caracas, Venezuela, contributed to this open source project by designing the Glossary module. He also maintains a discussion forum on creative uses of the Glossary. Further, the community works collaboratively to provide technical support for all of its members.

**Pragmatic Foundations**

As the name suggests, these foundations are concerned with doing a reality check. How does the learning environment correspond to the needs of target audiences? What are the benefits, and what are the limitations?

MOODLE is an open source online learning environment that is developed for the administrators of web-based courses for K-12 and university instructors. The system is efficient and features cross-platform compatibility and a low-tech browser interface. A highly relevant aspect of MOODLE for educators is that it is available as a free download on the Internet and can be installed in an hour. Even though one can administer the installation of MOODLE with just a basic knowledge of web interfaces, one should probably have experience managing database-driven dynamic websites.

With the software installed the creation and management of the learning environment can be performed by a person with limited technological expertise. MOODLE's creators realize that educators are not high-end developers and therefore all the administration is performed through a simple, intuitive graphical user interface (Figure 2). Help buttons are included for every component of the administration menu and provide guidance for novice users of the system.

Most text entry areas in MOODLE such as resources, forum postings, assignments etc. can be edited using an embedded WYSIWYG (What You See Is What You Get) HTML editor. The administrator (instructor) can allow or prohibit students to modify specific parts of the course, like journal entries. Further, MOODLE courses can be categorized and searched, allowing one MOODLE installation to support thousands of courses and function as a campus edition. Plug-in activity modules can be added to existing MOODLE installations and enhance the existing structure of the courses. Customizable themes allow the administrator to customize the site colors, fonts, layout, and other features to suit individual needs. MOODLE language packs allow full localization to 43 languages. Even the language packs can be easily edited using a built-in web-based editor. [Insert Figure 2 about here]

Technical support is freely available on the Web and is provided by MOODLE developers and users through discussion forums and Frequently Asked Questions section. Each learning module is supported by a separate discussion forum containing tips and tricks, teaching strategies, learning standards, course formats, and advice on how to build a strong learning community.

## Conclusion

Open source software has become increasingly popular in many areas. One such application, MOODLE, provides a constructivist learning environment that makes a significant contribution to enhance web-based learning.

As this paper demonstrates, the design of MOODLE integrates general principles of constructivist learning and provides an online learning context that supports student-centered pedagogy. This system is grounded in situated cognition and cognitive flexibility theory that provide the opportunity for an instructor to create a constructivist and constructionist environment to enhance teaching and learning. The capabilities to design student-centered learning are embedded in MOODLE and its modules; however, it is ultimately the responsibility of the instructor to make good use of them.

The MOODLE project indicates the growing interest of educators and open source programmers in joining their efforts to improve the quality and reduce the cost of education. Since it is distributed under the General Public License, MOODLE can be easily modified to meet individual needs. Further, development, customization, and support are all completed as part of the community effort to improve online teaching. This open source application provides an effective and cost-efficient alternative to expensive commercial software packages for those interested in joining the movement to provide high quality constructivist-based educational experiences in the online environment.

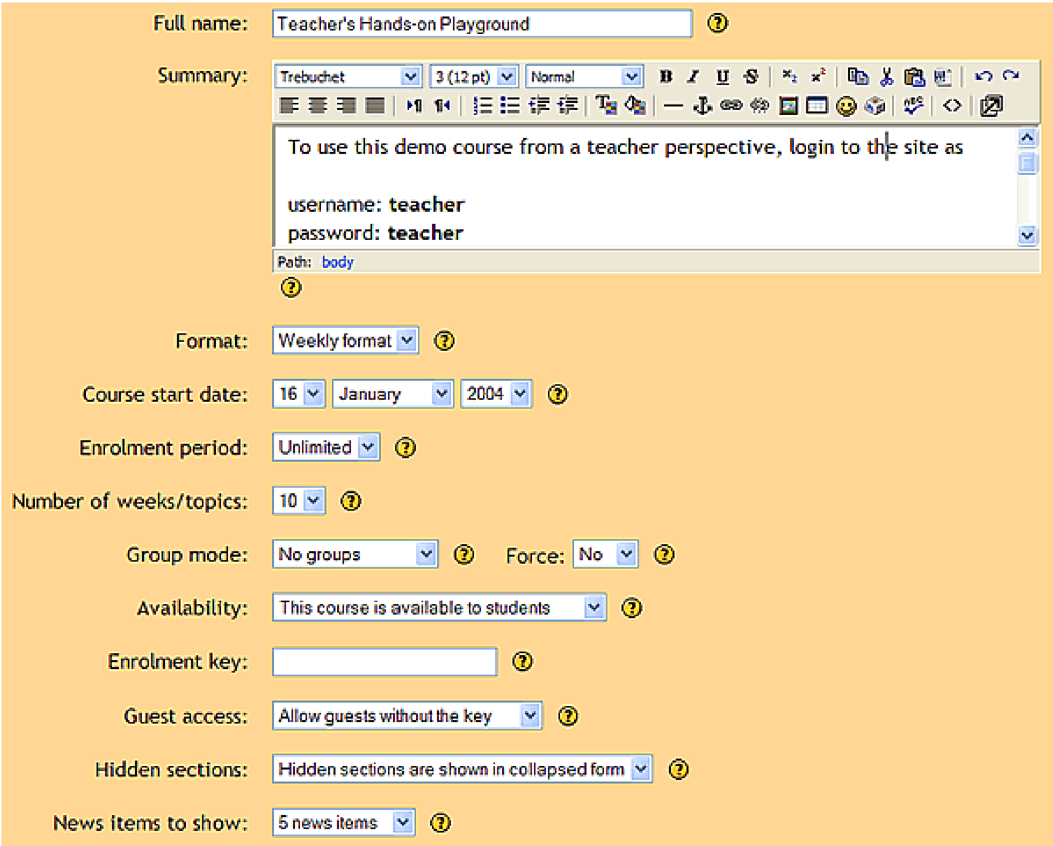


*Figure 2:* Screenshot of MOODLE course administration page

**References**

Beyer, B. K. (1991). Teaching *thinking skills: A handbook for secondary school teachers.* Boston, MA: Allyn and Bacon.

Boyle, C., & Encarnacion, A. (1994). Metadoc: An adaptive hypertext reading system. *User Modeling and User-Adapted Interaction*, *4*, 1-19.

Brown, J.S., Collins, A. & Duguid, P. (1989). Situated cognition and the culture of learning. *Education Researcher, 18(1),* 32-42.
Dougiamas, M., Taylor, P. (2003). MOODLE: Using learning communities to create an open source course management system. *Proceedings of the EDMEDIA 2003 Conference, Honolulu, Hawaii*.
Fulwiler, T. (1987) *The journal book*. Portsmouth, NH: Heinemann.
Hannafin, M.J., Hannafin, K.M., Land S.M., & Oliver K. (1997). Grounded practice in the design of learning systems. *Educational Technology Research and Development, 45*(3), 101-117.
Hannafin, M.J., & Land, S.M. (1997). The foundations and assumptions of technology-enhanced, student-centered learning environments. *Instructional Science, 25,* 167-202.
Hannafin, M.J., Land, S.M., & Oliver K. (1999). Open learning environments: Foundations, methods, and models. In C. Reigeluth (Ed.) *Instructional Design Theory and Models (Vol. 2)* (p.122). Mahwah, NJ: Lawrence Erlbaum Associates.
Hook K. (1997). Evaluating the utility and usability of an adaptive hypermedia system. *Proceedings of the 1997 International Conference on Intelligent User Interfaces*, 179-186.
Johnson-Eilola, J. (2002). Open source basics: Definitions, models, and questions. Proceedings of the 20th Annual International Conference on Computer Documentation, 79 – 83.
Kujawa, S., & Huske, L. (1995). *The strategic teaching and reading project guidebook*. Oak Brook, IL: North Central Regional Educational Laboratory.
Lally, V., & Barrett., E. (1999). Building a learning community online: Toward socio-academic interaction. *Research Papers in Education, 14(2),* 147-163.
Land, S.M., & Hannafin, M.J. (2000). Student-centered learning environments. In D. Jonassen (Ed.) *Theoretical Foundations of Learning Environments* (pp.1-19) Mahwah, NJ: Lawrence Erlbaum Associates.
McCombs, B. L., & Whisler, J. S. (1997). *The learner-centered classroom and school***.** San Francisco, CA: Jossey-Bass.
MOODLE Philosophy. (2004). In MOODLE Documentation. Retrieved April 7, 2004, from http://moodle.org/doc/?file=background.html
Moon, J, A. (2000). *Reflection in learning & professional development: Theory and practice*. Kogan Page.
Niederhauser, D. S., Reynolds, R. E., Salmen, D. J., & Skolmoski, P. (2000). The influence of cognitive load on learning from hypertext. *Journal of Educational Computing Research, 23,* 237-255.
Open Source Initiative. (2004). Retrieved April 8, 2004 from http://www.opensource.org
Papert, S., & Harel, I. (1991). *Constructionism*. Ablex Publishing Corporation.
Perens, B. (1999). The open source definition. In C. Dibona, S. Ockman, and M. Stone (Eds.), *Open sources: voices from the open source revolution.* O'Relly Press.
Rheingold, H. (2000). *The virtual community: Homesteading on the electronic frontier.* The MIT Press.
Spiro, R.J., Vispoel, W., Schmitz, J., Samarapungavan, A., & Boerger, A. (1987). Knowledge acquisition for application: Cognitive flexibility and transfer in complex content domains. In B.C. Britton (Ed.), *Executive control processes.* Hillsdale, NJ: Lawrence Erlbaum Associates.
Spiro, R.J., & Jehng, J.C. (1990). Cognitive flexibility and hypertext: Theory and technology for non-linear and multidimensional traversal of complex subject matter. In D. Nix and R.J. Spiro (Eds.), *Cognition, education, and multimedia: Exploring ideas in high technology* (pp. 163-205). Hillsdale, NJ: Lawrence Erlbaum Associates.
Spiro, R.J., Feltovich, P.L., Jacobson, M.J., & Coulson, R.I. (1991). Cognitive flexibility, constructivism, and hypertext: Random access instruction for advanced knowledge acquisition in ill-structured domains. *Educational Technology, 31(5),* 24-33.
Stein, D. (1998). Situated learning in adult education. *ERIC Digest, 195.* Retrieved April 10, 2004 from http://www.ericfacility.net/databases/ERIC_Digests/ed418250.html
Theng Y. L. (1997). Addressing the 'lost in hyperspace' problem in hypertext. *PhD Thesis,* School of Computing Science, Middlesex University.
Van Merrienboer, J.J.G., Kirschner, P.A., & Kester,L. (2003). Taking the load off the learner's mind: Instructional design for complex learning. *Educational Psychologist, 38,* 5-13.
Vessels, Terry (2004). Why should open source software be used in schools? Retrieved April 15, 2004 from http://edge-op.org/grouch/schools.html
Vygotsky, L. (1978). *Mind in society: The development of higher mental processes.* Cambridge, MA: Harvard University Press.

Young J.R. (2002). Pricing changes by Blackboard and WebCT cost some colleges more – much more. *The Chronicle of Higher Education.* Retrieved April 7, 2004 from http://chronicle.com/free/2002/03/2002031901u.htm

Wheeler, David (2003). Why open source software / free software (OSS/FS)? Look at the numbers! Retrieved April 5, 2004 from http://www.dwheeler.com/oss_fs_why.html

Wittgenstein, L. (1953). *Philosophical investigations.* New-York: Macmillan.

# MIDI Magic: Exploring the New World of Digital Music

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As the song goes, “Don’t know much about His-to-ry, don’t know much about Tech-no-lo-gy!” But what we do know is that music technology now plays a crucial role in most schools. Fully integrating this technology requires much greater awareness. From Mozart to Madonna, technology has forever changed the field of music. Although accessing music through the Web and through digital storage devices has been remarkably significant, perhaps to an even greater extent, music synthesizers and editing software have dramatically changed the very nature of music. Technology provides powerful aids to composing, notating, editing, and performing music that even elementary school students can learn to use.

If you've ever had an original song idea in your head and wished you could have it performed, MIDI is the way to do it. All you need is a MIDI Sequencer, plus a MIDI instrument to enter notes. You can also use MIDI Notation software to place notes on a musical staff without playing them at all. You can start with just a melody and then add backing chords, bass, and rhythm later, or add instruments in any order you like. If you make mistake, you can change it without having to play the part all over again. You can also make entire sections repeat without playing them again. And you can rearrange and re-orchestrate your song as many times as you like.

Many people enjoy arranging and orchestrating music as much as performing it. There are MIDI files available for songs from every style of music, as well as, software programs that generate the basic rhythm and chord patterns that define specific styles that you can use to create your own arrangements and orchestrations. Just change the instrumentation, add a verse or chorus here or there, even put in your own original phrase or section. All of this is easy to do with MIDI. You can also share your arrangements with others, who can then rearrange them. Many people download MIDI files from the Internet and arrange them to fit their own needs.

Band-in-a-Box (Image 1), described as an intelligent accompaniment software, is a powerful and creative music composition tool for exploring and developing musical ideas with near-instantaneous feedback. It contains features to display notation, enter lyrics, create melodies, add harmonization, and program a variety of musical styles. The Soloist generates professional quality solos over any chord progression. The Melodist creates songs from scratch with chords, melodies, intros, solos, and even a title.

Band-in-a-Box can add recordings of acoustic instruments or voices to the composition with special effects processing. Its built-in audio harmonies can turn an audio track into multiple harmony parts and even adjust its pitch by tracking the Band-in-a-Box melody track. Digital audio features make Band-in-a-Box the perfect tool for creating, playing, and recording music with MIDI, vocals, and acoustic instruments. You can print out your musical arrangement with repeats and endings, DC markings and codas, or save it as a graphic file for Web publication or even e-mail it to a friend. And when you're ready to let others hear your composition, you can burn it directly to an audio CD. Save your composition as a Windows Media File or other compressed formats for a file that's "Internet ready." It’s a great way to create your own backup band!

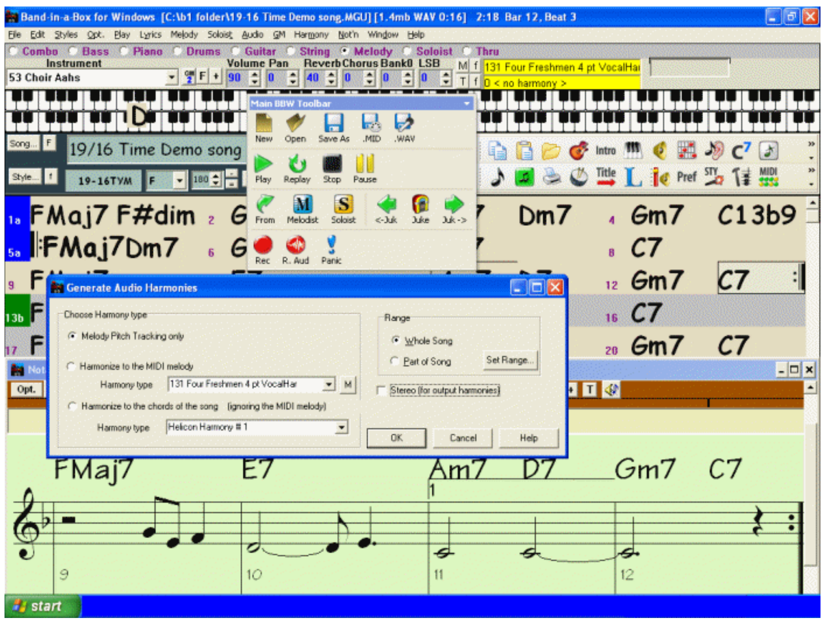
PowerTracks Pro Audio (Image 2) provides a fully-featured MIDI and digital audio sequencer and multi-track recorder. Unlike Band-in-a-Box, you do not create music in PowerTracks by typing in the chords to a song. Rather, you 'layer' tracks of MIDI and digital audio, each of which must be recorded from scratch. This takes longer, but in exchange you have much more control over the nuances of your music. Band-in-a-Box does not allow you to edit the individual events of the accompaniment tracks. This is because the program generates the accompaniment for you, and it is different every time you play your song. PowerTracks also comes loaded with a host of effects to help you put the subtle, finishing touches on your work. Use a bit of reverb to create a 'spacious' feel; add some chorus and distortion to enhance the 'grind' of your guitar tracks; fiddle with the compressor to give your drums that extra 'punch.' PowerTracks (and patience) are all you need to infuse your songs with a refined, 'studio' feel.

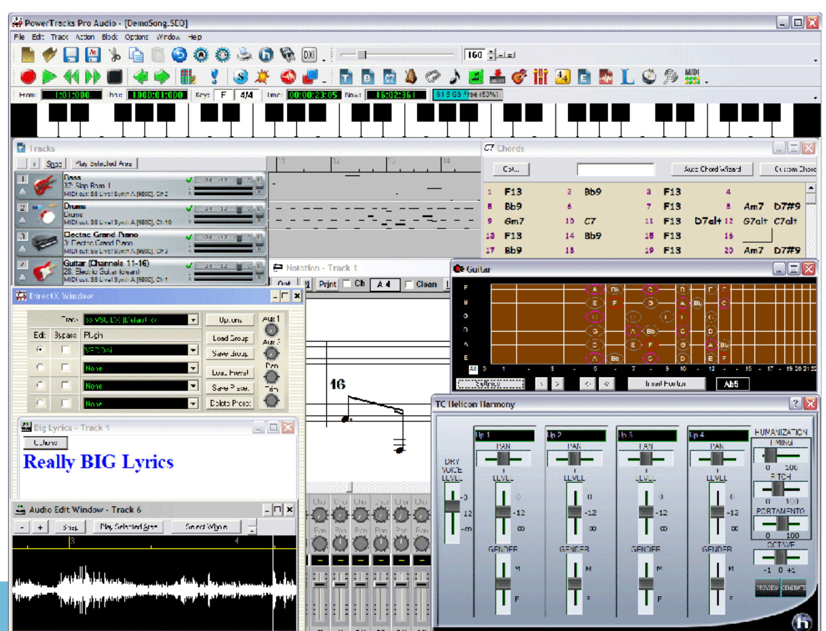
After creating music, playback usually occurs through devices called synthesizers. Although most computers have built-in synthesizer capability on their sound cards, more serious performers use specialized hardware or software to generate the sounds through their computer. Musical-Instrument-Digital-Interface (MIDI) is a technology that represents music in digital form. Unlike other digital music technologies such as MP3 and CDs, MIDI messages contain individual instructions for playing each individual note of each individual instrument. So with MIDI it is actually possible to change just one note in a song, or to orchestrate and entire song with entirely different instruments. Since each musical part in a MIDI performance is separate from the rest, it’s easy to listen to a single instrument and study it for educational purposes, or to mute individual instruments in a song so that you can play that part yourself. Hardware synthesizers can be expensive but software alternatives are quite inexpensive or even included with most arranging and composition programs. For example, the Edirol Virtual Sound Canvas (Image 3) allows you to customize playback of MIDI files using the same sounds and for a fraction of the cost of hardware synthesizers. You can even export your finished files into popular multi-media application formats.

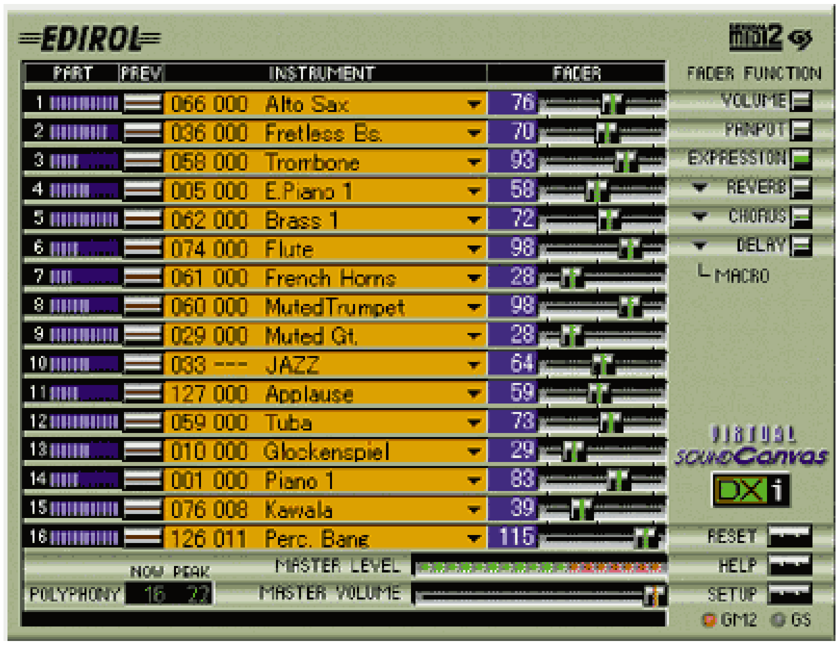
From beginner to the professional, technology has forever changed the way we create music. Experimentation with music scanning and pattern recognition software may soon make it possible to capture not only existing scores and recordings but allow even non-musicians to explore their ideas and produce unique arrangements and compositions, all with simple clicks of a mouse!

**Product References**

| | |
|---|---|
| BIAB | http://www.pgmusic.com/ |
| PowerTracks | http://www.pgmusic.com/powertracks.htm |
| Edirol Synth | http://www.edirol.com/products/software.html |




EDIROL
PART
PREV
INSTRUMENT
FADER
FADER FUNCTION
1 066 000 Alto Sax 76
2 036 000 Fretless Bs. 70
3 058 000 Trombone 93
4 005 000 E.Piano 1 58
5 062 000 Brass 1 72
6 074 000 Flute 98
7 061 000 French Horns 28
8 060 000 MutedTrumpet 98
9 029 000 Muted Gt. 28
10 033 --- JAZZ 64
11 127 000 Applause 59
12 059 000 Tuba 73
13 010 000 Glockenspiel 29
14 001 000 Piano 1 83
15 076 008 Kawala 39
16 126 011 Perc. Bang 115
VOLUME
PANPOT
EXPRESSION
REVERB
CHORUS
DELAY
MACRO
VIRTUAL
SOUND Canvas
DXi
RESET
HELP
SETUP
NOW PEAK
POLYPHONY 16 22
MASTER LEVEL
MASTER VOLUME
GM2
GS

# Effects of Varied Animation Strategies in Facilitating Animated Instruction

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## Background

The use of animation and audio as a virtual panacea for everything from advertising to educational videos and instruction has created the presumption that any materials that use them 'must be better!' Now doubt that the addition of animation can improve message delivery on a number of scales, but the use of animation regardless of message and with little concern for systematic placement may be causing more harm than good. Combined with the increasing prevalence of computing technology and increasing ease of development on standard workstations the integration of animation in web-based instruction is a more realistic possibility. This study explores the effect of animation on higher order educational objective achievement in a web-based, self-paced programmed instructional unit on the human heart and its functions for undergraduate students with majors outside of the life sciences.

## Introduction

In instruction the use of pictorial media has long been considered to be an important instructional variable supported by a number of theoretical considerations. Kulik and Kulik (1985) reported that computer-based instruction enhances learning and fosters positive attitudes toward instruction with college students. Unfortunately most of the studies that have been carried out examining animation in computer-based and web-based instruction have been cursed with confounding and poor designs. (Rieber, 1991; Dwyer 1978; Park & Hopkins 1993) There are various reasons for the conflicting results and inconclusive results. Dwyer (1978) pointed out that one of the major problems with media research was that it didn't describe the types of learning tasks or objectives that it expected the participants to achieve. Sadly upon review of available literature dealing with animation in computer-based and web-based instruction this still appears to be the case. In the subsequent literature review this author makes a case that not much has changed in the past 25 plus years in media research since Dwyer's observation. Further the questions of effectiveness in practice and convergence of theory remain largely inconclusive.

### Definition

With a lack of definition of terms being one of the major criticisms of the research reviewed in the subsequent pages the researchers will explicate their operating definitions for animation. Animation is a sequence of images played in rapid succession such that to the human eye the result is apparent motion (Park & Gittelman, 1992) and is generally used in instructional materials for one of three purposes: attention-gaining / attention-direction, presentation, and practice (Rieber, 1990).

## Literature Review

Paivio's dual coding theory (DCT) asserts that images and verbal processes together determine learning and memory performance (Clark & Paivio, 1991). According to Paivio's (1971, 1986) and later Clark and Paivio's (1991) explanation, using the information processing model and the spread of activation in the brain, the links between verbal and non-verbal symbolic storage can trigger each other, "…this spreading activation results in complex patterns of arousal among the representations in the network." (Clark & Paivio, 1991, p. 154) Further, Clark and Paivio propose that both types of mental representations have dedicated channels for the processing and encoding of information. Tulving (1976) suggests that information can be processed on several levels in parallel processes and a logical extension of this using information processing as a guide is that the parallel processing can aid in the transfer of information into long-term storage. The concept of parallel processing is not new to cognitive psychology, and will be generally accepted by the researchers. What is of interest to the researchers stems from the apparent inconsistencies in the literature regarding the use of animated sequences to facilitate learning or achievement.

**Animation Studies and Findings**

Park and Hopkins (1993) suggest that educational research on visual displays evolved from two distinct camps: the behaviorist with work by Guthrie, Skinner, and Thorndike on eliciting desired responses after some stimulus, and the cognitive with work by Paivio and his Dual Coding Theory (DCT). Tulving and his concept of 3 major types of memory: episodic, semantic, and procedural would also fall under the cognitive branch in this division as well. (Gredler, 2001, p. 171)

In Rieber's 1990 review of 12 studies spanning 25 years, he found inconsistent results in the effects of animation on achievement and learning by extension. Similarly, Park and Hopkins (1993) reviewed 25 empirical studies, 17 of which dealing directly with computer based instruction and also reported mixed results. Dwyer and Dwyer in a 2003 presentation reviewed 5 animation based studies using similar content and identical assessment tools on a total of 781 subjects, and found only three cases out of the 72 examined where animation showed significant benefits over static visuals. Owens and Dwyer (2003) in an unpublished study actually found animation to be less effective than static visuals at higher levels of learning.

In a study published in 1988 by Reiber and Hannafin looking at the effects of animated or textual orienting activities on learning in computer based instruction with fourth, fifth, and sixth graders, they report that neither text-based or animated activities were powerful influences on learning. This studies content was based on Newton's laws of motion, and the authors report that a 24 item posttest was administered with a KR-20 reliability of .83 overall. While not explained they also report that validity was established through expert review by independent science teachers.

In a study published one year later in 1989, Reiber ran another factorial study 3x2x2 looking at more factors comparing graphic type (animation, static graphic, not graphic) and text type (text, no-text) and practice type (relevant, irrelevant). Additionally within subject he examined factual verses application objectives and near verses far transfer. The overall reliability of the improved dependent measures was .91. In this study "The lack of main effects among the embedded elaboration conditions was surprising." (Reiber, 1989, p. 439) Two years later Reiber (1991) ran a simple version of the study looking only at graphic type (static graphics verses animated graphics) and practice type (simulation verses simulation with questions) found significant effects in favor of animation for near transfer on incidental and intentional questions.

In a 1998 animation study conducted by Park using a computer based instructional unit on electronic circuit repair he reports that static graphics with motion cues can be used instead of full graphical animation as they both were equally effective on the performance and transfer tests that were administered. Will this finding may well be true, Park did not identify the level of educational objectives measured or report any reliability or efforts to support validity on his dependent measures. If the dependent measures were measuring factual or conceptually based knowledge than the finding may offer some direction an support but with out it being reported the readers are left to their own devices and field suffers once again.

"Although much research has been done on the effectiveness of static visuals (Dwyer, 1978), little research has conducted on animation's instructional effects. Empirical data that are available are inconsistent." (Reiber, 1990, p. 78) In the almost 15 years since Reiber wrote this statement, little has changed. More studies have been run, but a general consensus has yet to be reached. This lack of consistency stems from several different sources in both internal and external validity issues. There are the more obvious issues of poor study design, varying and insufficient sample sizes, issues with content relevance, lack of systematic process for placement of treatments, use of assessments with out evidence of -or even reported assessment reliability and content validity. Even with all of these issues surrounding the existing literature, one of the most egregious errors revolves around the lack of definition of the types or methods of animation used and the levels of instructional objectives that were being addressed in the studies. The failure of previous researchers to provide reasoning for placement of the interventions casts yet more doubt on use and application of reported results. With out a systematic process for placement of the animation the net effect may well be supporting an instructional objective that is already sufficiently addressed in the instruction thereby wasting the time and attentional resources of the participants as they would have responded with the correct answer before the added stimulus was introduced.

**Literature Review Summary**

The numerous studies addressing animation and its effects are asking good questions, but are for the most part lacking in execution in some major areas of concern. Gagne (1985) in his book entitled The Conditions of Learning, proposed that there are different types of learning and that each type of learning requires a different approach. The problem remains that while all the previously mentioned studies are asking good questions they are not providing sufficiently based answers. The need for the systematic placement of independent variables, which previous studies lack, and the use of sound instruments with reported reliability, which previous studies also lack, is paramount in accurate interpretation of results.

**How This Study is Different**

Where this study set itself apart from the previous studies in the literature is through the systematic placement of the animation in a programmed instructional unit. Further, in this study the researchers have gone to great pains in the pilot studies to refine the programmed instruction so that the participants have the necessary factual and conceptual knowledge to build upon for higher order learning to take place. “An awareness of the fact that that there are different kinds of educational objectives each requiring specific prerequisites is crucial to educators who aspire to employ the visual media effectively” (Dwyer, 1978, p. 43). Additionally this study used instruments with previously reported reliability and demonstrated discriminatory power for its dependent measures. It is hypothesized that the use of the animation can reduce the overall cognitive load on the participant there by allowing them to queue to the import information in the instruction and process it more effectively.

**Statement of Purpose**

Specifically, this study sought to examine the effectiveness with which different types of stimuli, varied animation strategies, can be used to complement a web-based programmed instruction unit to improve learner achievement on four different types of educational objectives.

**Design and Methodology**

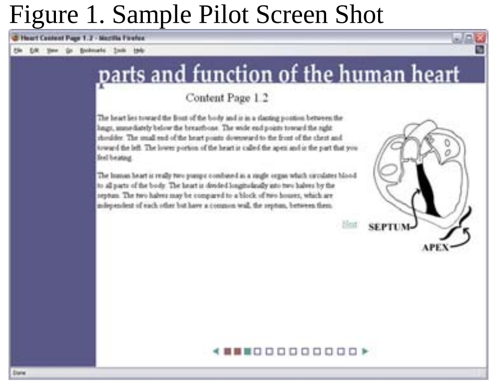
Eight-Eight undergraduate students enrolled in lower-division management, educational psychology, and information sciences technology classes were randomly assigned to one of three treatments in a randomized 1 X 3 post-test only experimental design. The type of animation strategy used was considered to be the independent variable with three levels (control with base animation employed, simple level with base animation and simple reveal, and complex level with base animation and progressive reveal). Dependent variables were the scores achieved on the criterion measures by the participants. Participation in the study was voluntary and at the recruitment sessions the students were able to select their preference of times to report to a list of labs were researchers would be waiting.

**Systematic Placement and Development**

Two pilot studies and the current study were run from September 2003 through September 2004 to systematically apply the effective use of the animated stimulus in the final iteration reported here. A brief explanation of the two pilot studies and treatments development will be covered in the following section.

Pilot Study #1: (n = 12) This first pilot and genesis for the larger study was done in response to criticism in the literature that one of the reasons for conflicting results was that it was unreasonable to expect any achievement differences at higher levels of educational objectives if the lower levels still were not addressed in sufficient detail as to achieve an acceptable score (average of 90%).The first pilot study was conducted to facilitate the development of the future instructional treatments and test the programmed instructional units effectiveness. This pilot study took the instructional booklet developed by Dwyer and Lamberski in 1977 and ported the treatment over to a web-based instructional unit and added five quizzes to make it into a programmed instructional unit. There was no use of animation and only a recreation of the static visuals used in the original paper based instruction (figure 1). The purpose was to identify items with a high of difficulty (.60 or below on the drawing and identification tests) to determine areas where the static visual instruction might be complemented by a refined programmed instructional unit to further improve student achievement.

Figure 1. Sample Pilot Screen Shot




Pilot Study #2: (n = 138) This second pilot built off of the lessons learning in first pilot on the programmed instructional unit. Adaptations and corrections were made in the programmed instruction in hopes of pushing achievement even higher. Additionally there were questions to the effectiveness of our programmed instructional unit. If you are building a structure you need a good foundation, the factual and conceptual information is that base for higher order objectives was specifically stressed in the programmed instruction. Simple (base) animations were developed using flash and fireworks for the graphical development. In this study three levels were established: First there was the instructional script from Dwyer and Lamberski (1977), with static visuals only totaling 20 content pages. The second treatment (figure 2) was the programmed instructional version with the same script broken down into no more than 2 parts or concepts per webpage for a total of 28 content pages with embedded quizzes after every 5 or six parts of the heart were covered in the first 17 frames. The third treatment (figure 3) has the same breakdown and structure as the programmed instructional unit, but added basic animation to help facilitate and reduce the information processing load on the part of the subjects.

Figure 2. Pilot #2 – Simple Screen Shot

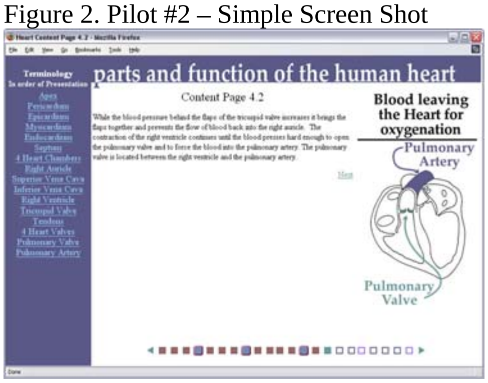
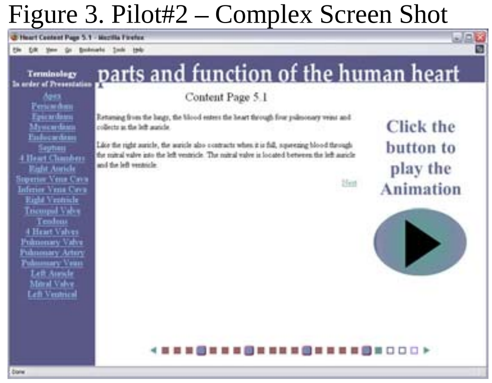



Figure 3. Pilot#2 – Complex Screen Shot




After the study was run and the groups of students (control n= 47, programmed instruction n = 47, programmed instruction + animation n = 44) data analyzed five items from the drawing test, nine items from the terminology test, and ten items from the comprehension test and zero items on the identification test were identified with a difficultly of .60 or less and the animation developed for the current study

Current Study: In this iteration of the study there are three levels of animations explored. The complex treatment from pilot study number 2 with the placed animation only at the right of center text area served as the base animation or control group. The second treatment (figure 4) used the same base animation as the control but added another effect of a simple reveal and fade that cycled two times than stayed on the screen until the subject moved on. The third treatment (figure 5) used the same base animation as the control but added another effect of a progressive reveal and fade that cycled two times than stayed on the screen until the subject moved on. The belief is that the

Figure 4. Current Study – Simple Screen Shot

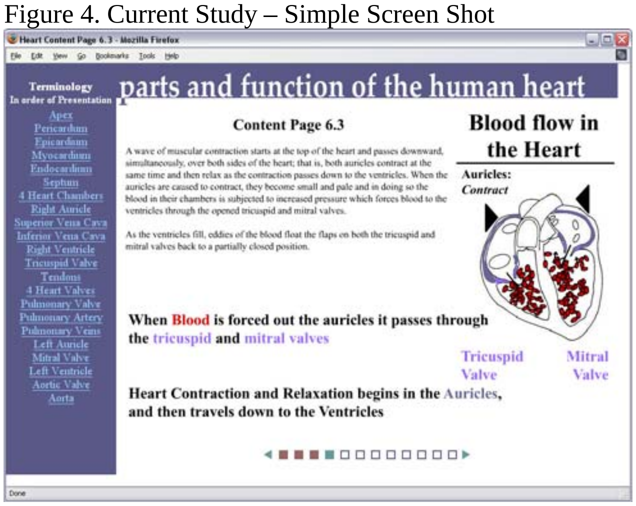
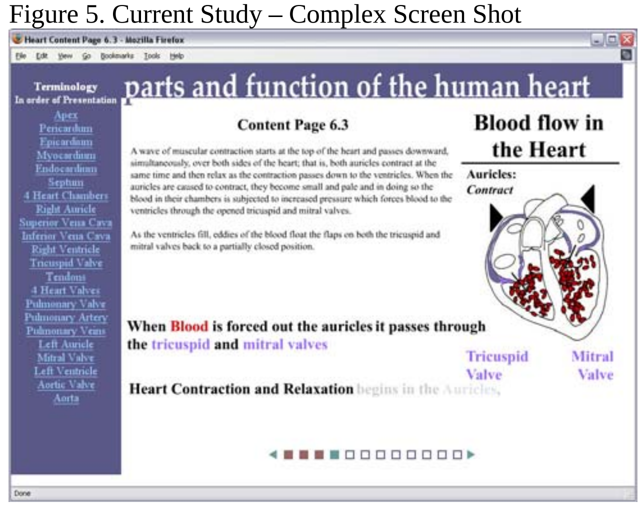



Figure 5. Current Study – Complex Screen Shot




forced information processing through the use of progressive display of information will not only be more effective in directing attention but also establish links in memory that the simple and control treatments may not.
In the complex or progressive reveal treatment the subject was presented three units (a word, or a symbol, or a group of words) of information in succession. The simple reveal treatment had the same information but it was displayed and faded in all at once. Additionally, in the progressive reveal treatment the part of the heart or first part of the statement faded in, then in the on screen animation the corresponding part blinked three times, then the next two sections of the phrase or idea faded in after a short delay. For each thought or idea the process was repeated once for a forced display of the information happening twice on any given screen. At the conclusion of this animated sequence the subject could choose to view the entire animation again or move on to the next webpage. It should be

noted that the complex animations, by the very nature of the progressive reveal, required more time to display and averaged around 22 seconds run time for the base animation and the progressive reveal. In the simple treatments where the idea was revealed all at once after the base animation the average run time was around 15 seconds. In the control group where only the base animation was displayed the average was around 11 seconds.

The subjects were given a moderate level of user control, they could replay or view previous animations at any time during the instruction, but were required to view the animation on a screen before being allowed to progress through the lesson. Additionally the environment allowed that subjects to pull up static images of all the parts of human heart after they had been covered in the instructional unit. There was a degree of linearity in programmed instructional part of the materials as there were required to correctly answer 4 out of 6 questions on the quizzes or they were automatically sent back the beginning of that section, generally 3 pages prior. If an acceptable score was achieved on the practice quizzes they were able to progress forward normally.

## Dependent Measures

In the pilot studies and in this iteration of the study four criterion measures developed by Dwyer (1965) each consisting of 20-items was employed to assess the participant's achievement. It should be noted that with the exception of the drawing test, which was administered in a paper pencil format, all other assessments and quizzes were administered in an online format to minimize any mixed medium effects between the lesson and the assessment. Reported reliability coefficients (KR-20) and brief explanation adapted from Dwyer (1978, pp. 45-47) of each tool are outlined below:

*Drawing Test. (K-R 20: .91)* A 20 object queued recall test designed to evaluate student ability to construct and/or reproduce items in their appropriate context. The drawing test provided the students with a numbered list of terms corresponding to the parts of the heart discussed in the instructional presentation. The students were required to draw a representative diagram of the heart and place the numbers of the listed parts in their respective positions. For this test, the emphasis was on the correct positioning of the verbal symbols with respect to one another and in respect to their concrete referents. Conceptual level educational objectives were addressed with this assessment.

*Identification Test. (K-R 20: .86)* A 20 question - 5 option multiple choice test designed to evaluate student ability to identify parts or positions of an object in the heart. This multiple-choice test required students to identify the numbered parts on a supplied detailed drawing of a heart. Each part of the heart, which had been discussed in the presentation, was numbered on the drawing. The objective of this test was to measure the ability of the student to use visual cues to discriminate one structure of the heart from another and to associate specific parts of the heart with their proper names. Factual level educational objectives were addressed with this assessment.

*Terminology Test. (K-R 20: .87)* A 20 question - 5 option multiple choice test designed to measure knowledge of specific facts, terms, and definitions. This multiple-choice test consisted of items designed to measure knowledge of specific facts, terms, and definitions. The objectives measured by this type of test are appropriate to all content areas that have an understanding of the basic elements as a prerequisite to the learning of concepts, rules, and principles. Specifically, conceptual level educational objectives were addressed with this assessment as a spring board for high level objectives.

*Comprehension Test. (K-R 20: .84)* A 20 question - 4 option multiple choice test designed to measure a type of understanding in which the individual can use the information being received to explain some other phenomenon. This multiple-choice test consisted of items where given the location of certain parts of the heart at a particular moment of the heart beat cycle, the student was asked to determine the position of other specified parts in the heart at the same time. This test required that the students have a thorough understanding of the heart, its parts, its internal functioning, and the simultaneous processes occurring during the systolic and diastolic phases of the heart beat. The comprehension test was designed to measure a type of understanding in which the individual can use the information being received to explain some other phenomenon and addressed the rule / procedural knowledge educational objectives.

*Total Criterion Score. (K-R 20: .95).* All items contained in the previously noted individual tests were combined into a composite test score to measure overall learning and understanding.

### Validity of Dependent Measures

Upon examination of the content pages, instructional script and materials face validity is believed to be evident by the researchers. Given that the tests were textually identical in the web based version used in this study content and construct validity for dependent measures is assumed as part of the original instruments umbrella. An explanation of the process used in establishing validity is covered in detail greater in Dwyer 1978 and in his 1965 thesis. In short the instructional materials and dependent measures were put through content expert and educational expert review with objectives and descriptions were developed and employed during test development phase by Dwyer originally in 1965 as part of his doctoral thesis.

**Results**

For statistical analysis the alpha level was set a priori at the 0.05 level, and an ANOVA was conducted on each dependent measure. Where significant differences are obtained, Scheffe or Dunnett C, according to Levene's test of homogeneity of variance, follow –up procedures were implemented. From the outset of the study it was the intention of the researchers to analyze the data from each criterion measure individually and collectively and in an effort to comprehensively examine the effects the animation. In the table 1 below the descriptive statistics for all items are displayed.

Table 1. Means and Standard Deviations for Each Treatment on Each Dependent Measure

| Dependent Measure<br>Mean # Correct<br>Standard Deviation. | Base Animation<br>Control Group (n=29) | Base Animation with<br>Reveal (n=31) | Base Animation with<br>Progressive Reveal (n=28) |
|---|---|---|---|
| Drawing | | | |
| Mean | 15.97 | 16.00 | 18.07 |
| S.D. | 3.26 | 3.61 | 2.26 |
| Identification | | | |
| Mean | 17.62 | 18.35 | 18.45 |
| S.D. | 2.47 | 1.70 | 1.99 |
| Terminology | | | |
| Mean | 11.93 | 13.65 | 15.10 |
| S.D. | 5.03 | 3.96 | 3.30 |
| Comprehension | | | |
| Mean | 11.00 | 12.55 | 12.79 |
| S.D. | 3.64 | 3.67 | 3.51 |
| Total Criterion Score | | | |
| Mean | 56.52 | 45.55 | 64.75 |
| S.D. | 11.90 | 7.76 | 8.75 |

Tables 2 and 3 show the results of the One–Way Anova and the appropriate follow up tests used. Significant effects were found on the Drawing (F=4.29 df (2,85), p=.02) and Terminology (F=4.25 df (2,86), p=.02) and Total Criterion (F=29.767 df (2,85), p≤.001). In the case of the drawing test, after using Scheffe post hoc test it was determined that the progressive reveal group did significantly better than both the simple reveal and control groups. For the Terminology test, after using Dunnett C follow up test because it failed the Levene test of homogeneity it was determined that the progressive reveal group statistically performed significantly better than the control group with base animation only. When looking at the Total Criterion measure the assumption of Levene's test of homogeneity test was not supported and Dunnett C was implemented on the results. The results were statistically significant in all comparisons and best illustrated by Figure 6.

Figure 6. Total Criterion Means Plot

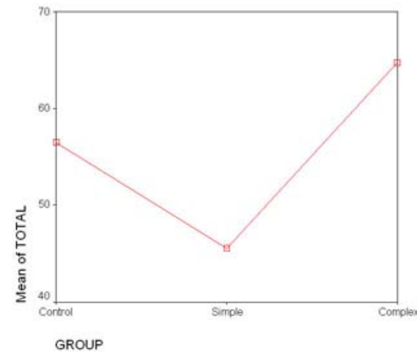



Table 2. Results of Analysis of Variance Across All Items

| | | Sums of Squares | df | Mean Square | F | sig |
|---|---|---|---|---|---|---|
| Drawing | Between groups | 83.26 | 2 | 41.63 | 4.29 | .016 |
| | Within Groups | 824.82 | 85 | 9.70 | | |
| | Total | 908.08 | 87 | | | |
| Identification | Between groups | 12.00 | 2 | 6.00 | 1.40 | .253 |
| | Within Groups | 369.10 | 86 | 4.29 | | |
| | Total | 381.10 | 88 | | | |
| Terminology | Between groups | 146.26 | 2 | 73.13 | 4.25 | .017 |
| | Within Groups | 1481.65 | 86 | 17.23 | | |
| | Total | 1627.91 | 88 | | | |
| Comprehension | Between groups | 55.20 | 2 | 27.60 | 2.189 | .118 |
| | Within Groups | 1084.44 | 86 | 12.61 | | |
| | Total | 1139.64 | 88 | | | |
| TOTAL | Between groups | 5491.29 | 2 | 2745.64 | 29.77 | .000 |
| | Within Groups | 7840.17 | 85 | 92.234 | | |
| | Total | 13331.46 | 87 | | | |

Table 3. Analysis of Variance Follow Up Tests With Significance All Items

| Test | Follow Up Used<br>Levene Statistic Sig. | Group 1 | Group 2 | Mean Difference |
|---|---|---|---|---|
| Drawing | Scheffe | Complex | Control | 2.11 |
| | .13 | | Simple | 2.07 |
| Terminology | Dunnett C | Complex | Control | 3.17 |
| | .001 | | | |
| TOTAL | Dunnett C | Complex | Simple | 8.23 |
| | .010 | | Control | 19.20 |
| | | Control | Simple | 10.97 |

Also of interest was the analysis run on just the items addressed in the treatments. For the Drawing test there were five items that had and item difficulty less than .60 after an item analysis. Similarly the Terminology and Comprehension tests had nine and ten items respectively that were specifically targeted. Table 4 displays the descriptive statistics for the items addressed. Table 5 shows the results of the analysis of variance and table six displays the appropriate follow-up tests and their significant results. It should be noted that there were no items on the identification test with a difficulty level less than .60 and therefore were not addressed. Also the terminology test was found significant with comparing all 20 items on the test but when looking at the 9 items addressed specifically it just misses the .05 alpha level coming in with p =.075.

Table 4. Means and Standard Deviations for Individual Items Addressed on Each Dependent Measure

| Dependent Measure (# of items address)<br>Mean # Correct<br>Standard Deviation. | Base Animation Control Group (n=29) | Base Animation with Reveal (n=31) | Base Animation with Progressive Reveal (n=28) |
|---|---|---|---|
| Drawing (5 Items) | | | |
| Mean | 3.28 | 3.81 | 4.50 |
| S.D. | 1.60 | 1.28 | 0.73 |
| Identification (0 Items) | N/A | N/A | N/A |
| Terminology (9 Items) | | | |
| Mean | 4.14 | 4.77 | 5.52 |
| S.D. | 2.49 | 2.29 | 2.01 |
| Comprehension (10 Items) | | | |
| Mean | 5.14 | 5.06 | 5.21 |
| S.D. | 1.66 | 5.21 | 1.78 |
| Total Score | | | |
| Mean | 12.55 | 13.65 | 15.32 |
| S.D. | 4.56 | 3.63 | 3.61 |

Table 5. Results of Analysis of Variance Addressed Items Only

| | | Sums of Squares | Df | Mean Square | F | Sig |
|---|---|---|---|---|---|---|
| Drawing | Between groups | 21.45 | 2 | 10.72 | 6.62 | .002 |
| | Within Groups | 137.63 | 85 | 1.62 | | |
| | Total | 159.08 | 87 | | | |
| Identification | None Targeted | | | | | |
| Terminology | Between groups | 27.64 | 2 | 13.82 | 2.68 | .075 |
| | Within Groups | 444.11 | 86 | 5.16 | | |
| | Total | 471.75 | 88 | | | |
| Comprehension | Between groups | 0.31 | 2 | 0.15 | 0.05 | .951 |
| | Within Groups | 258.38 | 86 | 3.00 | | |
| | Total | | 88 | | | |
| TOTAL | Between groups | 110.72 | 2 | 55.36 | 3.53 | .034 |
| | Within Groups | 1332.38 | 85 | 15.68 | | |
| | Total | 1443.09 | 87 | | | |

Table 6. Analysis of Variance Follow Up Tests With Significance Addressed Items Only

| Test | Follow Up Used<br>Levene Statistic Sig. | Group 1 | Group 2 | Mean Difference |
|---|---|---|---|---|
| Drawing | Dunnett C<br>.004 | Complex | Control | 1.22 |
| TOTAL | Scheffe<br>.246 | Complex | Control | 2.77 |

**Discussion**

From the initial pilot study run in the fall of 2003 there has been marked improvement in the raw mean scores with each successive iteration beyond simple static visuals, first using programmed instruction, and then adding in basic animation, and finally with the additional animation strategy of simple reveal vs. progressive reveal. Results of this study have shown some statistically significant findings for some educational variable levels and on the whole but not for all educational levels.

The results of this study indicate that the use of animation when properly designed and positioned is an important instructional variable for complementing web-based instruction. However, it should not be seen as a panacea that can cure all the ills of instruction and education. Results have also shown that the use of animation is not equally effective for facilitating achievement across all of the different levels of educational objectives. Even when subjects have the perquisite knowledge required to build upon for success at the higher levels achievement is not guaranteed. In the case of this study the researcher went to great pains to ensure that lower level objectives where addressed in sufficient detail and we believe that we succeeded with the control group averaging almost 80 and 90 percent on the drawing and identification tests respectively.

One interesting note was the large drop in the overall and addressed items mean scores exhibited by the simple reveal group. Possible explanations of this apparent anomaly vary and were a frequent topic of discussion by the researchers. One suggestion is that of a statistical anomaly. We randomly assigned all subjects to treatments but there is still a chance that it was a random error. We are fairly certain that we have avoided common pitfalls in our research design but a replication study is currently planned for the spring of 2005 and this competing explanation can explored in more detail then. Another possible explanation discussed by the group was lack of motivation by the individuals randomly assigned to this treatment, but once again we used random assignment this should have distributed this equally across groups. Further, upon inspection of the data and answers keyed into the assessments there did not appear to be any obvious patterns or clues indicating an obvious lack of effort by students. Participants were also allowed to exit the study at anytime if they so chose. No one exercised this option but all subjects were made aware of it at the onset when they read and signed their informed consent forms.

One possibility that seemed to resonate with researchers dealt with the level of cognitive processing load, part of the underlying theoretical basis for the study, was exceeded. Even though the subjects in the simple reveal and progressive viewed the same content and all textual and graphical information was identical, the presentation of information in the simple reveal increased the cognitive processing load beyond their individual thresholds. It is suggested that the subjects could no longer focus and direct attention and that onslaught of information that was taken in for processing was quickly disposed of. While experiencing this process of overload the subjects actually missed the other bits of information presented in all treatments that the control and complex groups were able to attune to. In future studies qualitative data and questions asking the students to rate the data presentation may be included but make the assumption that the subject is aware of the overload, which may or may not be the case.

Another interesting point that needs to be explored further is that when all items in the comprehension dependent measure the analysis of variance returned an F-ratio of 2.19, $p=.12$ but when compared to items addressed the F-ratio is .05 and $p=.951$. When viewed in tandem it appears that most if not all of the variance increase was on the ten out of twenty items that weren't specifically targeted or addressed by treatments. Further analysis is required to address this question.

What remains to be seen is the transfer and replication of these findings in future studies. Transfer of the findings of this study can be logically extended other domain areas where information is organized in a hierarchal manner. However, widespread generalization of findings is a dangerous proposition; never-the-less, implications for practitioners can be generated so long as they are 'taken with a grain of salt' and not assumed to be fact but merely a possible lens from which to view a problem. The use of animation increased overall achievement on the parts of the learners due in large part to effects on the factual and conceptual levels. Given the cost of development for use of animation this should be considered within a contextual frame work of what is it worth to you? If similar findings can be achieved with well designed and systematically placed static visuals the benefits out weigh the costs. There were clear areas where progressive reveal animation strategies were better in facilitating achievement. This relates to the clarity of the relationship between the way the animation was designed and information presented. When choosing to utilize animation, specific attention needs to be devoted to the cognitive load on the individual. If items require too great a processing time than they can do more detriment than not using them at all in an instructional module.

## References


Clark, J. M., & Paivio, A. (1991). Dual Coding Theory and Education. Educational Psychology Review, 3(3), 149-210.

Dwyer, F. M. (1978). Strategies for improving visual learning : a handbook for the effective selection, design, and use of visualized materials. State College: Learning Services.

Dwyer, F. M., & Dwyer, C. (2003). Effect of Static and Animated Visualization in Facilitating Knowledge Acquisition. State College, PA: The Pennsylvania State University.

Dwyer, F. M., & Lamberski, R. (1977). The human heart: Parts of the heart, circulation of blood and cycle of blood pressure. US: Published Privately.

Gagné, R. M. (1985). The conditions of learning (4th ed.). New York: Holt, Rinehart, & Winston.
Gredler, M. (2001). Learning and instruction: Theory into practice (4th ed.). Upper Saddle River: Prentice-Hall, Inc.
Kulik, C. L., & Kulik, J. (1985). Effectiveness of computer-based education in colleges. AEDS Journal, 19(2), 81-108.
Owens, R., & Dwyer, F. M. (2003). The Effect of Varied Cueing Strategies on Complementing Animated Visual Imagery in Facilitating Achievement of Different Educational Objectives. State College, PA: The Pennsylvania State University.
Paivio, A. (1971). Imagery and Verbal Processes. New York: Holt, Rinehart, and Winston.
Paivio, A. (1986). Mental Representations: A dual- coding approach. New York: Oxford University Press.
Park, O. (1998). Visual Displays and Contextual Presentation in Computer-Based Instruction. ETR&D, 46(3), 37-50.
Park, O., & Gittelman, S. S. (1992). Selective Use of Animation and Feedback in Computer-Based Instruction. ETR&D, 40(4), 27-38.
Park, O., & Hopkins, R. (1993). Instructional conditions for using dynamic visual displays: A review. Instructional Science, 21(5), 427-449.
Rieber, L. P. (1989). The effects of Computer Animated Elaboration Strategies and Practice on Factual in and Elementary Science Lesson. Journal of Educational Computing Research, 5(4), 431-444.
Rieber, L. P. (1990). Animation in computer-based instruction. ETR&D, 38(1), 77-86.
Rieber, L. P. (1991). Animation, Incidental Learning, and Continuing Motivation. Journal of Educational Psychology, 83(3), 213-238
Rieber, L. P., & Hannafin, M. J. (1988). Effects of Textual and Animated Orienting Activities and practice on Learning from Computer-Based Instruction. Computers in the Schools, 5(2), 77-89.
Tulving, E. (1976). Euphoric processes in recall and recognition. In J. Brown (Ed.), Recall and recognition (pp. 405-428). New York: John Wiley and Sons.

# Design and Architecture of Collaborative Online Communities: A Quantitative Analysis

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**Abstract**

*This paper considers four aspects of online communities. Design, mechanisms, architecture, and the constructed knowledge. We hypothesize that different designs of communities drive different mechanisms, which give rise to different architectures, which in turn result in different levels of collaborative knowledge construction. To test this chain of hypotheses, we analyzed the recorded responsiveness data of two online communities of learners having different designs: a formal, structured team, and an informal, non-structured, Q&A forum. The designs are evaluated according to the Social Interdependence Theory of Cooperative Learning. Knowledge construction is assessed through Content Analysis. The architectures are revealed by Statistical Analysis of p* Markov Models for the communities. The mechanisms are then identified by matching the predictions of Network Emergence Theories with the observed architectures. The hypotheses are strongly supported. Our analysis shows that the minimal-effort hunt-for-social-capital mechanism controls a major behavior of both communities: negative tendency to respond. Differences in the goals, interdependence and the promotive interaction features of the designs of the two communities lead to the development of different mechanisms: cognition balance and peer pressure in the team, but not in the forum. Exchange mechanism in the forum, but not in the team. In addition, the pre-assigned role of the tutor in the forum gave rise to its responsibility mechanism in that community, but not in team community. These differences in the mechanisms led to the formation of different sets of virtual neighborhoods, which show up macroscopically as differences in the cohesion and the distribution of response power. These differences are associated with the differences in the buildup of knowledge in the two communities. The methods can be extended to other relations in online communities and longitudinal analysis, and for real-time monitoring of online communications.*

## Introduction

Building communities is recognized as an essential strategy for online learning. An online community consists of actors who develop certain relations among themselves. For example, some actors only read what others write; some respond to queries posted by others and some influence others to do something (for example to access a web page), etc. This simple observation led us to adopt a network abstraction to describe online communities. A network is a set of actors – members of communities, groups, web-pages, countries, genes, etc., with certain possible relations between pairs of actors. The relations may – or may not – be hierarchical, symmetrical, binary, or other. Network abstraction is thus very flexible.

Social Network Analysis (Wasserman and Faust 1999) is a useful tool for studying relations in a network. It is a collection of graph analysis methods developed by researchers to analyze networks which consist of precise mathematical definitions of certain network structures and the methods to calculate them. Examples of network structures are cohesiveness and transitivity: cohesiveness measures the tendency to form groups of strongly interconnected actors; transitivity measures the tendency to form transitive triad relations (if i relates to j and j relates to k, then i necessarily also relates to k). SNA has been utilized to analyze networks in various areas, whose actors include politicians (Faust, Willet et al. 2002), the military (Dekker 2002), adolescents (Ellen, Dolcini et al. 2001), multi-national corporations (Athanassiou 1999), families (Widmer and La Farga 1999), and terrorist networks (van Meter 2002). SNA methods were introduced to online communities research in (Garton, Haythornthwaite et al. 1997). Since then several scholars have demonstrated the applicability of SNA to specific collaborative learning situations (Haythornthwaite 1998; Wortham 1999; Lipponen, Rahikainen et al. 2001; Cho, Stefanone et al. 2002; de Laat 2002; Martinez, Dimitriadis et al. 2002; Reffay and Chanier 2002; Aviv 2003).

Macro-level SNA identifies network macro-structures such as cohesiveness. Micro level SNA reveals significant underlying microstructures, or neighborhoods, such as transitive triads (Pattison and Robbins 2000; Pattison and Robbins 2002). The identified neighborhoods are the basis for revealing theories that explain their emergence (Contractor, Wasserman et al. 1999). For example, the theory of cognitive balance explains the emergence of transitive triads, which underlies the macroscopic phenomenon of cohesiveness. The precise definition of a neighborhood will be given in section 2.

We examine online communities of learners according to the constructivist perspective (Jonassen, Davidson et al. 1995). Rafaeli (Rafaeli 1988) emphasized that constructive communication is determined by its responsiveness. Accordingly, we analyze the network structures of the responsiveness relation between actors in the online communities. Previous work (Aviv, Erlich et al. 2003) demonstrated that certain macrostructures (cohesion, centrality and role groups) are correlated with the design of the communities and with the quality of the constructed shared knowledge. In this study, we extract the micro-level neighborhoods of the same communities. Our goal is to reveal the underlying theoretical mechanisms that control the dynamics of the communities and to correlate them with the design parameters and with the quality of the knowledge constructed by the communities.

## Architecture of a Community

An online community is modeled as a network of actors. Every ordered pair of actors has a potential response tie relation. The response tie between actor i and actor j is realized if i responded to at least one message sent by j to the community; otherwise the response tie is not realized. In addition, a (non-directed) viewing relation is realized between a pair of actors if they read the same messages. In a broadcast community, a realized response tie relation is also a realized viewing tie. The reverse is not necessarily true.

A virtual neighborhood (VN) is a sub-set of actors, endowed with a set of prescribed possible response ties between them, all of which are pair-wise statistically dependent. We identified the significant VNs of a community by fitting a p* stochastic Markov model (Wasserman and Pattison 1996; Robins and Pattison 2002) to the response tie data. In this model, every pair of response ties in a VN has a common actor, which is why they are interdependent. Same topology VNs are aggregated into a class of VNs. In the model every possible class is associated with a strength parameter that measures the tendency of the network to realize VNs of that class. The basic ideas and the formulas of the p* Markov model are elaborated in (Wasserman and Pattison 1996; Robins and Pattison 2002). The model equations are presented in the Appendix. Examples of Markov VNs are presented graphically in Figure 1.

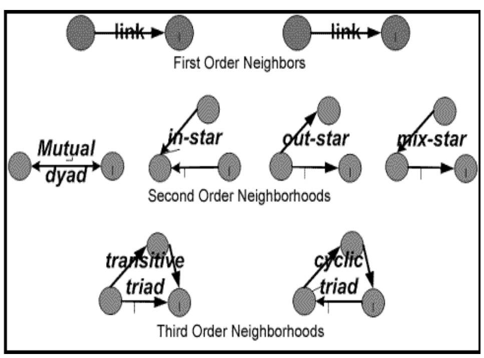

Figure 1. Virtual neighborhoods

In this research we consider the set of Markov classes of VNs listed in Table 1.

| VN Class | Participating Actors & Prescribed Response Ties |
|---|---|
| link | All pairs: (i→j) or (j→i) |
| $resp_i$ | All pairs: (i→j) fixed i |
| $trigg_i$ | All pairs: (j→i) fixed i |
| mutuality | All pairs: (i→j) and (j→i) |
| out-stars | All triplets: (i→j) and (i→k) |
| in-stars | All triplets: (i→j) and (k→j) |
| mixed-stars | All triplets: (i→j) and (j→k) |
| transitivity | All triplets: (i→j)and(j→k)and (i→k) |
| cyclicity | All triplets: (i→j) and (j→k) and (k→i) |

Table 1. Classes of VNs

Tendencies to form VNs of a certain class are the result of the underlying mechanisms. Several candidate mechanisms, postulated by certain network emergence theories are briefly described below. See (Monge and Contractor 2003) for an extensive survey.

The theory of social capital (Burt 1992; Burt 2002) postulates efficient connectivity in the hunt for a social capital mechanism. In an online broadcast community, efficiency means forming zero response ties because a response tie is a redundant viewing tie, so actors prefer to remain passive. This mechanism predicts a tendency for not creating VNs of any class. Thus, other mechanisms are responsible for creating responsiveness.

Exchange and resource dependency theories (Homans 1958; Willer 1999) postulate an information exchange mechanism, in which actors prefer to forge ties with potentially "resource-promising" peers. This mechanism creates tendency for VNs of class mutuality.

The theory of generalized exchange (Bearman 1997) postulates an information exchange mechanism via mediators. This theory then predicts tendencies for n-link cycles, in particular VNs from the cyclicity class.

Theories of collective action (Marwell and Oliver 1993) postulate a social pressure mechanism that induces actors to contribute to the goal of the community if threshold values of "pressing" peers, existing ties, and central actors are met (Granovetter 1983; Valente 1996). In that case, actors will respond to several others, forging out-stars VNs.

Contagion theories (Burt 1987; Contractor and Eisenberg 1990) postulate that the exposure of actors leads to a contagion mechanism that uses social influence and imitation to create groups of equivalent actors with similar behaviors (Carley and Kaufer 1993). Contagion predicts a tendency for VNs of the various star shaped classes.

| Theories | Predicted Tendencies | Hypotheses |
|---|---|---|
| Social capital | Few single tie links | H1: link < 0 |
| Collective action | If thresholds met then respond to several others | H2: if thresholds met then out-stars > 0 |
| Exchange | Tendency to reciprocate | H3: mutuality > 0 |
| Generalized exchange | Tendency to respond cyclically | H4: cyclicity > 0 |
| Contagion | Respond to same as others | H5: out-stars> 0; in-stars > 0; mixed-stars > 0 |
| Cognitive consistency | Respond via several paths | H6: transitivity > 0 |
| Uncertainty reduction | Attract many responses | H7: in-stars > 0 |
| Exogenous factors: Students | No tendencies to respond/trigger | H8: $\{resp_i = 0 \mid i \in students\}$<br>H9: $\{trigg_i = 0 \mid i \in students\}$ |
| Exogenous factors: Tutors | Personal tendencies to respond/trigger | H10: $\{resp_i > 0 \mid i = tutor\}$<br>H11: $\{trigg_i > 0 \mid i = tutor\}$ |

Table 2: Research Hypotheses

Theories of cognitive balance (Cartwright and Harary 1956; Festinger 1957; Harary, Norman et al. 1965) postulate a cognition balance mechanism with a drive to overcome dissonance and achieve cognition consistency among actors. This drive is implemented by transitivity VNs.

The uncertainty reduction theory (Berger 1987) postulates drives in actors to forge links with many others to reduce the gap of the unknown between themselves and their environment; this theory predicts a tendency to create in-stars (responses to triggering actors) VNs.

Finally, responsibilities of actors influence their residual personal tendencies toward response ties. In this study, students did not have pre-assigned responsibilities, predicting that the students' VNs $resp_i$ and $trigg_i$ will be insignificant. The tutors' residual tendencies will be significant, due to their roles.

The theories, and predicted tendencies stated as Research Hypotheses, are presented in Table 2.

**The Analysis**

We analyzed recorded transcripts of two online communities – two communities of students at the Open University of Israel. These communities were established for 17 weeks during the Fall 2000 semester (19 participants) and the Spring 2002 semester (18 participants) as part of an academic course in Business Ethics. Each community included one tutor. The designs of the activities of the two communities were different. The Fall 2000 community was designed as a goal-directed collaborative team, whereas the Spring 2002 community was a Q&A forum. Hence we have labeled the communities "team" and "forum," respectively. The data is available at http://telem.openu.ac.il/courses (password protected).

The team community engaged in a formal debate. Participants registered and committed to active participation, with associated rewards in place. Students took the role of an "advisory committee" that had to advise a company on how to handle the business/ethical problem of cellular phone emissions. The debate was scheduled as a 5-step process of moral decision-making, with predefined goals (Geva 2000). A unique feature of the team community was that the goals of the debate were to reach consensus up to the point of writing a joint proposal to an external agency. The forum community was open to all students in the course. Participants were asked to raise questions on issues relating to the course. We followed the social interdependence theory of cooperative learning (Johnson and Johnson 1999) to characterize the communities according to four groups of parameters: interdependence, promotive interaction, pre-assigned roles, and reflection. The two communities differ in most of the design parameters. Table 3 summarizes the differences between the designs of the two communities.

| Parameter | Team | Forum |
|---|---|---|
| Registration & commitment | Yes | No |
| Interdependence: deliverables | Yes | No |
| Interdependence: tasks & schedule | Yes | No |
| Interdependence: resources | Yes | No |
| Reward mechanism | Yes | No |
| Interdependence: reward | No | No |
| Promotive interaction: support & help | Yes | No |
| Promotive interaction: feedback | Yes | No |
| Promotive interaction: advocating achievements | No | No |
| Promotive interaction: monitoring | Yes | No |
| Pre-assigned roles: tutor | No | Yes |
| Pre-assigned roles: students | No | No |
| Reflection procedures | No | No |
| Individual accountability | Yes | No |
| Social skills | Yes | Yes |

Table 3: Design of Communities

Previous analysis (Aviv, Erlich et al. 2003) analyzed the constructed knowledge and the macro-structures of the communities. The analysis revealed that the team community exhibited high levels of constructing knowledge, developed a mesh of interlinked cliques, and that many participants took on bridging and triggering roles while the tutor remained on the side. The forum community did not construct knowledge, cohesion was dull, and only the tutor had a special role. In the team community, many students participate in many cliques, but the tutor belongs to only one clique. In the forum community, only one student and the tutor belong to the two cliques that developed. In addition, participants in the team community shared the role of responders among them, whereas in the forum community only the tutor was a central responder.

The p* model of the team community has 43 classes of virtual neighborhoods, each with its explanatory and parameter: 18 $resp_i$, 18 $trigg_i$, link, mutuality, transitivity, cyclicity, and the three stars. Similarly, the model of the forum community includes 45 classes of virtual neighborhoods: 19 $resp_i$, 19 $trigg_i$, link, mutuality, transitivity, cyclicity, and the three stars. The explanatories count the number of virtual neighborhoods that were completely realized in the networks. The strength parameters represent the tendency to create (or not) neighborhoods from the classes.

The analysis of the p* model consists of two steps: In the first step we calculate the explanatories. This was performed using the PREPSTAR program (Anderson, Wasserman et al. 1999). The second step involves solving the binary logistic regression (equation A5). The solution provides an approximate estimate for the strength parameters. This step was performed with SPSS. Details are provided in the Appendix. We configured the SPSS binary logistic procedure to work in forward steps, adding one class of virtual neighborhoods (i.e., its explanatory) at a time, according to its significance, where significance was assessed by the decrements in the PLLD (Pseudo Log-Likelihood Deviance). The analysis stops when no more significant explanatory variables can be identified.

The analysis revealed three significant classes of virtual neighborhoods for the team community, and four significant classes of virtual neighborhoods for the forum community. The PLLD estimates of the strength parameters are presented in Table 4.

| Class | θK | SE | Wald | p | exp(θK) |
|---|---|---|---|---|---|
| Team | | | | | |
| link | -3.13 | .32 | 97.5 | .000 | .043 |
| out-star | .18 | .06 | 9.6 | .002 | 1.199 |
| transitivity | .31 | .06 | 23.9 | .000 | 1.366 |
| Forum | | | | | |
| link | -2.6 | .8 | 10.29 | .001 | .076 |
| $resp_{18}$ | 6.1 | .12 | 26.78 | .000 | 456.28 |
| mutuality | 6.2 | 1.38 | 20.61 | .002 | 519.92 |
| in-stars | -3.2 | .91 | 12.39 | .000 | .041 |

Table 4: Revealed VNs

In Table 4, θK is the MPLE (maximal pseudo-likelihood estimator) for the strength parameter of class K of VNs; SE is an estimate of its associated standard error, exp(θK) measures the increase (or decrease, if θK negative) in the conditional odds of creating a response tie between any pair of participants if that response tie completes a new VN of class K.

We tested the hypotheses that θK = 0 by the Wald parameter $(\theta K/SE)^2$ which is assumed to have chi square distribution. Table 3 shows that all these null hypotheses were rejected with extremely small p values.
The statistical distributions of the MPLEs and the Wald parameters are unknown (Robins and Pattison 2002), so inferences are not precise in the pure statistical sense.

**Results**

Few classes of VNs are significant: 3 in the Team, 4 in the Forum. In particular, the personal classes of VNs of students, $resp_i$ and $trigg_i$, are not significant. This corroborates hypotheses H8 and H9.
The relative importance of the classes of VNs is depicted by their contributions to the goodness of fit of the Markov models. These are presented in Figure 2.

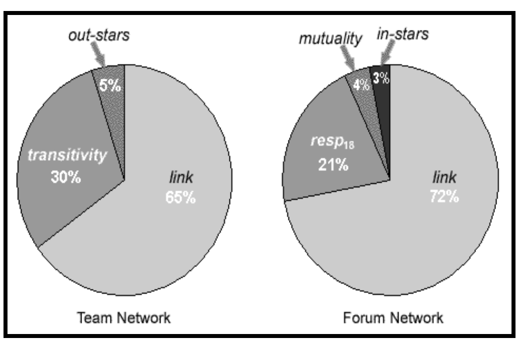


Figure 2. Relative importance of VNs

Figure 2 shows that the global class link of the single response tie virtual neighborhoods is the most significant in both communities: 65% and 72% of the goodness of fit are explained by the tendencies associated with this class. Table 5 shows that in both communities the strength parameter θ of the link class is negative. This means that the major observed phenomenon in both communities is a significant tendency for not creating single response tie neighborhoods – the phenomenon of lurking. As elaborated above, this can be explained by basic self interest – minimizing the effort required to forge a response tie vs. the possible social capital reward, given that every response tie is a redundant viewing tie. This observation is in accordance with hypothesis H1. Note that the fact that response ties are redundant viewing ties is a feature of every broadcast community, irrespective of the design of the community.

By itself, the negative tendency to create virtual neighborhoods of class link will give rise to a community of non-responsive isolates. The actual responsiveness is formed by the other neighborhoods. These neighborhoods are quite different in the two communities. The significant virtual neighborhoods in the team community are from the global classes transitivity and out-stars. The significant virtual neighborhoods in the forum community are from the personal class $resp_{18}$, and from the global classes mutuality and in-stars. In the subsections below, we will consider each of these virtual neighborhoods.

The goodness of fit of the Markov model for the team community increases by 30% when the transitivity class of virtual neighborhoods is included. In this community there is a positive tendency to create transitive virtual neighborhoods. This means that in the team community, the likelihood of setting up a response tie from any actor i to any other actor j is enhanced (by 1.37) if that tie completes a transitive triangle virtual neighborhood. This is relative to the likelihood of setting up any other neighborhood. No such preference exists in the forum community. Hypothesis H6 – the tendency for creating virtual neighborhoods of the transitivity class is positive – is therefore accepted for the team community but rejected for the forum community.

The tendency to create transitive structures can be explained by cognitive balance theory. It seems that the design of the team community leads to the cognition balance mechanism, by which dissonance between actors and between their perceptions of objects is resolved by balanced paths of communication. This can be attributed to the interdependence built into the design of the community and to the particular goal which forced the participants to reach consensus during the online debate (in order to submit joint proposals). The forum community, on the other hand, was a series of typical Q&A sessions. Here each of the students participating was interested at a certain point in time in a specific issue usually related to an assignment. The scope of the issue was, in many cases, limited; it interested few students. Other issues, or even related concepts not directly connected to the query, were less important to the student who asked the question, let alone to other students. The lifetime of each issue was short (usually until the assignment due date). There was no drive to settle conceptual inconsistencies regarding past issues, or dissonance in perceptions regarding others. Thus, no cognition balance mechanism was needed and none was established.

Introducing the personal class $resp_{18}$ to the model of the forum community increases its goodness of fit by 21%. This class includes all the virtual neighborhoods of single response ties initiated by N18 – the tutor. This means that the residual tendency of N18 to respond – above and beyond the common tendency accounted for by link – is significant. Specifically, in the forum community the odds of setting up a response tie ($i \rightarrow j$) increases (by 1,280) if actor i is N18, the main responder in this community. In contrast, the personal class of the tutor's responses in the team community, $resp_1$, is statistically insignificant. $resp_1$ neighborhoods are therefore not significant in the explanation of the behavior of the team community. This simply means that the tutor of the team community, P1, showed no tendency to respond. Hypothesis H10 – the tutor's residual responsiveness is significant – is accepted for the forum community but rejected for the team community.

This difference is attributed to the difference in the role-assignment design of the two communities, which leads to different responsibility mechanisms. The tutor of the forum community was assigned the job of responder. The tutor of the team community was – deliberately – not assigned that role. This results in a difference in their responsibility mechanisms which leads to the difference in their tendency to create the personal class of virtual neighborhoods. A similar observation, mentioned above, is that none of the students in either community showed a significant personal residual tendency to respond, which supports hypothesis H8. This again is attributed to the fact that students in both communities were not controlled by responsibility mechanisms because they were not assigned any particular role. Similarly, in both communities every actor could trigger others by posting a question. No student was pre-assigned the role of trigger. This is reflected in the insignificance of the $trigg_i$ class of neighborhoods (consisting of a single response tie towards actor i), in agreement with hypothesis H9.

We see that the tutors in both communities had no significant tendency to trigger others, contrary to assumption H11. Checking the designs of the two communities, we see that the tutors' behavior was not controlled by responsibility mechanisms, but by other factors. In the forum community, the tutor served only as a helper or responder; no initiation of discussion was designed; accordingly, no triggering role was assigned to the tutor. In the team community, discussion was initiated by the tutor, but the design of the collaborative work dictated that the tutor should step aside. The tutor was therefore not responsible for triggering others.

Incorporating the out-stars class increases the goodness of fit of the Markov model for the team community by 5% but has no significance for the forum community. This means that in the team community the likelihood of forging a response tie from any actor i to an actor j is enhanced (by 1.2) if the tie completes an out-star. No such tendency is observed in the forum community.

The tendency to create out-stars, that is, to forge more than one response tie can be explained by the contagion theory (hypothesis H5) and the theory of collective action (hypothesis H2). The theory of contagion predicts tendencies toward both in-stars and mixed-stars, but these predictions were not supported by the data of either community. Thus, hypothesis H5 was rejected for both communities. In general, contagion by exposure, as found in friendship relations, is a time consuming process, which presumably could not be developed during the short lifetime of the communities (one semester).

The hypothesis concerning the theory of collective action, H2, was accepted for the team community but rejected for the forum community. This theory assumes the development of peer pressure, provided that the community parameters of density and centrality are above threshold values. This condition is fulfilled for the team community, but not for the forum community, as can be seen in Figures 2 and 3. In general, developing peer pressure is not trivial, as it has to overcome the basic tendency for lurking. In the team community, appropriate initial conditions – commitments, interdependence, and in particular promotive interactions – were set up, and peer pressure was maintained by the tight schedule of common sub-goals imposed on the community. None of these features were designed into the forum community, hence the density and the number of central actors did not reach the thresholds required for peer pressure to work. In the absence of peer pressure, no drive for collective action arouse, which is the reason for the non-significance of the out-stars class of virtual neighborhoods in the forum community. The differences between the two communities in the tendencies for out-stars is explained quite well by the theory of collective action.

The mutuality class of virtual neighborhoods accounts for 4% of the goodness of fit of the Markov model for the forum community. It has no significance for the team community. This means that in the forum community the likelihood of setting up a response tie from any actor i to any actor j is enhanced (by 5,000) if that tie closes a mutual tie. (As stated elsewhere in this paper, the actual number is not precise). This is relative to the likelihood of setting up a tie which is not part of a mutual tie. No such tendency for mutuality neighborhoods exists in the team community. Thus, hypothesis H3 is accepted for the forum community but rejected for the team community.

Hypothesis H3 predicts a tendency for mutuality virtual neighborhoods on the basis of the exchange mechanism postulated by the theories of exchange and resource dependency. Actors select their partners for response according to their particular resource-promising state. In the forum community the actors prefer to forge response ties (if at all) with partner(s) who usually respond to them – which in this community is the tutor. The tutor is an a priori resource-promising actor as result of her pre-assigned role. This kind of exchange calculus is not developed in the team community because actors in that community cannot identify a priori resource-promising actors. Instead, actors in the team community chose another response policy, governed by the cognition balance mechanism, of responding via transitive triads, as we saw above.

The in-stars class of neighborhoods accounts for 3% of the goodness of fit of the Markov model to the forum community but has no significance in the team community. From Table 5 we see that in the forum community in-stars is negative. In the forum community, the likelihood of setting up a response tie from i to j decreases if this tie complements an in-star neighborhood, that is, if some other actor already has a response tie with j. Contagion theory and the theory of uncertainty reduction both predict a positive tendency for in-stars virtual neighborhoods. This prediction is not fulfilled. Hypotheses H5 and H7 are rejected for both communities. As mentioned above, the fact that a contagion process did not develop can probably be attributed to the short lifetime of the communities (one semester). In addition, it seems that there was no need in either community to reduce uncertainties by attracting responses from several sources: in the forum community, the tutor was assigned this role; in the team community, the rules of the game were clearly explained in the document detailing the design of the forum.

We have yet to understand the negative tendency toward in-stars virtual neighborhoods in the forum community. This negative tendency means that participants deliberately avoid responding again to the same actor. This phenomenon is explained by the theory of social capital: responding again to an actor is a waste of energy; it decreases the structural autonomy of the responder.

Neither community shows a tendency for mixed-stars or cyclicity classes of virtual neighborhoods. mixed-stars is predicted by the contagion theory, hypothesis H5; the tendency for cyclicity is predicted by the theory of generalized exchange, hypothesis H4. Both hypotheses were rejected for both communities. As mentioned above, it is plausible that the contagion mechanism could not develop during the short lifetime of the communities. The theory of generalized exchange relies on knowledge transfer through intermediaries, who seem to be unnecessary in online broadcast communities.

Our findings are summarized in Table 5.

| Predicted Hypotheses and Tendencies | Results |
|---|---|
| H1: link < 0<br>Few single tie links | Supported for both communities; feature of every broadcast community independent of design |
| H2: If large density, centralization, and size, then out-stars > 0<br>Respond to several others | Supported in team, but not in forum; difference in meeting threshold conditions due to built-in/lack of promotive interactions |
| H3: mutuality > 0<br>Tendency to reciprocate to resource promising partners | Supported in forum but not in team; difference in existence/non-existence of a priori resource-promising actors due to pre-assigned roles |
| H4: cyclicity > 0<br>Tendency to respond cyclically to resource-promising partner | Not supported in either community, probably because there was no need for information exchange via mediators |
| H5: out-stars > 0; in-stars > 0; mixed-stars > 0; transitivity > 0<br>Respond to same as other equivalent actors | Not supported in either community, probably because contagion process could not develop in the short lifetime of the communities |
| H6: transitivity > 0<br>Respond via several paths | Supported in team, but not in forum; difference due to difference in consensus reaching requirements and interdependence |
| H7: in-stars > 0<br>Attract responses from several others | Not supported in either community; uncertainties were clarified by the design (in team) and by the tutor (in forum) |
| H8: $\{resp_i = 0 \mid i \in students\}$<br>H9: $\{trigg_i = 0 \mid i \in students\}$<br>H10: $\{resp_i > 0 \mid i = tutor\}$<br>H11: $\{trigg_i > 0 \mid i = tutor\}$<br>Residual personal tendencies to respond or trigger only to actors with pre-assigned roles | H8, H9: Supported for both communities; no pre-assigned role of responders to students<br>H10: Supported in forum, but not in team; differences due to differences in pre-assigned roles of the tutor<br>H11: not supported for either community; no pre-assigned role of triggers to students |

Table 5: Summary of Results

## Discussion

Our analysis shows that the minimal-effort hunt-for-social-capital mechanism, predicted by the theory of social capital & transaction costs controls a large part of the behavior of both communities: a negative tendency to respond. This is a feature of every broadcast community, independent of design.

Differences in the goals, interdependence, and the promotive interaction features of the designs of the two communities lead to the development of different mechanisms: cognition balance, predicted by the balance theory, and peer pressure, predicted by the collective action theory developed in the team community, but not in the forum community. An exchange mechanism developed in the forum community, but not in the team community. In addition, the unique pre-assigned role of the tutor in the forum community gave rise to the responsibility mechanism in that community, but not in the team community. The differences in the mechanisms led to the formation of different sets of virtual neighborhoods, which show up macroscopically as differences in cohesion and in distribution of response power. These differences are associated with the differences in the construction of knowledge in the two communities (Aviv et al., 2003).

It should be noted that the important contagion mechanism did not develop in either community. This mechanism, if developed, would have led to social influence and imitation in attitudes, knowledge, and behavior, which would have developed all kinds of star virtual neighborhoods. The required design parameters – promotive interaction – were in place in the team community, but it seems that the lifetime of the community was too short for the development of this mechanism.

There are obvious limitations to the conclusions drawn here. First, we have considered only two communities. In order to capture the commonality, as well as the differences in design, neighborhoods, and mechanisms of online communities, one needs to consider a larger set of communities of different sizes, topics, and, in particular, with different designs. Furthermore, one should consider a set of relations embedded in these communities. One possibly relevant relation between actors is common interest, which can be captured by common keywords in the transcripts and/or common sets of visited web-pages.

Another limitation lies in restricting ourselves to Markov neighborhoods. Pattison and Robbins (Pattison and Robbins 2002) emphasized the possible importance of non-Markovian neighborhoods and brought initial evidence for the empirical value of models that incorporate such neighborhoods. Thus, the dependence structures can, and perhaps should, be treated as a hierarchy of increasingly complex dependence structures.

It seems that SNA can be a useful research tool for revealing community architectures and mechanisms of online communities. There are numerous directions for future research. One direction is "community-covariates interaction." Several studies, such as (Lipponen, Rahikainen et al. 2001), revealed that certain participants take on the roles of influencers (who trigger responses) or of celebrities (who attract responses). Others are isolated – no-one responds to them or is triggered by them. The question is whether this behavior depends on individual attributes or whether this is universal and found across communities. Another direction is "community dynamics," an inquiry into the time development of community structures. When do cliques develop? Are they stable? What network structures determine this behavior? Yet another direction is "large group information overload." It is well known that the dynamics of large groups leads to boundary effects that occur when the group and/or the thread size increases (Jones, Ravid et al. 2002). How are these manifested in online communities?

# Discussion Boards

Dennis Beck

Discussion boards are being used widely in a variety of educational contexts. It makes sense then to explore how the composition of discussion board messages influences the response. This study explores the characteristics of discussion board postings that seem to increase the replies per number of views.

## Discussion Boards

Much research has been done concerning the effectiveness of discussion boards in online learning (Cavalier, 1992; Collins, 1998; Hoadley & Linn, 2000). Several findings were of note. First, collaborative discussion adds value to online learning occurring in a social context (Hoadley & Linn, 2000). Also, students spend more time online learning in discussion boards than they do learning through an online textbook (Hoadley & Linn, 2000). Use of discussion boards seem to promotes interaction and increased communication among students and faculty (Collins, 1998; Coombs, 1992; Zack, 1995). They also seem to prolong course discussions beyond the synchronous time period and motivate even normally silent students to participate in discussions (Schoenfield, 1993). Discussion boards provide a place for students to discuss their internal discourse and share the results of their generative strategies (Morrison & Guenther, 2000). They also foster the development of online learning communities (Egan & Gibbs, 1997). These collaborative learning groups are useful when students need to create new models or correct misconceptions or misunderstandings (O'Malley & Scanlon, 1990).

Ferdig, Roehler, and Pearson (2002) mention intertextuality and level of engagement as two qualitative measures to analyze discussion board postings. Intertextuality is the degree to which responses mention multiple texts, experiences and examples. A high level of engagement is shown when a student responds to a posting by justifying his or her response rather than simply reiterating another's position. Their research found "…a high correlation between the use of a discourse forum to provide critical conversations and creation of a comparably complex and critical written product." (Ferdig, Roehler & Pearson, 2002, p. 11). One of the implications of their research is that discussion boards may provide learners with "…numerous opportunities for posting, reflection, and the internalization of key ideas" (Ferdig, Roehler & Pearson, 2002, p. 12). Based on this finding, I determined to discover what characteristics of discussion board postings would enhance these numerous opportunities for posting. However, the scope of Ferdig, Roehler & Pearson's article did not include whether the presence of intertextuality and high level of engagement in a discussion board posting elicited more responses per number of views than those postings that did not include intertextuality and high level of engagement. My research intended to discover whether a high incidence of intertextuality and high level of engagement may elicit more responses per number of views, as well as uncover any other characteristics of discussion board postings that may elicit more responses per number of views.

## Research questions

In this analysis I investigated which characteristics of online discussion board postings may produce more responses per number of views. I also investigated whether teachers who use these characteristics in their discussion board postings elicit more responses per number of views. I hoped to find out what kinds of messages teachers are posting, as well as how they were being answered.

More research on discussion boards is needed. Specifically, studies into what types of postings may elicit certain kinds of responses would be helpful in promoting discussion boards that develop students' ability to think critically. It is with this consideration that I undertook this study.

This qualitative study focused on the online interactions between those who identify themselves as ESL and EFL instructors on the website: www.eslcafe.com (Dave's ESL Café). Specifically, I looked at instructors whose expert use of discussion boards promotes more replies per number of views than other users. An expert poster was identified when an instructor was seen to have received more replies per number of views than the average of other posters.

## Background and process

Discussion boards are places in the web where people can go to and interact, ask or answer questions, and share ideas on specific topics. Several discussion boards are housed in *Dave's ESL Cafe.* The discussion boards in *Dave's ESL Cafe* are common to discussion boards in general. They provide an asynchronous format where site members may post a topic and responses. The responses within a consistent topic form a "thread." A “response” is recorded when an instructor clicks the reply button, types their message, and then clicks on the submit button. A “view” is recorded when another instructor views the posting, regardless of whether or not they reply to it.

This research studied the messages in the on-line public discussion boards called *Applied Linguistics* (http://www.eslcafe.com/forums/teacher/viewforum.php?f=3) and *Activities and Games* (http://www.eslcafe.com/forums/teacher/viewforum.php?f=1). Messages were collected, characteristics identified, and comparisons made, using the constant comparative method (Glaser & Strauss, 1967). Participant’s names were changed so that anonymity is guaranteed. The *Activities and Games board* and the *Applied Linguistics board* in the ESL Café were chosen specifically because one is a specific content area (applied linguistics) and the other is an activities area (Activities and Games). Thus, they provided a sampling of two different types of boards (content and activities) within the ESL asynchronous discussion boards.

**Research Locale**

This site was chosen because the site content and discussion boards seemed representative of other academically oriented sites on the web. The site is run by Dave Sperling. During the last 17 years, he has been a Professor of advanced English subjects at California State University, Northridge. He is recognized as an expert in ESL methodology on a global scale as he participates in numerous national and foreign conferences. ESL Cafe focuses in assisting worldwide ESL (English as Second Language) and EFL (English as Foreign Language) students and teachers. This web site offers links to all types of educational resources, including articles, online ESL publications and courses, teacher training, grammar, and writing. The site has a section devoted to bulletin boards, an asynchronous format where site members may post a topic and responses.

Data was gathered by first identifying several instructors whose postings generated more responses per number of views than the average of other posters. This was discovered by counting the threads, number of postings, and number of views per instructor during the week in question. After averages were calculated, the instructors who ranked in the top five in terms of rate of responses per number of views were selected as our expert posters. Non-expert posters were identified as those whose rate of responses per number of views was below the average of all posters. The responses of the expert posters were collected by logging on to the site, following the threads of each instructor, and copying all items in a thread. Data was collected from both the Applied Linguistics and Activities and Games forums during fall 2004 for one week. This yielded approximately 30 threads per instructor with anywhere from 5 to 20 messages in each thread. Similar data was also collected from an equal number of non-expert or average instructors.

The data were analyzed by first reading the threads associated with each selected instructor. It was through reading these threads that several specific characteristics began to emerge. Data from other instructors whose postings did not elicit the same rate of responses were then collected, read, and analyzed through the application of these specific characteristics. During the week in question, instructors began 13 topics, made 206 postings and viewed 2852 postings in the applied linguistics forum (.0676 replies per view). In the Activities and Games forum, instructors began 5 topics, made 27 postings and viewed 2213 postings (.0099 replies per view). Our expert posters averaged .1079 replies per view.

Table 1

| | Topics | Postings | Views | Postings per view |
|---|---|---|---|---|
| **Applied Linguistics Forum** | 13 | 206 | 2852 | .0676 |
| **Activities and Games Forum** | 5 | 27 | 2213 | .1079 |

Dave’s ESL Café is designed so that the topics or threads are divided into categories, which can include everything from activities and games to video in the classroom. In each topic, a member may begin a thread by posting a question or statement he or she would like answered or commented on in the forum of choice. Many of the topics or threads were those that would be considered relating to practical or academic issues related to ESL and EFL instruction. One thread followed throughout the week concerned the discussion of the quote, "Pragmatic failure has more potentially devastating consequences than linguistic failure." (Braden, taken from http://www.spanport.ucsb.edu/projects/llcf/Eral/Reviews/Susanb/Matsudainterlanguage.html, ERAL, E-reviews in applied linguistics and language learning on November 19, 2004). On this thread, teachers discussed whether they agreed or disagreed with the quote and why, citing other references, resources, and examples when appropriate. This topic was used to generate discussion about the importance of pragmatics and give support to instructors struggling in how to teach it.

**Investigation**

Dave's ESL Café publishes the messages in a public format that allows anyone who finds the site to read them. Thus, the data were collected by observing and following threads; as a researcher, I did not make my presence known, nor did I interact with or contact site members in any way. As part of the collection procedure to protect the confidentiality of the members, all screen names and dates of posting were immediately removed from each message. I chose to observe rather than ask for permission because of the public nature of the site, and the concern that identifying myself as a researcher might change the nature of the interaction online. This means that the members of the website were and are ignorant of my presence as a researcher. This study is limited to the single data source of the posts by members. While these posts provide a rich data source, they do not allow for any interaction between the researcher and the site participants. Therefore, the analyses provided do not allow for ethnographic analyses. Further research in this area must make use of other observation procedures in order to better understand the multifaceted character of online discussion board postings, as well as to give expression to the individuals posting the messages in an open interface with the investigator. Although the possibility exists to do research on the Internet in publicly accessible areas, depending on the situation, it may be more revealing to do so overtly. Future observation procedures which may yield interesting results are anthropological and ethnographical in nature. Research into the historical background of certain quotes, references, and examples which yielded more responses per number of views may produce interesting outcomes in terms of how it has been analyzed and commented on previously, and how those historical comments are similar or different in structure to present day commentary. Also, immersion into the culture of discussion boards may yield interesting insights into the thought processes that contribute to writing an expert posting.

**Data Analysis**

Why did *bobthelinguist*, *Andrea Jones*, *Jennagirl*, *punkrockartist*, and *SallySmith's* (names have been changed) postings elicit more responses per number of views than other users (from this point forward I shall refer to the above mentioned users as our expert posters)? Discussion boards can promote interaction and increased communication (Collins, 1998; Coombs, 1992; Zack, 1995), and foster analytical and evaluative conversations (Ferdig, Roehler & Pearson, 2002) while providing a place for students to discuss their internal discourse and share the results of their generative strategies (Morrison & Guenther, 2000). As a result, it makes sense to explore the question of why our expert posters elicited more responses per number of views than other users. In other words, what common characteristics or themes might cause this increase in responses, and are these characteristics consistent with current research?

*1. Number of Sentences in a posting*

As I analyzed the data, several common characteristics were identified in the postings. First, our expert posters averaged ten sentences in their postings. The average length of postings for non-experts was six sentences. Although length of postings was not uniform in the non-expert group, they were uniform among our expert posters.

*2. Content specific postings*

Second, our expert posters were very content specific in their postings. For example, consider the following postings by one of our expert posters (*Jennagirl*) and a non-expert poster (*Eddie*):

*Jennagirl:*

"This article is a clear reiteration of what we have all heard before. How about trying to deal with some of the criticisms instead? For example, that troublesome one on the other thread about how any old nonsense creates a polite 'distant' sentence, whether it be a past tense form or not.

Anyway, is this article surprising to anybody? Does anyone really think that tense and aspect are generated by a precise location on a rigid time chart, rather than by perspective and temporally linked context?"

*Eddie:*

"The mainstream has explained Present Perfect with *since*. "

Notice how content specific *Jennagirl* is in her postings. Now compare this with the post by a non-expert group poster, *Eddie*. While *Jennagirl* gives a rich context and specific content for her question, *Eddie* simply makes a statement without context. This content specific posting elicited more responses per number of views than *Eddie's*.

*3. The use of examples, quotes, and references*

Another common characteristic in the expert's postings was the use of plenty of examples, quotes, and references. Note the following examples by *bobthelinguist* (edited for brevity) and the non-expert poster, *Frodo*:

*Bobthelinguist:*

“"Critical period" only makes total sense to me in the context of feral "wolf children" and the like (that is, if children aren't exposed to ANY language before a certain age, they seem to have have little hope of ever being able to learn a language and make much sense of the world).

His (Krashen's) ideas about "comprehensibility" (of input, which can aid "acquisition" processes) are useful to consider, if only because approaches can often be either too "mindless" (repetitive, and not addressing meaningful contexts very much) or too "mindful" (explicitly studying grammar and pondering finer distinctions of meaning than is perhaps necessary).

Whether he really has a point about "acquisition" versus "learning" *absolutely* is another point entirely, however (I recall Jeremy Harmer providing a good discussion of this in the Second Edition of his *The Practice of English Language Teaching*); I think the important thing is merely that we come to possess insight or knowledge, and both formal and informal encounters can lead to pretty much the same thing somehow ending up in our heads (especially if the context as presented in a classroom were an informal context itself)!

In my own experience, I just know that I needed to have some idea of what was possible form-wise (from formal, book learning) to make total sense of and really appreciate whatever informal language spontaneously came my way, so I think Krashen is being a bit silly when he says that learning/studying is unnecessary or almost a bad thing. Even those people I've met who professed to have picked up a language without any formal study turned out to have often asked questions about meaning of their conveniently bilingual wives (their "walking, talking dictionaries"!).

*Frodo:*

“Does anybody can help me? I'd need some Halloween crafts to do with my little students (from 5 to 8 years old), so they should be easy to do and cheap. Many thanks in advance”

Notice that *bobthelinguist* uses several personal examples (in his comments about learning on the street, in comments on the need for studying, etc.), and references other sources (Jeremy Harmer, Krashen), while Frodo only asks a question. The examples and references used by *bobthelinguist* were referred to in several other user responses and seemed to promote more responses per number of views than postings that did not use examples and references.

*4. Quoting parts of previous postings*

When our expert posters quoted parts of previous posts before answering, the result seemed to be more responses. For example, *Andrea Jones* said:

> “**Quote:** *How are we with: It was a very fine day.*
>
> Yes, I'm fine with that.
>
> I think that :
>
> 1) "fine" when talking about threads or material means either gosamer-like or high quality.
>
> 2) When talking about other people or the weather it means high quality/great/nice.
>
> Both these uses are gradable.

This was not a common practice among non-expert posters. Quoting part or all of a previous posting seems to provide a link from the current posting to the one being quoted. Suler says that this technique may lead to “…interesting, interweaving, multi-layered dialogue.” (2004, p. 399). The link is clearer to the reader and is more likely to be commented on in future postings, resulting in more responses per number of views.

*5. Contributing to an ongoing story*

Another common characteristic in the expert's postings is that their postings seemed to contribute to an ongoing story. Here's one example:

> “I attended an interview recently to teach at a small school where the majority of my students would be kids between the ages of 3 and junior high school age.
>
> After some basic fact-finding Q&As, the manager of the school and her sole foreign teacher handed me a pile of food and drink flashcards (ice cream cone, slice of pizza, glass of OJ and the like) and asked me to demonstrate how I would "teach the difference between *like* and *want*".
>
> Now call me a slacker and inexperienced despite my years in the "profession", but I must admit that I was a bit stumped (then again, what can anyone expect given zero preparation time? It's not like I don't usually prepare for my lessons!).
>
> My initial reaction as I heaved myself up to do "something" (anything!) was that *want* is the far less appropriate or polite (at least in its probable relation to foodstuffs!) than *like* (and after a bit more thought, I think our *wants* are much "deeper" and not as easily or openly expressed as our *likes*). Anyway, in this context, I reckon *like* was by far the better thing to teach, why introduce *want* at all?!

I am sure we are all familiar with the "host offering refreshments to visitors" script:
Host: Do you want/Would you like anything to eat/drink? (I have OJ, coke...or do you want a beer? etc).
Visitor: Can I have... (?I'd like...; *I want...)
So, ultimately, I thought the demonstration question was more revealing of how my potential boss would teach it than how I would (or wouldn't) go about things. I could envisage the kind of lesson they wanted: me maniacally waving flashcards and shouting "I'm hungry! I like bananas! I want a/the (?) banana! NOW, dammit!!!". I won't presume to bore you with how exactly I winged my way through it before crash-landing (besides, I can't really remember much).”

The expert poster *punkrockartist* provided a personal story to set up his question. Story seems to possess an inherent ability to make a case without provoking intellectual opposition (Friedlander, 1992; Slater, 1990; Slater & Rouner, 1996, 1997). Story may also provoke less inquiry through the temporary deferral of skepticism (Graesser, 1981; Slater, 1990) and connection with the central character’s outlook (De Vega, Diaz, & Leon, 1997; Slater & Rouner, 1997). People regularly utilize story to show their positions and to persuade others of the soundness of their position (Berger, 1997; Fisher, 1984, 1985). There are multiple ethnically oriented groups that utilize story to enculturate members into their group. This stems from an educational viewpoint that story will lead to greater retention of information than isolated statements (Bruchac, 1996). Consistent with this literature, the result in this case was that our expert poster, punkrockartist, received more replies per number of views than other users who merely posted a question.

*6. Contributing to own thread after initial posting*

The last common characteristic I examined was that the expert posters seemed to contribute to their own thread after their initial post much more than other posters. In one particular thread, after her initial post, *Andrea Jones* responds three other times in a thread containing 16 posts. Compare this to the non-expert poster *Frodo,* whose only contribution to the thread is his initial posting. *Andrea Jones’* practice displays a high level of interactivity and high level of engagement. She is not merely restating what others say, but she is clarifying and justifying her posting. Other users replying in the thread seem to appreciate her attention to the topic, and are spurred on to post more replies.

*Discussion and Conclusions*

The common characteristics identified in the postings of those users who regularly elicited the most responses were a) User contributes to an ongoing discussion/story, b) User contributes to own thread after initial post, c) User’s posting was very content specific, d) User quotes parts of previous posting before responding, e) User averaged ten sentences or more in postings, and f) User regularly used examples, quotes, and references. From this study on these ESL discussion boards, it can be extrapolated that these are common characteristics that should be present in ESL/EFL discussion board postings on the whole. However, these characteristics of postings that promote more responses per number of views cannot be applied to other discussion boards without further cross-topical studies to confirm these results. Future studies may provide this needed confirmation, as well as answer the question of why each characteristic elicited more responses.

As stated in the introduction, it was my belief that a high incidence of intertextuality and high level of engagement may promote more responses to a discussion board posting. Our study showed that expert posters regularly used examples, quotes, and references. This would seem to indicate that intertextuality may promote more responses to a discussion board posting. Also, our study showed that expert posters regularly contribute to their own thread after their initial post, providing both clarification and justification for their initial posting. This seems to indicate that a high level of engagement promotes more responses to a discussion board posting.

One implication of these findings is that the characteristics found are connected. As noted above, contributing to your own thread after the initial post seems to be evidence of a high level of engagement. The content specific posting characteristic may also contribute to a high level of engagement, as the presence of specific content was often included statements of justification and clarification. Further, quoting parts of previous postings before responding seemed to provide an intellectual springboard to launch other opinions or arguments. This characteristic seems related to both intertextuality and a high level of engagement. The average of ten sentences or more in postings is most likely the result of instructors who have reflected deeply on a subject and thus have more to contribute than most users. Contributing to an ongoing story is connected to intertextuality in that the presence of multiple texts, experiences, and examples are often present in story.

Although these characteristics need to be confirmed by future cross-topical studies, it may be fruitful for instructors to use these characteristics in the creation of a discussion board posting rubric. Thus a posting that followed this rubric may help promote critical thinking and metacognition in learners (Ferdig, Roehler & Pearson, 2002).

Another difference in the study noted was the significant increase in responses per number of views in the Applied Linguistics board compared to the Activities and Games board. This may indicate that more responses are generated for a content specific discussion board (Applied Linguistics) than one that is cross-topical (activities and games). However, this comparison did not hold true when comparing the responses per number of views to other discussion boards in the ESL Café. Another possible explanation may be that because Applied Linguistics is central to ESL/EFL instruction, it garnered the highest responses per number of views. Determining whether this is the case would be a good question to investigate in a future study.

**References**

Berger, A. A. (1997). *Narratives in popular culture, media, and everyday life.* Thousand Oaks, CA: Sage.

Bruchac, J. (1996). *Roots of survival: Native American storytelling and the sacred.* Golden, CO: Fulcrum.

Cavalier, R.J. (1992). Course processing and the electronic AGORA: Redesigning the classroom. *EDUCOM Review, 27*, 32-37.

Collins, M. (1998). The use of Email and electronic bulletin boards in college-level biology. *The Journal of Computers in Mathematics and Science Teaching, 17(1),* 75-94

Coombs, N. (1992). Teaching in the information age. *EDUCOM Review, 27*, 28-31.

Davis, T., McLeod, M. (1999). Designing the tribal virtual college of tomorrow. *Tribal College. 10(3),* 10-13.

De Vega, M., Diaz, J. M., & Leon, I. (1997). To know or not to know: Comprehending protagonist's beliefs and their emotional consequences. Discourse Processes, 23, 169-192.

Egan, M. W., & Gibbs, G. S. (1997). "Student-centered instruction for the design of telecourses." In T. E. Cyrs (ed.), *Teaching and Learning at a Distance.* New Directions for Teaching and Learning, no. 71.

Ferdig, R.E., Roehler, L., Pearson, P.D. (2002). Scaffolding preservice teacher learning through web-based discussion forums: An examination of online conversations in the Reading Classroom Explorer. *Journal of Computing in Teacher Education, 18(3),* 87-94.

Fisher, W. R. (1987). *Human communication as narration: Toward a philosophy of reason, value, and action.* Columbia, SC: University of South Carolina Press.

Fisher, W. R. (1984). Narration as a human communication paradigm: The case of public moral argument. *Communication Monographs, 51*, 74-89.

Fisher, W. R. (1985). The narrative paradigm: An elaboration. *Communication Monographs, 5*, 347-367.

Fisher, W. R. (1985). The narrative paradigm: In the beginning. *Journal of Communication, 35*, 74-89.

Friedlander, S. (1992). Talks on Sufism: When you hear hoofbeats, think of a zebra. Costa Mesa, CA: Mazda.

Giorgi, A. P., & Giorgi, B. M. (2003). The descriptive phenomenological psychological method. In P. Camic, J. Rhodes, & L. Yardley (Eds.), *Qualitatie Research in Psychology* (pp. 243-273). Washington, DC: American Psychological Association.

Glaser, B. & Strauss, A. *The discovery of grounded theory.* Chicago: Aldine, 1967.

Graesser, A. C. (1981). *Prose comprehension beyond the word*. New York: Springer.

Hoadley, C. M., Linn, M. C. (2000). Teaching Science through Online, Peer Discussions: SpeakEasy in the Knowledge Integration Environment. *International Journal of Science Education 22(8),* 839-857

Morrison, G. R., Guenther, P. F. (2000). Designing Instruction for Learning in Electronic Classrooms. *New Directions for Teaching & Learning. 84(Winter, 2000),* 15-22.

O'Malley, C. E., & Scanlon, E. (1990). Computer-supported collaborative learning:
Problem-solving and distance education. *Computers in Education, 15*, 127–136.

Robinson, K. M. (2001). Unsolicited Narratives From the Internet: A Rich Source of Qualitative Data. *Qualitative Health Research, 11(5),* 706-714

Schoenfield, C. (1993). Electronic forum vivifies the classroom. *Academic Leader, 9(11),* 1.

Slater, M. D. (1990). Processing social information in messages: Social group familiarity, fiction vs. non-fiction, and subsequent beliefs. *Communication Research. 17*, 327-343.

Slater, M. D., & Rouner, D. (1996). Value-affirmation and value-protective processing of alcohol education messages that include statistical evidence or anecdotes. *Communication Research. 23*, 210-235.

Slater, M. D., & Rouner, D. (1997, May). The processing of narrative fiction containing persuasive content about alcohol use: Effects of gender and outcome. Paper presented to the International Communication Association, Montreal, Canada.

Suler, J. (2004). In class and online: Using discussion boards in teaching. *Cyberpsychology & Behavior, 7(4),* 395-401.

Zack, M.H. (1995). Using electronic messaging to improve the quality of instruction. *Journal of Education for Business, 70*, 202-206.

# A Tool for Supporting Urban Teachers in Training

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### Introduction

The authors' aim is to help novice teachers develop as purposeful instructional designers and reflective practitioners – professionals who can work with the complexities of teaching and classroom contexts in an age of rapidly advancing digital technology and cultural diversity. This paper will briefly describe the context, rationale, and a conceptual model for an electronic tool that will help address this goal.

### Context

The Crossroads project is sponsored by the Preparing Tomorrow's Teachers for Using Technology (PT3) program of the Department of Education. Based on one of the grant's objectives, the presenters were charged with designing and ultimately developing an online support environment for novice teachers' technology integration in urban schools. The system, TEPSS (Teachers Electronic Support System), consists of four fully integrated components: a) An instructional design/lesson planning wizard will guide the users through designing an activity based on the CITIS ID model for Culturally Infused Technology Integration; b) a Video Reflection tool will guide students through editing and reflecting on video footage of themselves implementing their activities; c) communications tools (Email, BLOG, Chatroom); and d) information/resources (systems help, instructional resources, best practices, job aids) will be available at any point within the system.

### Rationale

Novice teachers experience a variety of challenges not limited to classroom management, subject matter expertise, teacher-parent communications, organization, locating resources, and developing rapport with students. Preparing to teach in a high need, low socio-economic status (SES) school can significantly increase the burden placed upon novice teachers in urban environments. Sachs (2004) identified five attributes of effective urban teachers that have been consistently recognized by researchers: a) sociocultural awareness b) contextual interpersonal skills, c) self-understanding, d) risk-taking, and e) perceived efficacy. According to a literature review by Hogan, Rabinowitz and Craven (2003), there are several important differences between expert and novice teachers in the area of pedagogy. Unlike expert teachers, novice teachers fail to visualize planning as a scaffold of events. Instead, they perceive lesson planning as an individual, daily episode unconnected to the curriculum as a whole. Experienced teachers require more details when planning a lesson (such as availability of equipment, student ability and prior knowledge). In contrast, novices generally disregard these details and proceed to develop the lesson. Experts tend to use multiple assessment strategies throughout a lesson in order to understand students' schema before introducing new material. Novices tend to teach in ways that disregard the importance of the connection between prior and new knowledge. While experts regard the classroom as a make-up of individuals with personal prior knowledge and individual differences, novices attach a group identity to the class and base their instructional strategies on a general level of ability, knowledge, interest and cultural identity.

Increasingly, beginning teachers are encountering schools with students diverse in culture, ethnicity, race, religion, and language. Effective teachers who meet the needs of these diverse learners are skilled in culturally responsive pedagogy (Gay, 2002; Ladson-Billings, 1995). According to Gay and Kirkland (2003), culturally responsive teaching includes "using the cultures, experiences, and perspectives of African, Native, Latino, and Asian American students as filters through which to teach them academic knowledge and skills" (p.181). This approach validates students' cultures by teaching racially diverse students to have a positive cultural identification of themselves and others. In order for preservice teachers to create meaningful instruction that is culturally relevant, they need to develop deeper self-knowledge about how their own backgrounds and beliefs might shape their teaching and their students' self- perceptions (Howard, 2003).

Reflection is an important part of professional practice and professional growth (Dewey, 1933; Schön, 1983; 1987). It is especially important in the development of culturally relevant pedagogy (Howard, 2003). Schön (1983) suggested that there are two types of reflection: reflection-on-action (looking back on an incident) and reflection-in-action (considering the incident as it unfolds). According to Schön, reflection-in-action depends on the intuitive performances that lead to surprises. These "surprises" may be something pleasing and desired or confusing and unwanted. Reflection-in-action is bounded by the "action-present," the amount of time in which an action can impact the situation. Killion and Todnem (1991) extended the ideas of Schön to include reflection-for-action, the desired outcome to guide future action. Thus the reflection process simultaneously includes past, present and future timeframes.

The key to effective reflective practice lies in helping pre-service teachers look beyond the "technical" and contextual aspects of teaching to questioning their knowledge and assumptions (Van Manen, 1977; Gay & Kirland, 2003). Ideally the level of reflection parallels the growth of the practitioner from novice to expert (Van Manen, 1977). However, Ferry and Ross-Gordon's (1998) research on links between experience and reflection indicates that experience alone may not promote more sophisticated levels of reflection. It may have more to do with the way in which the educator uses the experience to reflect upon specifics of a problematic situation that fosters development into an expert as apposed to an experienced non-expert.

Although teacher education programs can not graduate experts, they can assist pre-service teachers in developing their pedagogical expertise more quickly and increasing their level of reflection. As emphasized by Sparks-Langer and Colton (1991), "teachers need the opportunities to construct their own narrative, context-based meaning from information provided by research, theoretical frameworks, or outside experts" (p.43). We would add that these narratives can and should be connected somehow to their experiences in schools. Instructional design models are useful tools in helping novice instructional designers to think more like an expert. They provide explicit directions, steps and scaffolding for the beginning designer. A design model which addresses the pedagogical gaps typical of novice teachers, the complexity of technology integration and the tenets of reflective practice could assist pre-service teachers with lesson design in urban environments.

**Proposed Model: CITIS**

Culturally Infused Technology Integration Support (CITIS) is a two-part model (see figure 1). One component is a scaffold for lesson/activity design; the other represents a metacognitive process to promote reflection. The authors' aim is to help novice teachers develop as purposeful instructional designers and reflective practitioners – professionals who can work with the complexities of teaching and classroom contexts in an age of rapidly advancing digital technology and cultural diversity. CITIS blends a learner-centered philosophy with the proper amount of guidance needed to help novice teachers become more comfortable planning activities for their classrooms. CITIS also infuses the cultural and socioeconomic awareness necessary for working in urban environments. This is not a prescriptive model, rather one that can guide novice teachers and teacher educators in their investigation of successful teaching practice.

Part 1 contains nine elements of lesson design performed in five stages. In stage 1, the preservice teachers identify the curriculum and its corresponding standards as well as the cultural context and learner characteristics. They identify the students' knowledge, skills, and attitudes related to the curriculum as well as preferred learning styles. Curriculum and standards information may be obtained from local and state curriculum guides, national educational organizations, textbooks, school faculty and other resources. After reviewing the curriculum, the beginning teachers consider how they will tailor the subject matter to better reflect students' ethnic and cultural diversity. A review of the materials may reveal gender or cultural bias or absence of a particular culture's representation such as those of Indigenous or Latino authors. Supplemental materials may need to be added. During this time, the preservice teachers may use surveys, pre-tests, or class discussions in order to identify students' prior knowledge and skills as they relate to short stories, such as story elements and literary devices, as well as interest inventories to measure attitudes such as those towards the genre, the potential themes to be discussed, reading in general, and preferred learning styles.

Once the initial analysis is complete, the preservice teachers move to stage 2: identify the long-term goals. The long-term goals reflect both the analysis of the learner as well as an analysis of the curriculum. Repeating the goals for the unit of curriculum each time the daily lesson plans are written is designed to help novice teachers avoid the pitfall of dividing lessons into discrete pieces of instruction (Hogan, Rabinowitz & Craven, 2003).

At stage 3 the preservice teachers write the objectives and plan the assessments, design the activities and select the technology and materials needed for the lesson. These elements are recursive. The teachers may modify each as they works through this stage of the design process. Teachers often list performance standards as their objectives; thus, CITIS prompts the novice teacher to rewrite these standards into measurable outcomes that reflect their learners' characteristics and align with the broad curriculum goals. At the same time, the preservice teachers should also determine what evidence they will use to determine if the students have achieved the desired understanding. Teachers tend to think of assessment as a "single-moment-in-time test at the end of instruction" (Wiggins & McTighe, 1998, p.12). As suggested by Wiggins and McTighe's Backward Design Model, our model encourages beginning teachers to collect multiple and varied pieces of evidence over time in order to document students' ongoing inquiry, rethinking and growth. As the teacher designs the activities and plans for integrating technology and/or other materials into the lesson, consideration is given to creating instruction and learning opportunities that recognize students' differing cultural capital, promotes critical thinking and problem solving, and uses technology as a tool to support meaningful learning. Students could be given options for the format such as a newspaper, short story, or visual presentation. A variety of software and could be used to create the final products. The novice teachers would plan to conduct process interviews with students throughout the project in order to gain information about the students' metacognitive processes during the project's process phase. Rubrics would be used to assess the products of student learning. During this recursive step, the preservice teachers might realize that their learners need other skills in order to complete the final product; thus, add additional objectives and modification of the lesson activities would occur during this stage.

In stage 4, the teacher is asked to implement the activity and assess student performance. These activities generally occur simultaneously as the teacher checks students' understanding and ability to meet the lesson objectives. In the final stage, the beginning teachers evaluate how well they implemented the lesson. This is the critical reflection piece of our model: the metacognitive component.

Part 2 of the model focuses on the metacognitive activities of teachers. This part of the model is designed to help novice teachers develop more complex schemas for both pedagogical problem solving and pedagogical content knowledge development. Based on Schön's (1983) idea of reflection-in-action, pedagogical problem solving is the ability of the teacher to analyze a learning situation in progress, select appropriate strategies or interventions and make corrections while teaching. Pedagogical content knowledge (PCK) is the teachers' ability to identify learning difficulties and students' misconception combined with the fluidity to transform subject matter using "the most powerful analogies, illustrations, examples, explanations, and demonstrations—in a word, the ways of representing and formulating the subject that makes it comprehensible for others" (Shulman, 1986, p. 9). The concept of schema is fundamental to cognitive theories of representation. These theories seem to agree that a schema has the following characteristics: a) it is an organized structure that exists in memory, and in total, contains the sum of one's knowledge of the world; b) it exists at a higher level of generality, or abstraction than one's immediate experience with the world (Paivio, 1974 as cited by Winn, 2004); c) it provides a context for interpreting new knowledge as well as the structure to hold knowledge; and d) it is dynamic and can be changed as a result of general experience or through instruction. As novice teachers learn through daily experiences and instructional intervention, their memories and understandings of the world change (Winn, 2004). Based upon the definition of schema as a dynamic construction, we propose to facilitate the continuous development of preservice teachers' *schema* regarding effective teaching and learning.

Thus, in this stage of CITIS preservice teachers are scaffolded through a reflective process in which they consider four elements: student data, experiential data, cultural awareness and their mental models of teaching. First the preservice teachers make meaning of the students' performance derived from both informal and formal assessments given during this lesson and built upon it from previous lessons. Next, the preservice teachers are asked to reflect on the experiential data derived from the lesson they have recently designed and implemented in order to select Critical Incidents (Tripp, 1993) that impacted their students' learning. Tripp (1993) suggests that teachers identify or "create" Critical Incidents based upon value judgments: "Incidents happen, but critical incidents are produced by the way we look at a situation" (p.8). Critical Incidents provide preservice teachers a venue for deeper and more profound levels of reflection as well as a means to challenge their schema (Griffin, 2003; Hamlin, 2004). By "a deeper level of reflection", we are referring to not only analysis and clarification of practices and consequences (technical), meanings and assumptions (practical), but also consideration of ethical, moral, and political issues (critical) (Gay & Kirkland, 2003; Sparks-Langer, Simmons, Pasch, Colton, & Starko, 1990; Van Manen, 1977). Using Griffin's (2003) framework for reflecting on the Critical Incident, preservice teachers document what occurred during the episode, how they felt about it and why certain events happened (telling it from the perspective of each participant). Next they classify aspects of teaching, learning and schooling that occurred and connect this to educational theories, professional standards, etc. The preservice teachers are then asked to consider their own cultural background, beliefs, prejudices and notions of culture and how these might have influenced the lesson design, lesson implementation, and their students' understandings and perceptions. Next they describe their mental model of effective teaching and compare their own practice to this. With the insights gained from this metacognitive activity, the novice teacher is encouraged to make modifications to the current activity and future lessons, thus moving from reflection to action (Killion & Todnem, 1991).

## Electronic Support

Two tools have been designed to be included in an electronic support system for urban preservice teachers based on the CITIS model, careful analysis, and review of current literature. *The Lesson Planner* will provide users with an activity design "wizard" that would guide the novice teacher through planning an activity using a series of textual prompts. By wizard, we mean an electronic device that would guide the user through a given process through a series of textual and/or visual prompts. An example of this might be software that assists users in completing their tax returns. The textual prompts would be guided by stages of lesson design as described in the CITIs model. We have also considered using pedagogical agents as guides and/or information sources (for more on using pedagogical agents, see Baylor, Kisantas, Chun, 2001; Kisantas, Baylor, Hu, 2001). *The Video Window* will be a mechanism through which users can upload video footage of themselves teaching, edit the footage, and reflect on their teaching experience - while taking advantage of the immediacy of the digital video media. The video window is essentially a tool that facilitates novice teachers' progression through the metacognitive components of CITIs. For example the video can be used to assist them in reflecting on critical incidents after the real-time teaching moment (Griffin, 2003; Hamlin, 2004; Killion & Todnem, 1991; Tripp, 1993).

It is hoped that the mechanism created by combining the Lesson Planner and Video Window tools would facilitate an iterative process that should help develop reform-based teaching habits and prepare teachers for working with digital technology and contextual diversity of the modern classroom. Student use of these two tools could help create powerful, realistic teaching cases to be shared with peers or stored in a knowledge management system for future use.

## References


Baylor, A., Kitsantas, A., & Chung, H. (2001). The instructional planning self-reflective tool: A method for promoting effective lesson planning. *Educational Technology 41*(2): 56-59.

Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the educative process.* Chicago, Ill: D.C. Heath.

Ferry, N. M. & Ross-Gordon, J. M. (1998). An inquiry into Schön's epistemology of practice: Exploring links between experience and reflective practice. *Adult Education Quarterly 48*(2): 98-113.

Gay, G. (2002). Preparing for culturally responsive teaching. *Journal of Teacher Education 53*(2): 106-116.

Gay, G. & Kirkland, K. (2003). Developing cultural critical consciousness and self-reflection in preservice teacher education. *Theory into Practice 42*(3): 181-187.

Griffin, M.L. (2003). Using critical incidents to promote and assess reflective thinking in preservice teachers. *Reflective Practice 4*(2): 207-220.

Hamlin, K.D. (2004). Beginning the journey: Supporting reflection in early field experiences. *Reflective Practice 5*(2): 167-179.

Hogan, T., Rabinowitz, M. & Craven, III, J. A. (2003). Representation in teaching: Inferences from research of expert and novice teachers. *Educational Psychology 38*(4), 235-247.

Howard, T. C. (2003). Culturally relevant pedagogy: ingredients for critical teacher reflection. *Theory into Practice 42*(3): 195-202.

Killion, J. P. & Todnem, G. R. (1991). A process for personal theory building. *Educational Leadership 48*(6): 14-16.

Kitsantas, A., Baylor, A.L. & Hu, H. (2001). The constructivist planning self-reflective tool (CPSRT): Facilitating a constructivist instructional planning approach. *Educational Technology 41*(2): 39-43.

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal. 32*(3), 465-491.

Sachs, S. K. (2004). Evaluation of teacher attributes as predictors of success in urban schools. *Journal of Teacher Education 55* (2): 177-187.

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. New York: Basic Books, Inc.

Schön, D. A. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions*. San Francisco, CA: Jossey-Bass Inc.

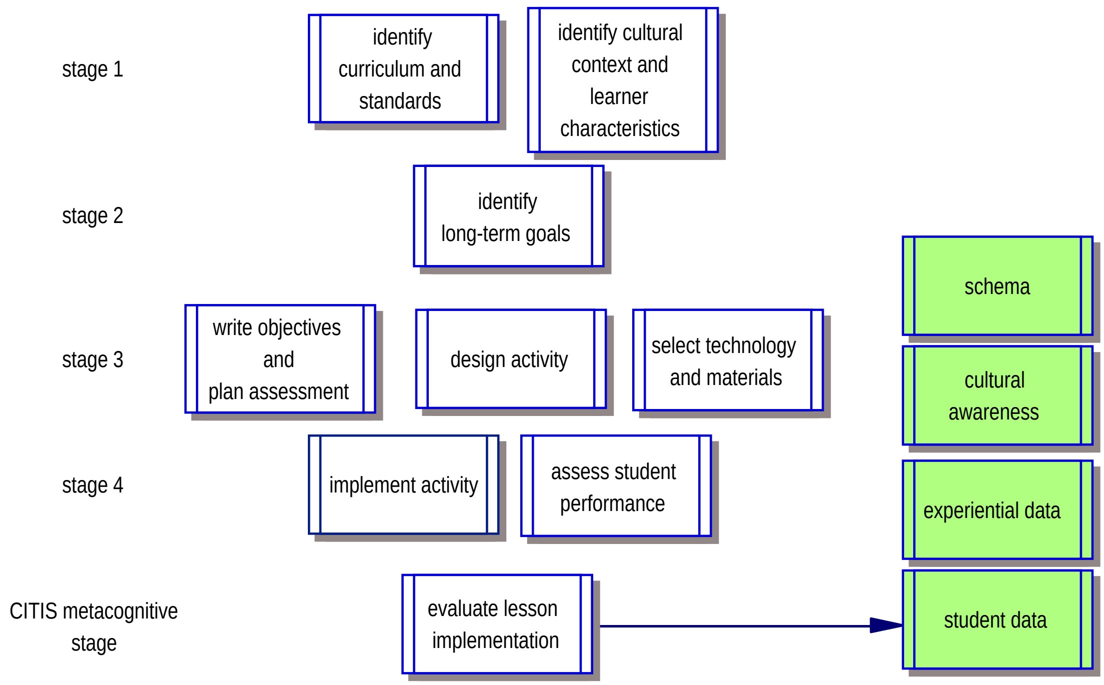
Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2): 4-14.

Sparks-Langer, G. M. & Colton A. B. (1991). Synthesis of research on teachers' reflective thinking. *Educational Leadership 48*(6): 37-44.

Sparks-Langer, G. M., Simmons, J. M., Pasch, M. Colton, A., & Starko, A. (1990). Reflective pedagogical thinking: How can we promote it and measure it? *Journal of Teacher Education 41*(4): 23-32.

Tripp, D. (1993). *Critical incidents in teaching: Developing professional judgment*. London: Falmer Press.
Van Manen, M. (1977). Linking ways of knowing with ways of being practical. *Curriculum Inquiry 6*(3): 205-228.
Winn, W. (2004). Cognitive perspectives in psychology. In. D. H. Jonassen (Ed.), *Handbook of research on educational communications and technology* (pp. 79-112). Mahwah, NJ: Laurence Earlbaum.
Wiggins, G. & McTighe, J. (2001). *Understanding by design*. Upper Saddle River, NJ: Merrill Prentice Hall.

CITIS ID Model



# Digital Primary Sources for Classroom Instruction: What do teachers say?

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## Introduction.

In history or social studies classrooms, teachers emphasize the importance of how people, geography, and economics are interconnected to bring about the events studied in the textbook. Teachers of language arts and techniques for creative writing know that written communication is greatly enhanced through personal experience. The curriculum for many school districts include writing skills in “problem-solution” or “definition essays” Information literacy skills are best taught using motivational forms of media that touch the heart and soul of a student. Diaries of Civil War brides, photos from the Great Depression, and digital clips of music from "Negro churches" of the 19th century add realism and pizzazz to the chronological events typically presented in school classrooms or media centers. These and other primary sources are being digitized and are accessible from many excellent online sources. Digital primary source (DPS) documents and artifacts are easily accessed through portals at academic libraries, museums, and government agencies. The number of these primary source websites is growing. By searching the Internet Public Library (Available: http://www.ipl.org/), hundreds of educational sites can be located. For example, by using the keywords “digital primary sources” in the Education subject heading 470 entries are found using www.IPL.org website. A review of the literature reveals that teachers and media specialists have used PDS as a tool for critical thinking and analysis of historical artifacts (Bennett & Trofanenko, 2002). McElmeel (2001) suggests that one of the best uses of these resources is for analytical comparisons. PDS documents can be used to take the student beyond simple reading and reporting of information. Using a case study at a nearby high school and focus groups/interviews from a representative sample of teachers across the region, this researcher began an investigation in how PSD can be used to guide students and teachers from simple fact gathering and reporting to the applied use of information to solve problems and generate new ideas (Loertscher, 2004). The purpose of this study is to investigate teachers' understanding in the instructional use of primary source documents and their personal evaluation of a newly developed resource developed by a regional university in eastern North Carolina.

## Review of the Literature

Constructivist classrooms and laboratories are common in K12 schools. Resource and project-based learning are highly valued (Todd, 2005). Higher-order thinking includes processes for content analysis, synthesis of new ideas, and evaluation of documents, all of which are the valued outcomes for inquiry-based projects (Lamb, 2004). Primary source documents are excellent resources for guiding students in constructivist thinking. Some of the benefits for using primary sources documents include historical thinking [processes], point of view, and identifying bias (Friedman, 2005). In addition, students can be taught to become active investigators who will gather evidence that can be used to write their own history book (VanFossen & Shiveley, 2000). Students are motivated to read first person accounts, especially when the author is a young person who may have lived in a different time period (Barton, 2005). For example, the strong and sustained interest in the journals of Anne Frank is an indication that young people relate to the personal writings of peers who have lived in different times and cultures (Anne Frank House, 2005).

Currently, the most expansive project for PSD is the “American Memory Project” provided by the Library of Congress (Balas, 1999). Over four million objects are archived on the project's server. Instructional anchors guide the teacher through basic information related to use of digital resources, best practices for the classroom, and methods for integrating into specific content areas. “Documenting the American South” is a project sponsored by the University Library at the University of North Carolina (University of North Carolina, 2005). Documents and artifacts available on this website are selected by the UNC Library editorial board. This valuable resource for teachers includes an expansive database with artifacts related to the southern region of the United States. The Chicago Historical Society, the Gilder Lehrman Institute of American History, and others are working collaboratively with the University of Houston to develop “Digital History” (University of Houston, 2005), a richly endowed interactive multimedia history of the United States. Unique features of “Digital History” include an online textbook with interactive timelines, guided readings, and an online expert known as "Hyperhistorian". Hundreds of primary source documents and objects are listed in the expertly designed pathfinders within this website.

In 2003, Joyner Library at East Carolina University received a Library Services and Technology Act (LSTA) grant (North Carolina State Library, available online) to supply funding needed for the "North Carolina Digital History and Fiction" (Joyner Library, 2005) project. Working in partnership with three regional museums, the website provides hundreds of digitized documents related to the eastern area of this state (available online http://www.lib.ecu.edu/ncc/historyfiction/ ). Approximately 200 texts have been digitized pertaining to the history of 29 eastern North Carolina counties. The documents, dating from the early 19th century, are extremely rare, fragile, and not accessible through normal library circulation. Joyner and its partners are making available over 20,000 additional pages of historic texts related to eastern North Carolina. An interesting collaboration between, the "Tobacco Farm Life, Country Doctor Museum," and "Historic Hope Plantation" has yielded a rich display of artifacts, objects, video, and audio files that are uniquely important to eastern North Carolina history and culture. The URL's for each of these museums is included in the references for this article. In addition, there are links to NC ECHO (ECHO, 2005) which links to Cultural Heritage sites located across the United States. These, and other online resources, provide a large collection of digital artifacts that include metadata for descriptions and recommended use of the resource.

## Research Method

During the fall and spring semesters for 2004-2005, graduate students enrolled in media and technology courses have been given access to the North Carolina Digital History and Fiction Project. Their discussion threads and interviews have provided insight into the usability of the resources on the ECU digital project. In spring of 2005, a series of focus groups were conducted in several locations in the eastern region of North Carolina. Teachers, media, and technology specialists from elementary, middle, and high school were randomly selected from a list replying to an invitation to review and evaluate the North Carolina Digital History and Fiction Library. In order to achieve representative samples from the K12 schools, the participants were selected based on grade level and content area. Participants were compensated with a small stipend and a light supper meal. Jamesville High School in the "down east" country of the state participated in a case study use of primary sources provided by the researcher. These included The "American Memory Project," "Documenting the American South" and the "North Carolina Digital History and Fiction Library" project. The media coordinator and classroom teachers worked collaboratively with the university researcher to examine (1) student response to the use of digital primary sources, (2) efficiency in use of research strategies, and (3) quality of writing for the final research paper. By using the archived stories, interviews, diaries, and other documents available through digital primary sources, students have authentic artifacts for analysis using an efficient method of access.

## Results and Discussion

### Discussion Threads

In spring and fall of 2005, graduate students in EDTC 6035 Integrating Computers in Social Studies, Language Arts, and Information Literacy Skills were asked to evaluate the contents and design of the North Carolina Digital History and Fiction website. The enrollments (n= 52) for this course consist of classroom teachers – grades K-12, library media specialists, and technology facilitators in N.C. public schools. Graduate student responses were framed within the following contexts- 1) What is most useful; 2) What is least useful; and 3) Instructional use for the website.

Table 1. Summary of pro's and con's for North Carolina Digital History and Fiction Library as evaluated by teachers.

| Most Useful | Not Useful | Instructional Uses |
|---|---|---|
| Could be used with Webquests | Video clips take long time to download | Useful to teach research skills using such models as Big6 or I SEARCH |
| Maps | Search option not efficient | Complete a research project, copy public domain images and insert in PowerPoint for class presentations |
| Detailed Information that could be used to build database files and spreadsheet activities; graphing activities | Needs a better navigation system. Needs more cross references among resources | Research personal names in home county |
| NC ECHO with cultural heritage information | Reading levels too high for elementary and middle school students | Map skill using the travel maps available with each of the 29 counties |
| Museum Partners | Homepage needs more information about purpose of the site | Use the museum images as advance organizers before taking a field trip |
| Easy navigation | Homepage needs more color, especially for younger students | Use the museum images as a follow-up activity after a live filed trip |
| Tutorial for Search Operators | All laptops trying to access the same site at the same time…too slow | Visualization projects for life in the past |
| Images and objects from the museums | Needs more alignment with state standards and state curriculum | Students and parents visit the sites. Parents and grandparents share oral histories with students |
| Access to rare materials | | Pirate projects – what were they really like? |
| Clear uncluttered pages | | Students read an excerpt from a primary source and answer a question or situation about it… |
| Interactive Map on homepage | | Art lesson using paper mache or pottery to recreate artifacts on museum site. |
| Image and text version of the books | | |

Graduate student evaluators clearly were supportive of the Joyner website. The strongest response came from that student who identified the website as a useful resource for local histories and for teaching basic facts about North Carolina history. Nearly every evaluator commented on the value of the website for local history and for fostering pride in one's birthplace and personal heritage. Many of the evaluators commented on their own county region first, before any mention of other resources available through the website. Many of the evaluators live in a region of the state west of the 29 county region that is the focus of the website. These teachers all wanted to know when the remaining 71 counties would be added.

**Focus Group Interviews.**

An analysis of the transcripts from the focus groups provided very useful formative information for the design and development team of the project. Because the focus groups were conducted earlier in the year (2004), many of the interactive features for the website needed reevaluation and revision. Comments from the focus groups greatly facilitated this process. The most valuable information gained form the focus groups included comments on both the design of the website and the informational contents. The strongest recommendation was to add links to resources for all of the 100 counties in North Carolina. Students and teachers are "naturally going to search the contents of their home county first!" Many of the focus group evaluators commented on design of the homepage. Suggestions were made to add more color, thus making the website more inviting for elementary and middle school students. Others suggested that links be added for "kids' page" and a teacher resource page. The most common recommendation for content was "add a topics page" with links to specific topics related to the North Carolina Standard Course of Study. Teachers also liked the idea of linking suggested lesson plans to specific student competencies with in the state curriculum. Many of the teachers suggested adding shorter lesson activities rather than a full and formal lesson plan. Teachers, they commented, rarely use a full lesson plan as written, but instead, pull selected activities for use in their classrooms. Teachers also liked maps, but found little practical use for the soil sample survey maps. Many remarked on the excellent selection of fictional works dating from the 1800's. Many of the high school teachers commented on how these might be used in their literature classes. Middle school and high school teachers commented on the readability of most fiction and nonfiction works. These would be "too hard to read" for their students. Some suggested that excerpts from selected readings could be used to teach concepts and skills for "main idea", "point of view", and other reading comprehension skills that are included in standardized tests. Several teachers liked the basic information listed on each County homepage. Though basic factual information is mainly used for recall questions, it is useful for standardized tests that are typically administered in K12 public education. In addition, the almanac information is useful as a springboard for problem solving and other research topics requiring baseline information. For example, one teacher suggested using the information for building databases and comparison problems. Another teacher suggested using the population data to show trends in growth by region and county. To quote one high school social studies teacher:

> My problem, and every history teacher's problem in this state, is that we are driven by the End of Course test. I can tell you right now, we would not have the time for students to look up who opposed slavery in North Carolina. We would tell them, the Quakers, then move on. . . We might discuss the Civil War and I could use a Civil War poem, but I wouldn't expect the students to go out and find the poems themselves.

Other teachers commented on advantages that could be used to support the End of Course tests.

> It would be good if 10th grade writing teachers could search with the keywords that lead to some quotes or speeches from Eastern North Carolina…keywords like heroism or justice, and then they could ask the students to respond to the quotes in their essays. . . teachers need access to famous speeches and documents which cover particular themes so that students can practice writing for the (EOC) test.

**Case Study.**

Students at Jamesville high school (Dotson & Grimes, 2005) were instructed to research a topic and locate information that would provide answers or a conclusion to the focused research questions. Results from their research of primary sources were presented electronically by using PowerPoint slides. At the conclusion of the project, each student completed a reflective response sheet. Students responded to questions related to their interest in digital primary sources, the most helpful websites, usability of the websites, what significant things were learned, satisfaction levels for the use of the technology, and what parts of the project caused frustration and anxiety. Students were also questioned on their understanding of primary sources and the benefits for using this kind of resource for research. Comments from the reflective surveys were summarized and analyzed for patterns that might indicate a major theme underlying attitudes and understanding of primary source documents. . As can be seen in Table 2. comments fall into two categories. About half the students found the sources helpful and enjoyed the project. In contrast, several students reported frustration and lack of satisfaction.

Table 2. Digital Primary Sources: What was helpful and what was frustrating for secondary school students.

| What was helpful | What was frustrating |
|---|---|
| The document helped me write my focus question [note: student research strategy is in reverse order] | "can't find anything" comments= 8 total |
| I read, in depth, some documents and made inferences. | navigation problems; dead links= 7 total |
| More interesting and more useful [than secondary] | Hard work, had to dig into the information to find answers |
| "Enjoyed going into the school library to work" comments = 4 total | Sometimes the websites were confusing and hard to use …confusing and outdated…. |
| My focus question helped me stay on topic and not include information that did not support or relate to my topic. | Primary research is much harder than using [just] any source available. |
| …much more accurate because it was written by the people of that time period. | …time consuming, missed being in the classroom… time consuming |
| Focus question narrowed my search and it was less time consuming for the research. | …just did searching and wrote my focus question at the end….[reverse order] |
| I learned that people living in different places had different and like experiences, but also people felt different about things like the war… | …learned it is difficult to do a presentation from newspapers and diaries… |
| …learned to dig deep into a database | |
| …learned that some views in modern times and history disagree with the views of people during that time… | |
| You get first person views of your research …you learned about how people reacted to a historic event.... | |

Clearly, students need instruction in how to use primary source documents within a particular context. Students in this case study were able to describe the characteristics for a variety of primary documents, however, it was not until a second project was planned that students began to formulate questions that used point-of-view, comparisons problems, and bias in primary documents. Leslie's project, on the other hand, showed great potential for research with point-of-view. She demonstrated understanding of primary sources as biased and that the researcher must "write history" based on comparison of a variety of documents. In response to reflective question, "What was the most significant piece of information you learned in doing this project," she responded, "Opinions vary greatly depending on what you are reading and who you are reading. Also, since you are reading opinions don't take everything as fact." When students were asked, "What did you learn about primary sources for doing research?...that primary sources we had were not very good at finding information," strongly indicates a need to provide more effective methods for instruction in the purpose and best use of primary source documents.

**Conclusions**

Based on the analyses of focus-group transcripts, interviews, discussion threads, and survey responses, the use of digital primary sources can be a valuable resource for teachers, media and technology specialists. There are three main benefits with the use of online primary sources. First, teachers report that the digital documents and artifacts are motivational and engaging for students. Images of artifacts, sound bytes, and interviews using streaming video provide rich multimedia environments for students. Secondly, they are a good tool for enhancing higher order thinking processes. Students have the opportunity to "write their own history" through position papers, point-of-view, and analysis of controversial documents. Finally, digital primary sources are readily available on the web and accessible to any student with Internet access. A simple search of the web using any of the popular search engines will result in several thousand valid educational websites housing the primary digital resources.

There are some disadvantages. Websites with streaming audio and video presentations that include metadata or other supporting information may not be accessible to schools with low bandwidth or older computers. Slow downloads lead to problems with classroom management and impatient students. Understandably, the original documents were usually written for adults, thus reading levels may not be suitable for younger students. When planning lessons for middle school and children in older elementary grades, excerpts from documents should be selected in advance and presented as a whole class reading opportunity and discussion. When using primary source documents for a traditional "research paper", teachers should review and evaluate several sources prior to classroom instruction and research activities. Selected resources should be bookmarked and a pathfinder (Kuntz, 2003) provided to eliminate aimless wandering on the web and loss of valuable time for thinking and problem solving discussions.

Digital primary sources provide documents and artifacts that bring history and culture to a new dimension for both teachers and students. Priceless resources in the form of fiction and nonfiction can be read by any student without the necessity of traveling to an archived collection in a distant library or museum. Most importantly, this paper suggests that students have the potential for reading first hand accounts and drawing their own conclusions about controversial topics. Students no longer must be entirely dependent on the historical reports by secondary sources but have opportunity to think as an historian does, piecing together the story from a variety of sources and personal accounts.

**References**


Anne Frank House (2005). Available online <http://www.annefrank.org/content.asp?pid=1&lid=2 >

Balas, J. L. (1999). Bringing library collections on line. *Computers in Libraries*, *19* (9), p. 46 – 29.

Barton, K. C. (2005). "Primary Sources in History: Breaking Through the Myths. *Phi Delta Kappan 86* (10), pp.745-753.

Bennett, N., & Trofanenko, B. (2002). *Digital primary source materials in the classroom.* In proceedings for Museums and the Web 2002: Selected Papers from an International Conference, Boston, MA, April 17-20, 2002. (Eric Document ED 482 103)

Country Doctor Museum. Available online: < http://www.countrydoctormuseum.org/ > Accessed October 11, 2005.

Dotson, K. & Grimes, C. (2005) personal interview. Jamesville High School Library, spring, 2005.

Friedman, A. (2005). "Using Digital Primary Sources to Teach World History and World Geography: Practices, Promises, and Provisos." *Journal for the Association of History and Computing* Volume III (May 2005): 1, Available < http://mcel.pacificu.edu/jahc/JAHCVIII1/articles/friedman.htm > Accessed September 14, 2005.

Historic Hope Plantation. Available online: < http://www.hopeplantation.org/> Accessed October 11, 2005.

Joyner Library, East Carolina University. *North Carolina History and Fiction Digital Library.* Available: < http://digital.lib.ecu.edu/historyfiction/> Accessed September 14, 2005.

Kuntz, K. (2003). "Pathfinders: Helping Students Find Paths to Information". *Multimedia and Internet Schools.* Available online: http://www.infotoday.com/MMSchools/may03/kuntz.shtml

Lamb, A. (2004). "Webquests." *School Library Media Activities Monthly 21*(2), p. 38-29.

McElmeel, S. L. (2001). Beyond reporting. *Library Talk*, 14(5), p. 16 – 18.

East Carolina University Joyner Library. *North Carolina History and Digital Fiction Library.* Available online: http://www.lib.ecu.edu/ncc/historyfiction/ Accessed January, 2005.

Loertscher, D., Koechlin, C., & Zwann, S. (2004). *Ban Those Bird Units! 15 Models for Teaching and Learning in Information-rich and Technology-rich Environments.* San Jose, CA: Hi Willow.

North Carolina ECHO (2005). North Carolina ECHO: Exploring Cultural Heritage Online. Available online < http://www.ncecho.org/> Accessed October 11, 2005.

North Carolina State Library. *Library Services and Technology Act*. Available online: http://statelibrary.dcr.state.nc.us/lsta/lsta.htm Accessed January, 2005.

Tobacco Farm Life Museum. Available online: < http://www.tobaccofarmlifemuseum.org/ > Accessed October 11, 2005.

Todd, R. (2005). "Todd's Letter from America". *Orana 41*(1), p. 9-10. University of Houston (2005). *Digital History: Using new technology to enhance teaching and research.* A collaborative project with Chicago Historical Society, Gilder Lehrman Institute of American History, The Museum of Fine Arts, Houston, the National Park Service, and TAH. Available online: < http://www.digitalhistory.uh.edu/ > Accessed October, 2005.

VanFossen, P., & Shiveley, J. (2000). "Using the Internet to Create Primary Source Teaching Packets." *Social Studies 91*(6), pp. 244-253.

University of North Carolina Library. *Documenting the American South.* Available:

< http://docsouth.unc.edu/ > Accessed September 14, 2005.

# A New Perspective for Effective Evaluation of Human Performance Technology Interventions

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**Abstract**

*Human Performance Technology (HPT) provides interventions for improving performance of humans, groups and organizations in variety of settings. Effective evaluation strategies are needed to justify and improve these interventions. Kirkpatrick's framework is widely utilized to evaluate training as well as non-training HPT interventions in business setting. However, the distinction between the natures of training and non-training solutions in HPT requires a new evaluation model. This paper, first, has analyzed strengths, weaknesses and utilization aspects of Kirkpatrick's framework in corporate settings, second, has examined alternative evaluation models and finally, has proposed the Dimensions and Systems model for evaluating HPT interventions.*

## Introduction

Performance Technology (PT) is a field committed to enhancing the performance of human beings and organizations (Van Tiem, Moseley, & Dessinger, 2000). In order to validate the effectiveness of PT interventions, an evaluation process is needed (Rosenberg, Coscarelli, & Hutchinson, 1999). In 1959, Kirkpatrick published a four-step evaluation model consisting of reaction, learning, behavior and results to evaluate corporate training programs (Kirkpatrick, 1996). Since then, the model has become a core for several evaluation models (Goldwasser, 2001). Kirkpatrick's framework is not only used for evaluating training programs, but also for evaluating performance improvement interventions (Klein, 2002). However, training is not the only solution to performance problems, so Kirkpatrick's framework may not be sufficient to evaluate the effectiveness of PT interventions. This paper aims to provide an expanded view of Kirkpatrick's framework to meet the need for a complete model for evaluating PT interventions.

Human Performance Technology is a systemic and systematic way of applying scientific and practical knowledge about human, group and organizational behavior to improve human performance and achievement economically and effectively by using a wide range of interventions drawn from several disciplines (Rosenberg, 1996; Rossett, 1996; Stolovitch & Keeps, 1999). The field is usually referred to as Performance Technology (PT) with the human prefix implied (Rosenberg, 1996). The operational dimensions of PT are divided into human, workplace and work (Rosenberg, 1996). PT practitioners employ a wide range of solutions to any given performance problem including, but not constrained to, training (Rosenberg, 1988).

Evaluation is a process of making judgments about the worth of observed phenomena based on collected data (Shrock & Coscarelli, 2000). In the PT field, formative evaluation is conducted during the intervention development process and the summative evaluation process is conducted after intervention implementation (Thiagarajan, 1991). Summative evaluation has three purposes, to justify existence of the intervention, to improve the intervention for possible future implementation, to determine whether to continue or stop the intervention (Kirkpatrick, 1998). This paper will focus on summative evaluation.

Significant resources are spent on training and non-training interventions to increase human performance (Lee & Pershing, 2002). As a result, PT practitioners are expected to make contributions to the organizations' bottom line (Phillips, 1991; Robinson & Robinson, 1989; Rosenberg, 1996). In order to determine effectiveness and justify PT interventions, evaluation is needed. Since the literature has not presented a comprehensive model to evaluate the effectiveness of PT interventions (Holton, 1996; Lee & Pershing, 2002; Sleezer, Zhang, Gradous, & Maile, 1998). Generally, PT practitioners utilize Kirkpatrick's four-level framework for evaluating PT interventions. The reasons for this situation stem from the origins of PT and current PT practices.

## Origins of PT and Training's Place

As implied in the definition of PT and claimed by several authors, training is not the only solution to performance problems. As a field, PT evolved from instructional systems, systems thinking, informatics, ergonomics and psychometrics (Rosenberg et al., 1999). Historically, the roots of PT are deeply embedded in Instructional Systems Design (ISD) in terms of concepts, principles and theories (Reiser, 1987).

Additionally, many practitioners have stated that training is the least effective approach to performance problems (Gordon & Zemke, 2000; Zemke & Rossett, 2002). PT practitioners are therefore shifting from training to other performance improvement solutions (Carr & Totzke, 1995; Guerra, 2001). However, this transition is a slow one. According to Rossett and Tobias (1999), 40 percent of practitioners do not conduct any needs assessment and implement training as the only solution to the performance problems in their organizations. Furthermore, Klein (2002) conducted a literature review of PT interventions published in Performance Improvement Quarterly, the premier journal of the PT field, and his findings show that the prevailing type of intervention is several forms of training in performance improvement. Consequently, Kirkpatrick's framework is the only tool to evaluate these interventions. The framework suggests four levels (Kirkpatrick, 1998):

*Reaction*: "How those who participate to the program react to it…a measure of costumer satisfaction." (p. 19)

*Learning*: "The extent to which participants change attitudes, improve skills as a result of attending the program." (p. 20)

*Behavior*: "The extent to which change in behavior has occurred because the participant attended the training program." (p.21)

*Results*: "The final results (low absenteeism, increased profit, low turn over, tangible results) that occurred because the participants attended the [training] program." (p.23)

## The Philosophy and Utilization of the Framework

Although it was introduced in 1959, the framework is still in use and has served as source of inspiration for several approaches to evaluating training programs (Kaufman & Keller, 1994; Molenda, Pershing, & Reigeluth, 1996; Phillips, 1996), human resources development (Dye, 2001; Holton, 1996) and teacher professional development programs (Guskey, 2000). However, its name has evolved from four-step to four-level (Kirkpatrick, 1998) and there is an ongoing controversy about whether it is merely taxonomy or a model (Dye, 2001; Holton, 1996) and a prescriptive or descriptive framework (Lewis, 1996; Twitchell, Holton, & Trott, 2000). For the purpose of consistency, throughout this paper, Kirkpatrick's evaluation approach will be referred to as a framework.

### Why is the framework so popular?

The reasons, for which the framework is widely used, cited, modified and attacked, are the philosophy underneath it, its strengths and shortcomings. Drawing from Kirkpatrick's articles and book written on the four-level evaluation framework, the ideas below can be identified as philosophy of the framework:

*1. Only for training:* The framework aims at evaluating training programs only (Kirkpatrick, 1998).

*2. Evaluation as complete a four-level:* According to Kirkpatrick (1996), partial application of the four-level evaluation does not complete the evaluation process. In order to provide useful information about the effectiveness, a training program all four levels should be applied in sequence.

*3. Simplicity and practicality:* According to Kirkpatrick (1996), many practitioners are not interested in complex and scholarly evaluation methods, they seek for a model that they can understand and apply.

*4. Evidence rather than proof:* In connection with the third point, Kirkpatrick makes a distinction between proof and evidence when conducting level 3 and level 4 (Kirkpatrick, 1977; Kirkpatrick, 1998). He argues that proof is difficult to obtain at levels 3 and 4, so practitioners should collect evidence about the contribution of training.

The framework's philosophy creates its strengths, below are the identified strengths of the framework in its practical application as reviewed in the literature.

*Simplicity and elegance*: The most important strength of the approach is that it provides a simple and applicable evaluation model for training practitioners (Alliger & Janak, 1989).

*Completeness*: Kirkpatrick drew on all evaluation methods practiced up until his time and created his approach to evaluation with a complete framework (Spitzer, 1999).

*A consistent framework for comparison*: The framework provides a consistent template to compare the effectiveness of training or professional development programs across industries and organizations. Using a common framework to evaluate the programs could help practitioners to decide which methods are effective in training and fit for their context.

### But, is the framework truly popular?

Although several authors and practitioners claimed wide use of the framework consistent with its strengths, research from the literature does not reflect these claims. Studies from the USA (ASTD, 1996; Moller & Mallin, 1996; Twitchell et al., 2000), Canada (Blanchard, Thacker, & Way, 2000), Britain (Bramley & Kitson, 1994) and

Kuwait (Al-Athari & Zairi, 2002) show that most evaluation activities are conducted at level 1 and level 2 and spurned at levels 3 and 4, which makes partial use of the framework widespread. The low utilization of level 3 and level 4 is not a new issue (Twitchell et al., 2000). As cited in Twitchell et al. (2000), Catalanello and Kirkpatrick (1968) published similar results in the past.

**Why were Level 3 and Level 4 applied rarely?**

Regardless of country, industry and time, level 3 and level 4 evaluations are rarely conducted. Eight answers to the question; "what are the reasons for not applying level 3 and level 4?" come from research studies and the experiences of prominent training practitioners.

*No need to conduct evaluation at level 3 and level 4:* Dixon (1996) suggests that some companies (such as Motorola, IBM, Arthur Andersen, etc.) do not feel a need to justify the existence of their training departments. Moller and Mallin (1996) and (Twitchell et al., (2000) support this point with their findings.

*The impracticality of utilizing all levels for every training program*: Geber (1995) argues that applying level 3 and level 4 to every single training program that a company offers would be impractical for some organizations because of the nature of some programs.

*Lack of knowledge and skills*: Some of the training practitioners do not have the knowledge and skills to design sophisticated evaluation methods and the required metrics (Twitchell et al., 2000).

*Lack of collaboration*: Some organizations do not have a culture of openness and trust between employees and management (Harrell, 2001) and some managers perceive data collection and evaluation as disruptive (Moller & Mallin, 1996; Riley, Davani, Chason, & Findley, 2002).

*Lack of administrative support*: Riley et al. (2002) listed stakeholders' inadequate understanding about the importance of level 3 evaluation as one reason. Additionally, in a survey study, most of the practitioners stated that their companies placed significant barriers to evaluation at all levels (Moller & Mallin, 1996).

*Time and money costs:* Geber (1995) states that "No one who does level 3 and level 4 evaluation pretends that it's free" (p.34), level 3 and level 4 are more time consuming and cost more money than level 1 and level 2 evaluations.

*Abuse of results*: In a survey study, Moller and Mallin (1996) found that most practitioners do not want to see negative evaluation results for a training program as they may be used to cause damage rather than improvement.

*Access to data*: In connection with lack of administrative support, access to pre-intervention and post-intervention data is another barrier (Moller & Mallin, 1996)

**Why is Kirkpatrick's framework used in PT?**

The literature suggests three reasons for utilizing Kirkpatrick's framework in PT interventions: training as the prevailing intervention, lack of alternatives and the intuitive power of the model.

*Training as the prevailing solution*

As stated previously, instructional systems design has been the main influence on PT. For example, the early name of the field's professional organization was the National Society for Programmed Instruction and later became the National Society for Performance Improvement. Furthermore, journal names for the field followed suit. In terms of solutions to performance problems, although there is a transition from training to other interventions, training is still the dominant intervention method for performance problems (Klein, 2002; Rossett & Tobias, 1999). Consequently, in order to evaluate the effectiveness of performance interventions, Kirkpatrick's framework is the primary model to be utilized.

*Lack of alternative evaluation models*

As cited in Carr and Totzke (1995), once, Maslow stated "if all you have a hammer, you will treat all problems as nails" (p.11). Lack of models to evaluate performance improvement interventions is a glaring problem and it has been stated by several authors (Sleezer et al., 1998). Other evaluation models such as 360-degree feedback and Balanced Scorecards might be considered as alternatives.

*Intuitive power of the framework*

The elements of Kirkpatrick's framework were being utilized before Kirkpatrick published his framework, however not systematically as Kirkpatrick suggested (Kirkpatrick, 1998; Spitzer, 1999). By providing this simple and complete framework, Kirkpatrick showed how a training program's outcomes could affect individuals and organizations (Spitzer, 1999). Practitioners' experiences suggest that the levels of the framework can be applied to any type of PT intervention, which makes these categories almost universal (Edwards, Scott, & Raju, 2003).

**Then, the model should be adequate?**

Although Kirkpatrick's framework has been utilized to evaluate training programs, it is not sufficient to evaluate general performance improvement interventions (Lee & Pershing, 2002; Sleezer et al., 1998). Two main reasons inherent to the framework can be identified from the literature as the framework's inadequacy for PT.

*The Multi- disciplinary nature of PT interventions*

As originally stated many times by Kirkpatrick (1998) and other authors, the framework is designed for evaluating training programs. The main focus of training is teaching and learning, whereas the main focus of PT and the performance technologist is performance and accomplishment (Rossett, 1996). Performance is a combination of several variables. Many authors have attempted to provide a comprehensive taxonomy for performance variables (Holton, 1999; Sleezer et al., 1999). (Stolovitch & Keeps, 1999) categorized performance variables into two categories, learning interventions and non-learning interventions. Performance is a function of many variables and training is just one of the interventions capable of increasing performance (Brinkerhoff & Dressler, 2002).

*Inadequacy to take systems approach*

One view of PT is to see the organizations as systems (Sleezer et al., 1999). A system is a set of elements interacting in an environment to achieve results (Ackoff, 1994). An outcome in an organization is a result of several interactions of related elements within an environment. At level 3 and level 4, practitioners actually are not only measuring the effects of training on performance but also a large system of organization's effects to the performance and results (Brinkerhoff & Dressler, 2002). Kirkpatrick's framework does not accommodate all the elements that have effects on outcomes at each level and their interactions with each other (Holton, 1996).

## Criteria for an Alternative Model

It is clear that Kirkpatrick's framework partially meets the first set of criteria and (Holton, 1996; Lee & Pershing, 2000), and a substitute for the framework is needed, but what might be the attributes of an ideal model for evaluating PT interventions? An integration of knowledge from the literature suggests a set of criteria; the serving purposes of evaluation in PT. An evaluation model for PT interventions should:

provide outcomes to improve interventions,
provide outcomes to validate if the intended objectives are achieved,
provide outcomes to justify existence of intervention,
provide a systemic view of performance interventions,
accommodate multiple interventions,
accommodate individuals and organizations,
be applicable by practitioners.

**Models at work in organizations**

The literature suggests other evaluation models for evaluating performance of individuals and organizations, among them, 360-degree feedback evaluation (Scott & London, 2003), balanced scorecards (Kaplan & Norton, 1992) and Holton's model for evaluating HRD interventions (Holton, 1996) are the best known models.

*360-degree feedback*

360-degree feedback evaluation is a technique for evaluating an employee's job performance based on feedback from everyone with whom the employee has contact. Its primary methodology is collecting data from multiple sources in an employee's environment (Scott & London, 2003). The main objectives of 360-degree evaluation are to increase the objectivity of the performance assessment, to increase the self-awareness of the performer and to stimulate professional development (Alimo-Metcalfe, 1998). The main drawback of this method is that it is an aggregated form of evaluation. It does not aim to show the effects of an intervention on performance.

*Balanced Scorecards*

The Balanced Scorecards model has been specifically developed to measure and evaluate the linkage between financial results and employee behavior at the group and organization levels (Edwards et al., 2003; Kaplan & Norton, 1992). Simplicity and the least number of performance and result outcome measures are essentials (Kaplan & Norton, 1992). Although the Balanced Scorecards method is sufficient method for bottom line, it does not meet the first three requirements of evaluation in PT. Evaluated results and performance are presented in aggregated forms. It does not discuss contributions of an intervention to performance and its results.

*Holton's HRD model*

Holton's framework discusses how an intervention (training in his case) can be evaluated in terms of learning, performance and results perspectives. He provided an expanded view of Kirkpatrick's framework and claimed that the framework's level 1, reaction, is not an outcome of training, but rather a moderator (Holton, 1996).

Holton's framework is an effort to explain the influences on outcomes of an intervention, however, it cannot be used in PT evaluation for three reasons. First, it is not intended for all performance improvement interventions. As stated by Holton (1996), it is intended for a single training intervention. Second, it evaluates performance on the individual level, while PT focuses on groups and organizations as well as individuals. Finally, practitioners in the field need a simple and elegant model for evaluating interventions.

All three models above only partially meet the criteria of an ideal evaluation model for PT. Therefore, a model which addresses the criteria for an ideal evaluation model and attributes of PT is needed.

## Proposing an Expanded View of Kirkpatrick's Framework

In order to address two sets of criteria presented in the paper, a three dimensional model with systems theory is proposed. The model is named Dimensions and Systems since application of the model requires, first, selecting dimensions and, second, configuring the systems.

### Dimensions

In order to address all the elements in PT, a three dimensional matrix is needed. Dimensions of the model are variables/interventions, evaluation outcomes and subjects of evaluation. Figure 1 depicts each dimension.

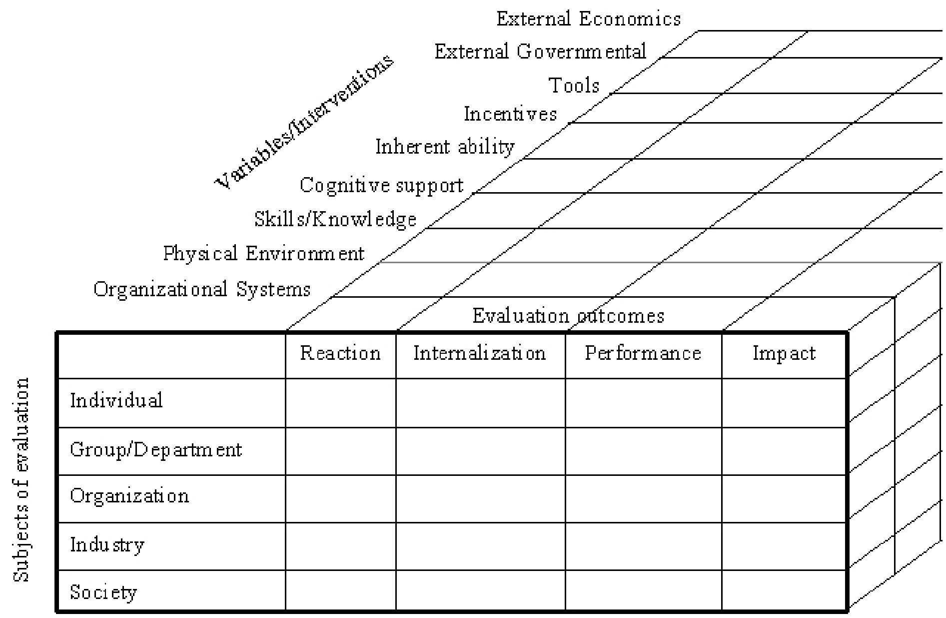


Figure 1. Illustration of dimensions

*Subjects of Evaluation*: Performance improvement interventions can be applied to individuals, groups or organizations (Brethower, 1999). Furthermore, these interventions may have an effect on external environments (Molenda et al., 1996; Watkins, Foshay, & Kaufman, 1998). Therefore, five subjects of evaluation are purposed; individual, group, organization, industry and society.

*Evaluation outcomes*: Evaluation outcomes of an intervention are basically Kirkpatrick's framework modified as; reaction, internalization, performance and impact. The names have been modified in order to better generalize to other interventions.

*Reaction* refers Kirkpatrick's reaction level and provides feedback for further improvement in the intervention, e.g., reactions to a training program are feedback for further improvements (Lee & Pershing, 2002).

*Internalization* refers to the acceptance or acquisition of intervention. Evaluating internalization is intended to determine if the intended intervention is absorbed by the subject, if the subject is willing or able to perform with the intervention and if the intervention is effective.

*Performance* refers to performance under the effects of the intervention. The aim of PT is to improve performance. Since behavior is training specific term, it is replaced with the term performance to embrace all interventions for all subjects.

*Impact* refers to accomplishments of performance. Impact can be different for each subject. Kirkpatrick (1998) referred to results as tangible improvements in the characteristics of organizations such as reduced turnover, absenteeism and scrap, and increased profit and costumer satisfaction. The term "impact" refers to results at the individual, group and organizational level. Watkins et al. (1998) added one more level to Kirkpatrick's framework, societal contribution. In this model, impact outcome at the social level refers to Watkins et al. (1998) societal contributions of intervention.

*Variables/Interventions elements*: The third dimension of the model is Variables/Interventions elements, which affect the occurrence of each evaluation outcome to some degree. Wile (1996) proposed seven elements for performance to occur, organizational systems, incentives, cognitive support, tools, physical environment, skills knowledge and inherent ability. This taxonomy provides a complete list of outcome elements for reaction, internalization and performance evaluation outcomes. Holton (1996) included external to organization events variable in his model to show the effects of external forces. In this model, in order to include the influences external to the organization, external economics and governmental elements are added. Variables/Interventions can have two roles, first, they are the components of each evaluation outcome and, second, if they are modified to improve the performance, they become interventions whose effectiveness is evaluated.

**Systems**

The second part of the model is systems. Systems thinking is a discipline dedicated to seeing the whole, its elements and the interrelations between them (Senge, 1990). Organizations are systems and when performance technologists implement an intervention, this intervention has interactions with the existing elements of the organizational systems (Brathower, 1999). Systems thinking can help a performance technologist to see the complexities in organizations and the effects of their intervention (Sleezer et al., 1999). Basic system elements are inputs, outputs, process, feedback and environment (Hutchins, 1996).

*Inputs* are Variables/Interventions elements that are listed above.

*Process* consists of the subject of the evaluation; individual, group, organization, industry or society.

*Outcomes* are measured evaluation outcomes; reaction, internalization, performance and impact.

*Surrounding environment* is the environment in which the system exists. In the model the surrounding environment for individual is the group. For group, the surrounding environment is the organization and so on.

*Feedback* is any effect that outcomes produce and feed back to the inputs. Depending on the intervention, feedback could be motivation.

By selecting the elements in dimensions model, appropriate evaluation systems are to be set up.

## Application of the Model

**Selecting outcomes to be evaluated**

As the literature shows, not all levels of Kirkpatrick's framework, especially level 3 and level 4 are practiced. Reasons for this situation vary from organization to organization. A decision matrix for the objectives of the evaluation should be set up to selects appropriate outcomes to be evaluated. The items in the following table are an integration of the criteria that practitioners use when designing an evaluation (Geber, 1995; Twitchel et al., 2000; Moller and Mallin, 1996; Dye, 2001).

Table 1. Decision matrix for obtaining evaluation outcomes

| | **Levels of evaluation outcomes** | | | | |
|---|---|---|---|---|---|
| | | *Reaction* | *Internalization* | *Performance* | *Impact* |
| **Criteria for obtaining** | Alignment with purposes of evaluation in the organization | | | | |
| | Decision makers' interest | | | | |
| | Stakeholders' interest | | | | |
| | Cost of intervention | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Number or people affected by the intervention | | | | |
| | Expected impact of intervention | | | | |
| | Expected cost of evaluation | | | | |
| | Access to data | | | | |
| | Required competency/skills to obtain outcome | | | | |
| | Climate toward evaluation | | | | |
| | **Decision** | | | | |

After deciding on the evaluation outcome, a practitioner needs to consider hierarchical order of outcomes which suggests evaluation outcome of one level is affected by the preceding level. For example if the criteria above suggest that the intervention should be evaluated at the performance level, reaction and internalization evaluation outcomes should also be obtained. When a training intervention is implemented, the connection between internalization, as learning in a training situation, and performance seems clear and logical, because if a person does not perform, it is possible that the person lacks skills and knowledge as well as other variables. To insure that the person has the skills and knowledge to perform, internalization outcomes should be obtained.

**Selecting elements**

After deciding to what extent an intervention is to be evaluated, using the presented three-dimensional matrix (Figure 1), practitioners can choose elements of the system. Using their best judgment, practitioners choose relevant elements from each axis of the matrix, since each situation has its unique features. For instance, while conducting an evaluation of a job aid at individual level, it may or may not be helpful to consider external economics and governmental factors for reaction outcomes.

**Setting up the evaluation systems**

In order to determine the variables/interventions that effect evaluation outcomes for each subject and their interactions, the evaluation systems involved need to be made explicit. Systems are diagrammed with elements selected from the three-dimension matrix. One important point here is that each evaluation outcome should become one of the inputs of the following level, because the evaluation outcome of preceding level is necessary for the purpose of insuring that the intended objectives of the intervention were achieved. For example, in a job aid intervention case, if an employee did not internalize the benefits and use of a job aid, trying to obtain only performance evaluation outcomes with this employee would cast doubt on the success of intervention.

**Identifying data to be collected and developing instruments**

After determining evaluation outcomes, subject of evaluation and variables, next step is to identify data to collect for each evaluation outcome. Three dimensions of the model, subjects, intervention and evaluation outcome, determine the criteria about the data to be collected. From intervention to intervention and from organization to organization the nature of evaluation outcome data can change. The dimensions in the model yield 180 (9x5x4) different cells and situations, and it would be impossible to explain each of them here. Again practitioners need to use their best judgment to decide what data to collect, but here are some general guidelines:

*Define evaluation outcomes operationally*: Evaluation outcomes need to be defined operationally. Although each evaluation outcome has been defined previously at the beginning of this section, practitioners need to answer the question of what constitutes the evaluation outcome while considering the intervention and the subject of evaluation. For example, when evaluating the internalization of a process improvement for the individual, a practitioner needs to answer the question of what indicators constitute the acceptance and understanding of the new process for the individual. An approach to this question would be to determine the awareness of the employee and his/her knowledge about the process.

*Identify primary elements for the evaluation outcome*: Primary elements have direct and immediate interactions on an intervention with subjects at an evaluation level. For example, the instructor and material for a training intervention can be primary elements of the reaction outcome for an individual or group.

*Identify secondary elements for the evaluation outcome*: Secondary elements have indirect and non-continuous interactions on an intervention with subjects. Examples would be External economics or the governmental variable for training intervention at learning level.

After identifying the relevant data with the help of the three-dimension model and the evaluation systems, instruments can be developed.

**Measurement activities**

Measurement or data collection activities are an important part of this model, they provide the data to make judgments about worth of an intervention or attempts at further improvements. Two points can be considered. First, several data collection methods can be employed such as surveys, interviews and observations. Second, generally, evaluating the effectiveness of an intervention process means comparing the evaluation outcomes of presence and absence of the intervention, to this end, two types of measurement activities can take place; pre and post intervention measurement, or utilizing a control group (Harris, 1998). These two points help increase the effectiveness of the evaluation process.

## Limitations and Further Application Recommendations

The model presented in this paper provides guidelines to evaluate the effectiveness of performance interventions by synthesizing from two sets of criteria for an ideal evaluation model for PT. One limitation of the model is that it only provides guidelines for selecting evaluation methods and setting up the forces for each evaluation outcome. It does not provide specific methods or ready-to-use procedures. The model relies on practitioners to set up the evaluation systems for evaluation. This is one disadvantage of providing a great degree of freedom to practitioners and attempting to encompass a wide range of interventions.

In order to increase the effectiveness of this evaluation model, two recommendations can be considered. First, as mentioned earlier, the applications of Kirkpatrick's framework showed that managerial support and creating a trust environment in the organizations are crucial for obtaining behavior or performance evaluation outcomes (Harrell, 2001). In order to successfully conduct performance and impact evaluations, managers should be educated about the importance of evaluation activities at the performance and impact level (Riley et al., 2002). Second, institutionalization of the evaluation process is an important step to increase effectiveness of evaluation (Smith & Brandenburg, 1991). Continuous measurement activities, especially for performance and impact evaluation outcomes, can serve as indicators of the subjects' situations before and after implementation of performance improvement interventions. Measuring all the variables continuously in the proposed model can indicate the effectiveness of an intervention when it needs to be evaluated.

## Conclusions

The focus of PT is to improve individuals' and organizations' performance through implementing interventions drawn from multiple disciplines. After the implementation of a performance improvement intervention, it is necessary to answer three basic questions; did the intended outcome occur, is the intervention worth continuing, and how can the intervention be improved. This is why an evaluation process should be conducted. Kirkpatrick's four-level evaluation framework is the dominant model in the corporate world for evaluating training and non-training interventions. Although simplicity and practicality are the advantages of the framework, its inadequacy for addressing several performance improvement interventions and its inability to consider organizations as systems are signs of a need for a new evaluation model for PT.

The Dimensions and Systems model presented in this paper can be an alternative for Kirkpatrick's framework to evaluate performance improvement interventions. The Dimensions and Systems is an attempt to provide simple and applicable, yet adequate, model for practitioners to evaluate effectiveness of PT interventions in their organizations.

## References


Ackoff, R. (1994). Systems Thinking and Thinking Systems. *Systems Dynamics Review, 10*(2-3), 175-188.

Al-Athari, A., & Zairi, M. (2002). Training Evaluation: An Empirical Study in Kuwait. *Journal of European Industrial Training, 26*(5), 241-251.

Alimo-Metcalfe, B. (1998). 360 Degree Feedback and Leadership Development. *International Journal of Selection and Assessment,, 6*(1), 35-44.

Alliger, G. M., & Janak, E. A. (1989). Kirkpatrick's Levels of Training Criteria: Thirty Years Later, *Personnel Psychology* (Vol. 42, pp. 331): Personnel Psychology, Inc.

ASTD. (1996). *The 1996 American Society for Training and Development Report on Trends that Affect Corporate Learning & Performance,2nd edn,* . Alexandria, VA: American Society for Training and Development.

Blanchard, P. N., Thacker, J. W., & Way, S. A. (2000). Training Evaluation: Perspectives and Evidence from Canada. *International Journal of Training and Development, 4*(4), 295-304.

Bramley, P., & Kitson, B. (1994). Evaluating Training against Business Criteria. *Journal of European Industrial Training, 18*(1), 10.

Brethower, D. M. (1999). General Systems Theory and Behavioral Psychology. In H. D. Stolovitch. & E. J. Keeps. (Ed.), *Handbook of Human Performance Technology* (2 ed.). San Francisco: Jossey-Bass/Pfeiffer.
Brinkerhoff, R. O., & Dressler, D. (2002). Using evaluation to build organizational performance and learning capability. *Performance Improvement, 41*(6), 14-20.
Carr, C., & Totzke, L. (1995). The Long and Winding Path (from Instructional Design to Performance Technology). *Performance and Instruction, 34*(3), 9-13.
Catalanello, R. F., & Kirkpatrick, D. L. (1968). Evaluating Training Programs - The State of the Art., *Training & Development Journal* (Vol. 22, pp. 2): American Society for Training & Development.
Dixon, N. M. (1996). New Routes to Evaluation, *Training & Development* (Vol. 50, pp. 82): American Society for Training & Development.
Dye, K. (2001). *Effective HRD Evaluation: An Expanded View of Kirkpatrick's Four Levels.* Unpublished PhD dissertation, Indiana University, Bloomington, IN.
Edwards, J. E., Scott, J. C., & Raju, N. S. (2003). *The Human Resources Program-Evaluation Handbook*. Thousand Oaks: Sage.
Geber, B. (1995). Does Your Training Make a Difference?  Prove it! *Training, 32*(3), 27.
Goldwasser, D. (2001). Beyond ROI. *Training, 38*(1), 82.
Gordon, J., & Zemke, R. (2000). The Attack on ISD. *Training, April 2000*, 42-53.
Guerra, I. J. (2001). Performance Improvement Based on Results: Is Our Field Interested in Adding Value? *Performance Improvement, 40*(1), 6-10.
Guskey, T. (2000). *Evaluating Professional Development*. Thousand Oaks, CA: Sage.
Harrell, K. D. (2001). Level III Training Evaluation: Considerations for Today's Organizations. *Performance Improvement, 40*(5), 24-27.
Harris, M. B. (1998). *Basic Statistics for Behavioral Science Research*. Needham Heights, MA: Ally & Bacon.
Holton, E. F. (1999). An Integrated Model of Performance Domains: Bounding the Theory and Practice. *Performance Improvement Quarterly, 12*(3), 95-118.
Holton, E. F., III. (1996). The Flawed Four-Level Evaluation Model [and] Invited Reaction: Reaction to Holton Article [and] Final Word: Response to Reaction to Holton Article. *Human Resource Development Quarterly, 7*(1), 5-29.
Hutchins, C. L. (1996). *Systemic Thinking: Solving Complex Problems*. Aurora, CO: Professional Development Systems.
Kaplan, R. S., & Norton, D. P. (1992). The Balanced Scorecard-Measures That Drive Performance. *Harvard Business Review, January-February*, 71-79.
Kaufman, R., & Keller, J. M. (1994). Levels of Evaluation: Beyond Kirkpatrick. *Human Resource Development Quarterly, 5*(4), 371-380.
Kirkpatrick, D. L. (1996). Great Ideas Revisited. Techniques for Evaluating Training Programs. Revisiting Kirkpatrick's Four-Level Model. *Training and Development, 50*(1), 54-59.
Kirkpatrick, D. L. (1977). Evaluating Training Programs: Evidence vs. Proof. *Training & Development Journal, 31*(11), 9.
Kirkpatrick, D. L. (1998). *Evaluating Training  Programs: The four levels* (Second ed.). San Francisco: Berrett-Koehler.
Klein, J. D. (2002). Empirical Research on Performance Improvement. *Performance Improvement Quarterly, 15*(1), 99-110.
Lee, S. H., & Pershing, J. A. (2000). Evaluation of Corporate Training Programs: Perspectives and Issues for Further Research. *Performance Improvement Quarterly, 13*(3), 244-260.
Lee, S. H., & Pershing, J. A. (2002). Dimensions and design criteria for developing
training reaction evaluations. *Human Resource Development International, 5*(2), 175-197.
Lewis, T. (1996). A Model for Thinking About the Evaluation of Training. *Performance Improvement Quarterly, 9*(1), 3-22.
Molenda, M., Pershing, J. A., & Reigeluth, C. M. (1996). Designing Instructional Systems. In R. Craig (Ed.), *The ASTD Training and Development Handbook* (4 ed.). New York: McGraw-Hill.
Moller, L., & Mallin, P. (1996). Evaluation Practices of Instructional Designers and Organizational Supports and Barriers. *Performance Improvement Quarterly, 9*(4), 82-92.
Phillips, J. (1991). *Handbook of Training Evaluation and Measurement methods*. Houston, TX: Gulf.
Phillips, J. J. (1996). ROI: The search for best practices. *Training & Development, 50*(2), 42.
Reiser, R. A. (1987). Instructional technology: A history. In R. M. Gagne (Ed.), *Instructional Technology: Foundations* (pp. 11-48). Hillsdale, N.J.: L. Erlbaum Associates.

Riley, T., Davani, H., Chason, P., & Findley, K. (2002). Practices and Pitfalls: A Practitioner's Journey into Level 3 Evaluation. *Performance Improvement, 41*(5), 14-23.
Robinson, D. G., & Robinson, J. C. (1989). *Training for Impact: How to link training to business needs and measure results*. San Francisco: Jossey-Bass.
Rosenberg, M. J. (1988). The role of training in a performance-oriented organization. *Performance and Instruction, February*, 1-5.
Rosenberg, M. J. (1996). Human performance technology. In R. Craig (Ed.), *The ASTD training and development handbook*. NY: McGraw-Hill.
Rosenberg, M. J., Coscarelli, W. C., & Hutchinson, C. S. (1999). The origins and evolution of the field. In H. D. Stolovitch & E. J. Keeps (Eds.), *Handbook of Performance Technology* (Second edition ed.). San Francisco: Jossey-Bass/Pfeiffer.
Rossett, A. (1996). Job aids and electronic performance support systems. In R. Craig (Ed.), *The ASTD Training and Development Handbook* (4 ed.). New York: New York.
Rossett, A., & Tobias, C. (1999). A Study of the Journey from Training to Performance. *Performance Improvement Quarterly, 12*(3), 31-43.
Scott, J. C., & London, M. (2003). The evaluation of 360-degree feedback programs. In J. E. Edwards, J. C. Scott & N. S. Raju (Eds.), *The human resources program-evaluation handbook*. Thousand Oaks: Sage.
Senge, P. (1990). *The Fifth Discipline: The art and practice of the learning organization*. New York: Doubleday.
Shrock, S., & Coscarelli, W. (2000). *Criterion-Referenced Test Development* (Second ed.). Washington DC: International Society for Performance Improvement.
Sleezer, C. M., Hough, J. R., & Gradous, D. B. (1998). Measurement Challenges in Evaluation and Performance Improvement. *Performance Improvement Quarterly, 11*(4), 62-75.
Sleezer, C. M., Zhang, J., Gradous, D. B., & Maile, C. (1999). A Step beyond Univision Evaluation: Using a Systems Model of Performance Improvement. *Performance Improvement Quarterly, 12*(3), 119-131.
Smith, M. E., & Brandenburg, D. C. (1991). Summative Evaluation. *Performance Improvement Quarterly, 4*(2), 35-58.
Spitzer, D. R. (1999). Embracing evaluation. *Training, 36*(6), 42.
Stolovitch, H., & Keeps, E. (1999). What is Human Performance Technology. In H. Stolovitch & E. Keeps (Eds.), *Handbook of human performance technology*. San Francisco, CA: Jossey-Bass.
Thiagarajan, S. (1991). Formative Evaluation in Performance Technology. *Performance Improvement Quarterly, 4*(2), 22-34.
Twitchell, S., Holton, E. F., III , & Trott, J. W., Jr. (2000). Technical Training Evaluation Practices in the United States. *Performance Improvement Quarterly, 13*(3), 84-109.
Van Tiem, D. M., Moseley, J. L., & Dessinger, J. C. (2000). *Fundamentals of performance technology: A guide to improving people, process, and performance*. Washington, D.C: International Society for Performance Improvement.
Watkins, R. L., Foshay, D., & Kaufman, R. (1998). Kirkpatrick Plus: Evaluation and Continuous Improvement with a Community Focus. *Educational Technology Research and Development, 46*(4), 90-96.
Wile, D. (1996). Why doers do. *Performance & Instruction, 35*(1), 30-35.
Zemke, R., & Rossett, A. (2002). A hard look at ISD. *Training*(February 2002), 27-35.

# Conversation As Inquiry: A Conversation With Instructional Designers

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The missions, goals, and practices of instructional designers are defined by organizational and cultural frames. What are these frames? What images fill these frames and who is involved in creating them? If one frame replaces another, how does the focus change? Over the past three years we have been exploring this idea of "frames" as a problem of practice for instructional designers who work in institutions of higher education (HE). We believe that instructional designers create meaningful images within frames that reflect constantly interacting personal, professional, institutional, and social visions and goals. These frames are described and mediated through a series of conversations – with our personal and professional histories, our discipline, our colleagues, our clients, our institutional and cultural contexts and, most importantly, our own values. We believe that there is a reciprocal relationship between design and conversation: conversation is design, and design emerges through conversation. Since we live our personal/professional lives in a series of conversations, we believe that a series of constant collaborative conversations with designers is a reasonable approach to inquiry. At the same time we know that conversation is not always deliberate, nor do instructional designers always reflect deeply on conversations they have. Therefore, it was an intention of our research to have conversations with designers that are deliberate and that encourage deep reflection about their purpose and practice, and ours!

Through their work with others instructional designers engage in a process of professional and personal transformation that has the potential to transform the HE institution, particularly through faculty client relationships. Borrowing from disciplines as diverse as sociology and cognitive science we maintain that learning involves shared thinking or understanding, and is most effective if it is embedded in social experience and situated in authentic problem-solving contexts (cf. Glaser, 1991; Jonassen, Dyer, Peters, Robinson, Harvey, King, & Loughner 1997; Rogoff, 1990). Instructional design, rarely played out in social isolation, may be a form of cultural learning or collaborative learning for all those engaged in the interaction. Exploiting the metaphor of instructional design as conversation has implications for both personal and social action. Understanding this process through conversation has implications for both professional and methodological change in our field.

In this paper we explore four main themes—reflexivity, voice, strong subjectivity, and power/authority—that are woven together by the idea of moral action. We look at each theme twice— once from a methodological view or frame (i.e., conversation as inquiry), and again from a practice-based frame (i.e., instructional design as conversation). This is one of a series of completed (cf. Campbell, Schwier & Kenny, 2005; Kenny, Schwier, Zhang & Campbell, 2005; Schwier, Campbell & Kenny, 2004) and developing papers that will explore identity, social action and community and challenge the so-called "grand narratives" of instructional design.

## The Research Study

The stories shared in this paper were drawn from a three-year (2002-2005) study, funded by the Social Sciences and Humanities Research Council of Canada, involving six Canadian universities and smaller HE institutions. The participating institutions have an administrative and/or academic unit whose mandate is to support faculty developing technology-enhanced, blended, or online learning environments.

### Methodology

We elicited participation through a range of strategies including personal email invitations, advertisements on listservs and blogs, personal contacts at professional meetings, membership lists from professional associations and visits to graduate classes. Sources of data include research conversations with instructional designers, email correspondence, and group meetings and/or focus groups.

The narrative study is constructed as a series of collaborative conversations. They refer to designers' lives as learners and their memberships in social and professional communities, their career choices, their core values about the purposes of education and of design, and their design practices, dilemmas and relationships.

**The Rationale**

We believe that narrative inquiry and the "storying" of experience are socially and contextually situated interpretive practices. We start from personal stories because "personal knowledge has a practical function…as a source for deliberation, intuitive decisions, daily action and moral wisdom" (Conle, 2000, p. 51). That is, a deep understanding of instructional design practice is most accessible to us in the forms in which designers actually do design. Through a series of socially-referenced, scaffolded conversations participants reveal how and why they design as they do, and how we can use that understanding to prepare and support designers to practice in the most agentic, authentic, and profound ways. For the instructional designers involved in this study, telling stories of practice requires a personal critical, reflective engagement with the potential to change or transform their practice. Thus the methodological approach for the study mirrors a social constructivist framework for instructional design practice, which is one of social interaction and construction of meaning through conversation.

The conversations we included in this paper were selected from the data pool of 49 research conversations (with 20 instructional designers) because these participants told stories that very directly reflect the practice dimension of conversation. We chose these conversations because they clearly reflect the idea of the design conversation and impressed us as effectively representing plausible, authentic, and compelling accounts that are both believable and invitational.

**Data Analysis**

Two researchers independently coded each transcript of the conversations using Atlas Ti™ software; the third completed a broader thematic analysis. That is, two researchers independently used a micro coding approach while one examined the transcripts with a wider lens. As themes emerged, they were negotiated with the entire research team and, where possible, shared with the participants. The themes were then used to construct networks of meaning. This reflexive process is intended to further engage participants in identifying issues related to instructional design by bringing the personal and community problems of practice into self-awareness. In this way, narrative inquiry involves the "politics of identity construction and ongoing identity maintenance", where the lived experiences of instructional designers can "be used as the sites wherein and whereby we interrogate the social world theoretically and critically" (Goodson, 1995, 4).

## Conversation As Inquiry: An Alternate Frame

It is generally accepted that ID practice was originally based on the behaviorist learning theories of Skinner and Thorndike, among others (Saettler, 1992), and that instructional design was based on the empiric assumption that behavior is predictable, and that educational design can occur in isolation from the contexts in which learning will take place (Koper, 2000, 8). As a result, the language of design has reflected a systematic approach based on social engineering and reflecting the values of efficiency and effectiveness (cf. Merrill & $ID_2$ Research Group, 1996; Dick, Carey & Carey, 2005). These are supposedly value-free ways of shaping and representing knowledge based on the assumption that educational technologies and environments are neutral and democratic and that knowledge can be codified and presented in templates or blueprints that describe reality. Designers, programmers, and media developers emerging from this "scientific" field have learned models that value objective, rational, instrumental, and empirical approaches (e.g., Braden, 1996). Critical theorists have described the products and environments they produce and deliver as too often prescriptive, restrictive, and reductionist, due in no small way to the culture they have acquired by their training (c.f. Garrison, 1993; Vrasidas, 2001).

Research about instructional design has, until very recently, also reflected an objective, rational approach. The behavioral science-based approach, in particular, began to have an increasing impact on the field in the 1970's as researchers sought a design science "as developed by experts in the areas of psychology, anthropology, sociology, learning, group processes…communications, cybernetics, perception, psychometrics, human factor engineering, branches of economics such as personnel utilization, and computerized systems" (Saettler, 1990, 12). The cognitive approach to inquiry emerged from the behavioral science approach and endeavored to understand a learner's internal cognitive processes, such as thinking, organizing and remembering, and activating the appropriate learning strategies during the instructional process. This approach considered media attributes, learner strategy implementation, and task analysis (Saettler, 1990). The search for a design science engendered hundreds of studies of experimental design examining learning conditions and outcomes, many of which revealed "no significant difference" (c.f. Hannafin & McDermott, 1995; Russell, 1999). In all these approaches the instructional designer's scope was restricted to systematically choosing and applying the design model likely to yield the most effective instruction. The design-science vision has underpinned its dominant cognitive science culture for many decades and eliminates the messy process of problem solving where non-systematic human thoughts and emotions are involved (c.f. Willis, 1998).

But, there is a cultural shift in ID, framed by social constructivists for whom is constructed in communities of practice through social interactions. Cobb (1996) argues that knowledge is not held objectively, but is unique, wholly subjective, and passed on by establishing common ground between the knower and the learner. That is, "instruction and instructional technology are human inventions that spring from human values and human designs. They are value-saturated and operate in the social world…social inventions… are never value-free or value-neutral. They resonate with the values of their human creators, who themselves are situated in a particular culture in a specific time and place" (Johnsen & Taylor, 1995, 94). After Connelly and Clandinin (1990) we see instructional design practice in an alternative way: knowledge is embodied within individuals in a relationship, for example faculty clients/collaborators and instructional designers, who together interpret their experiences through personally and socially constructed visual and verbal forms, whether that be language, pictures, or actions.

Since design decisions are often experiential, intuitive, aesthetic, and phenomenological, related instructional design research should reflect critical paradigms that "provide a mode of inquiry which can provide insight and information which goes beyond the possibilities of scientific inquiry…(into) the realm of art" (Hlynka & Belland, 1991, 9). Here we make a case for narrative as a form of critical inquiry in instructional design practice. The unstructured interview design, or collaborative conversations, captures the participants' own constructions of experience, families and social cultures: seminal personal and professional encounters; moral and ethical beliefs and dilemmas; development and understanding of their work as instructional designers, and how their knowledge is embodied in their relational practice with faculty. We explore four main ideas as methodological issues: reflexivity, voice, strong subjectivity, and power/authority.

**Theme 1: Reflexivity**

These designers told us that they design by asking faculty to tell stories about their teaching, and reflecting these stories back through the learning design. Storytelling recounts personal action and reflects learning for both faculty and designer. In a design conversation, both designer and faculty are critically aware of how each other's role affects the telling and challenges the other's construction of the story. What emerges is a socially transformative story of the design process (Campbell, 1994). The narrative conversation is a fundamental activity of mind, involving an intentional reflective activity (Lyons & Kubler LaBoskey, 2002). As we talk to the designers about their past projects the temporal distance requires a cognitive and emotional reconstruction of the experience. In its collaborative form the conversation becomes an opportunity for growth for both designer, who has new knowledge to use, and us (who are also instructional designers), whose new appreciation for the design process is reflected in both refined methods/better questions and enhanced personal design practice.

**Theme 2: Voice**

As a conversation-based practice, instructional design is plurivocal. In the conversation, clients and designers and researchers share space and moral authority in the acts of listening, taking turns, attenuating; acting in each other's stories. The story is "a statement of belief, of morality, it speaks about values" (Goodson, 1995, 12). Storying experience establishes complex interrelationships, is social and political and assumes equity. In the end no one owns the story, because the research story would not exist without its telling and its hearing; its resonance and dissonance with the listener's experiences (Gudmundsdottir, 1998). As researchers, we can interrogate design practice through active social participation in the conversation, because storying the design experience requires conscious knowledge and understanding of action (Lyons & Kubler LaBoskey, 2002).

Accountability to the storyteller and the story becomes both an ethical and a methodological, or interpretive, issue in this research. Even though we intend the conversations to be collaborative and equitable, by recounting the conversation we have also co-opted it. For example, in a conversation there are silences, facial expressions, vocalizations; certain stories become unavailable. If we listen to the original tape during the transcript analysis we may be aware of these "meaning units" but may choose not to include them. If we were not present during the conversation and are working with transcripts only, we might not realize that an extended silence occurred because the designer might have been struggling to gain control of his emotions. In one transcript, our transcriber inserted comments like "laughs nervously" and "sighs heavily", which was only her interpretation of the emotional context of the conversation. Another transcriber did not insert any affective or descriptive markers in the transcripts. Listening to the tape from an earlier conversation one researcher realized that she was talking more than the designer, an indication of unequal voice. However, "mutuality" is another way to interpret this interaction: the stories were so resonant that the conversation reflected deep connections in parallel finished thoughts and shared cultural memories.

**Theme 3: Strong Subjectivity**

As instructional design is a social project, so too is understanding the process, an act with moral and political undertones. Moral in that the design conversation reflects values and beliefs that guide practice, and political in that practice at least implies the possibility for social action in the institution. As designer-researchers we are agents of change, because we can retell design stories in ways that challenge the dominant research culture of instructional technology, or dominant practices in HE. Our shared experiences with designers, rather than our differences, makes us activists, because we have chosen issues close to our own hearts and feel responsible to represent this social process. In essence this is why the research conversation, like the design conversation, is a moral rather than a technical act (Herda, 1999).

As instructional technology has been concerned by a reproducible product in practice alternative research frames have been held up to the "quality measures" common to the positivist requirement for "truth claims", that is, reliability, validity, generalizability; the rigor associated with an "objective" research design. But narrative inquiry, in which conversation is both method and data, is more critically concerned with ethical conduct, voice, reflexivity, and resonance. The researcher brings his or her "cultural self" as a set of resources for the relational work of narrative. Utilizing oneself as an interpretive resource is critical to understanding how the research process is unfolding and how meaning is made in conversation. In other words, identifying the interviewer as a designer-researcher permits us to use the commonly understood language of design. A shared language enables us to "create and acknowledge meaning as we engage in discourse and fulfill social obligations…(that) are characterized as moral activities" (Herda, 1999, 24). We become part of the past and the future as "temporal and social, cultural horizons are set and reset" (Connelly & Clandinin, 1990, 5) through the conversation; our stories are merged with those of our participants and emerge as scripts for further practice or action. The quality measure here is the moral obligation we share as designer-researchers with designers to "tell it the way we now understand it", rather than as "the way it was". This strong subjectivity requires that we investigate rather than deny our relationship with our conversation partners and to explicitly, consciously and critically examine and respond to the interpersonal dynamics. The relationship between us pervades every aspect of the process, determining the quality and quantity of the information gathered (Cole, 1991). A reciprocal relationship is enhanced by the collaborative sharing of personal experience as a component of trust, rather than an effort to maintain an objective distance during conversations about experiences we all share.

**Theme 4: Power and authority**

Empowerment is a goal of conversation-as-inquiry, which is political in the same way as this project, having a different purpose from historical and traditional forms of educational technology research. is political. The historical purpose of the latter has been to gain knowledge for the power to define "evidence-based" instructional design models and control over the ways that designers are supposed to practice. The stories we are hearing and retelling are potentially subversive and disruptive, because they encourage us to see the design world and understand our own design practice in new and different ways. They become counter-narratives of instructional design. (Elbaz-Luwisch, 1997; Kanno, 1997; McEwan, 1997).

The relationships that designers build with their clients often reflect their "ethic of care" for vulnerable faculty dealing with the cultural expectations of HE institutions (Noddings, 1991; Schön, 1987), and at the same time with the issue of class membership in that same hierarchical culture. We have heard stories of struggle for identity and credibility that resonate with our own experiences as designers, and as qualitative researchers in this field (Schwier, Campbell & Kenny, 2004). However, it came as a surprise that our designers sometimes felt the same inequity in power and authority with us. This raises questions about power and authority within a research relationship which is defined as collegial by the researcher, who is also a designer, and the participant, who feels uneasy about fully disclosing conflicts, mistakes; times of doubt in her practice. This sort of dilemma highlights the differences in epistemology and purpose between objective (traditional experimental design) and emancipatory (narrative) forms of research. Shotter and Logan (1988) suggest that the former leads to a "decontexted kind of theoretical knowledge…expressed in a hierarchically arranged, closed system of binary oppositions…concerned with…a unity of vision and thought…everything in its proper place and all conflict eradicated, once and for all" (75). Emancipatory forms contextualized by relationship, on the other hand, make space for a "plurality of otherwise conflicting voices" (75).

It doesn't surprise us that designers struggle with identity and agency in a culture that privileges individual, monological knowledge held in an authoritative closed hierarchy (HE), and in a research culture that is dominated by the “discovery of yet more techniques of control, use, appropriation…” (Shotter & Logan, 1988, 75). The current project positions us as members of the design and the research communities with a particular vision: as designer-researchers we can challenge the power dynamics in educational technology research, we can democratize the structures that specify the sphere of the designers’ professional action by clearing space for their authentic stories. Practice is contingent on social context and what we learn about practice from these conversations is likewise of practical and contingent use in professional development, graduate study, and research contexts. Capturing the idea of designer-researcher agency Herda (1999) proposes that by grounding the notion of action in moral decisions, and changing our idea and understanding of professional identity “we change our actions as researchers within the broader professional community so that our findings may take on a significance in our own lives and in the lives of our participants” (91).

**Instructional Design As Conversation**

In the second part of this paper we explore critical questions about the conversation-based, social practice world of the instructional designer through the four integrating ideas of reflexivity, voice, strong subjectivity, and authority. These ideas are articulated through the pseudonymous voices of three designers, Steve, Yan, and Maria.

**Steve and Wilhelm: Conceptual Constraints and Reciprocity**

Steve came to as an intern from a graduate program that was significantly project-based; the university was ideally situated to attract clients from the corporate sector. Graduate students learned the “evidence-based” models (Steve talks a lot about ADDIE) and became skilled at experimental research design. Steve was attracted to the internship placement because the hosting development centre at another university had just been established as a centrally supported unit. He was pleased to be able to contribute to “building processes internally…so a lot of the design work was actually experiential.” The centre’s approach of working with faculty in a professional development model encouraged him to work intensively with faculty based on their personal connection with each other. That is, the centre emphasized faculty learning over more technical, course production goals. His design practice involved a long phase of informal conversations followed by another phase of formal, team-oriented design meetings. Steve felt that faculty learning happened in the first phase, where in the second phase design decisions were consolidated and implemented by a more technical/production group.

Steve talked retrospectively about one project in particular that had the most influence on his growth as a designer. Wilhelm, the faculty client, was an internationally renowned teacher/philosopher, who was initially very skeptical about the support that a virtual environment could provide. A pragmatist, Steve had his own doubts about the nature of hermeneutic inquiry, admitting that he is “more empirically minded so a lot of what he would talk about I couldn’t buy.” However, these tensions helped the design conversation evolve as each struggled to understand the knowledge base and values of the other.

As Wilhelm described his instructional approach, Steve visualized “lessons that would just sort of unfold…they are not designed, they are not planned, they unfold and that is part of that whole (hermeneutic) philosophy…allowing that to happen.” Accepting that this was a viable model challenged Steve’s beliefs about a designed learning environment. Wilhelm’s teaching was conversation-based, reflecting his deep curiosity about how individuals live in and understand their world. Steve remembers that “there was always this conversation about ‘Well, how do you interact with the students?’ and he would describe things that he did in the classroom.” Wilhelm’s instructional goals were embedded in his experiences of and beliefs about living actively in the social world, and his responsibility as a teacher to represent that kind of relationship with life phenomena.

> *We were also talking about how we could…really to allow it so it wouldn’t need to be managed (by Wilhelm)…we came up with a number of activities including things where students would…be given pictures and then they would quickly…respond to the pictures with their feelings or with their thoughts or whatever the picture evoked… they would go through a number of these and they would be randomly pulled out of the database and then they would go through them again but with other people’s comments attached and then they would make comments and then (Wilhelm) would use these…to talk about…different things about the experience…*

The resulting design, an interactive concept map, is one outcome of a process in which Steve struggled to understand a way of looking at the world so that he could help Wilhelm faithfully represent online the dialogic nature of phenomenology. But while at times the design conversation was “over my head” there was also a “deeply cultural reason” for liking and personally committing to Wilhelm.

> *my background is German…(his) accent always reminds me of members of my family…and one of my favorite high school teachers was actually a student of (his). He did his Masters with Wilhelm…. I remember…this teacher talked about Wilhelm...and then his son was my best friend in high school...*

*(Wilhelm) always reminds me of that teacher…because my teacher was like Wilhelm… There's this certain way of looking at things.*

We picked up on the notion that a shared cultural heritage opened up a space for Steve and Wilhelm to work in harmony, although Wilhelm's project caused some cognitive dissonance for both. Steve responded that his doubts actually allowed him to ask the questions that encouraged Wilhelm to interrogate his own assumptions, and…"start breaking things down…pieces and examining assumptions and helping me to help them understand where the learning problems are gonna occur."

We see through this exchange that the agency relationship is reflexive; both participants influence the cognitive processes of the other and as a result both change. Certainly the amount of reciprocity between a designer and client is defined by the relationship and the institutional context within which their relationship operates. For example, an institution that emphasizes a hierarchical relationship between faculty and designers introduces power and authority to the conversations. Reflexivity can introduce dissonance to the conversations, and the resolution of that dissonance can result in designs that are marked by nuance and depth. The relationship is moral because it leads to positive action. The design does not even have to come to fruition; it's the process, the conversation, and the relationship that is important. Steve acknowledges his personal and institutional agency in faculty clients' changed perspectives.

*People (that) would come back afterwards and say, "I'm teaching differently now. Because of our interaction I'm teaching differently" and that would be like an epiphany, right? Even Dr. Stone…(whose) project never got off the ground, he would come back and we would talk about other things…we would talk about the problems he was having, we would talk about ways that he could address them, and afterwards him saying, you know, "I'm changing the way that I'm looking at these instructional problems for my classroom."*

**Yan and Design as Activism**

Yan is typical of many in this study who "cut their design teeth" in settings other than universities, and before obtaining formal graduate education in the field. We have observed that these designers tend to bring both a pragmatic and a political sensibility to their practice at universities. For example, Yan and Maria, the designers in the next two stories, understand the practice of instructional design as a way to embody their goals of accessibility and inclusion. Yan refers to her background as lower middle-class, giving her an interpretive lens in the 80's and 90's as she worked in various community service settings with "the disenfranchised".

*It seems to me that…there's kind of a political landscape that has allowed…people who are disenfranchised or just disadvantaged in some way, to be pushed even further down in terms of their own…opportunities…. That has been…a consciousness that has evolved for me in the past twenty years.*

Aware of the lack of social engagement of some faculty, Yan talks about teaching and design as political acts whose purpose is to improve the kinds of learning opportunities that will lead to social justice. Soon after obtaining an undergraduate education degree she took a full-time position as an ESL instructor in a community college with a large student population of political refugees. Her colleagues "had a very radical orientation to education, were quite active in a number of political movements,

*awakening my awareness to larger issues because when you talk about teaching in that context, you're not just talking about content; you're talking about a wider role, like what are issues of social justice?…it's quite interesting for me to come (to this university) and work with professors sometimes who are very knowledgeable in their area, but…it's hard for them to convey to their students what the significance of that content is within the wider context of the world. So that's an interesting situation for me…not as a result of my formal education; it's more my informal education through working with people who were very, very committed educators…who really walked the talk of what they believed…who were very much into people like Freire…*

As a result of this powerful socialization to critical frameworks for education, Yan decided to pursue an interdisciplinary Masters degree from both adult education and educational technology, hoping that learning technologies would broaden access for the groups to whom she had been committed for two decades. Instead, in her program she found a "micro-focus" on technical skills. When we talked about ways to have the sociopolitical impact engendered by a more critical focus for instructional design she pointed to writing for the professional community—she was working on a chapter for a book on technological and information literacy. Interested in equality (as)…a value that I bring to the table" and seeing "nothing in there in terms of marginalized groups" she decided to contribute a chapter on digital divide issues.

Yan's practice as a designer is framed by a moral purpose, which she often disguises when working with faculty with more instrumental goals. She describes one project in which, by having a series of conversations about her own experiences as a teacher of political refugees, she convinced a client to develop case studies framed by a relevant social issue.

> *In a couple of different case studies…I tried to make (the family) lower middle class in terms of how they talked…one of the characters decided to become a vegetarian and she announced at the dinner table that she was an ovo-lacto-vegetarian and her father said, 'What the hell is that?' And the… instructor said, 'That's really funny. That's exactly what my father would have said.'…. I kind of wanted to set the stage--here's a family that is struggling financially…the father loses a job…. The daughter is in university…and in the very last story the daughter is visiting the food bank at the student union. So we have a whole case study in terms of student hunger. We wanted to make the case studies relevant to student life and the fact that there are probably people on campus who don't have enough money for a balanced diet.*

Yan identified this project as one where she felt her own social values were aligned with the goals of the faculty in nutrition "because there's a social science element to (their practice)…they're trying to include things in their introductory class-- like aboriginal health…. social issues are part of that mixture…. The people who work there reflect that." Because her sociopolitical values harmonized with those of these faculty clients she felt more effective, her voice was heard and incorporated in the design; her instructional design practice embodied societal agency.

However, while at times Yan is able to work in moral, relational ways, when her clients focus on content outside of the context of significant cultural political issues she wonders whether she has any impact on the socially detached culture of the university. She looks back at her early career "dealing with people who…saw half their family get killed, and now they're in a new country, and they have to learn the language and…get a job…" She has identified other ways to measure success that reflect her global social conscience, "so I have to measure success in a different way… the instructor has acknowledged that there are more people in the class other than the keeners…. And I really feel the few things...like the teachable moments (with faculty)… have been very worthwhile."

**Maria and Intellectual Wrestling**

Maria feels that her instructional design career reflects her life, as part of being "constantly in process." She credits relationships with colleagues and faculty with being "extremely instrumental" in helping her define her goals "flow(ing) towards what I think now is more authentically what I need to be doing." Maria's design approach is one of strong subjectivity, referenced by her memories of learning, and of teaching in a college, seeing explicit connections between her experiences, values and practice.

Maria told the story of a development project for a theology course. The instructor was untenured, newly hired and still working on his dissertation. Maria had met him and connected on a deep level with him as she respected that "religion…really gets to the heart of who a person is and how they interpret the world" and she was interested in exploring how his spiritual lens would frame the design process. She found that he did not have a lot of experience in the classroom and that he initially characterized the Internet as a "tool of war and social aggression."

> *His own experience in the teaching process had been very lecture-oriented and his vocation as a priest is very intellectually-oriented… in the first few meetings he came across as…quite skeptical about whether or not a course of this nature could be taught.*

Maria planned to "set up some cognitive dissonance" through a series of conversations. They met many times, informally, to talk about the meaning of worship and the goal of religion in the schools. She attended a Mass. She describes her agentic role in course development as facilitative, respecting the relationship and at the same time requiring "a sort of intellectual wrestling…. posing challenging questions about what it is they are doing, why they are doing it; why they think that might work… perhaps creating enough discomfort about that, (so) that change can happen." Although the instructor was initially resistant to the idea of technology, and as a priest in a theological college was cloaked in both institutional and moral authority. she didn't feel resistance from him on a personal level. She noted that "after several months…he was starting to integrate things that we had talked about even in his face-to-face version of his class and that he was thinking about and wrestling with the way he was teaching, what that meant…"

Maria explicitly resists the expectation for an optimal, reproducible, impersonal course design. If a client's "absolute insistence" on a particular approach is ill advised, she will still try to "somehow honor that piece and come up with creative ways of making it happen that will be useful to learning." Her ethic of care for the person involved in the process "comes back to my original feeling that this course has to be a reflection of the person that is teaching and has to be part of their personality, they have to buy into it." Maria is purposeful in a reflexive design conversation that values a more reciprocal, relational process, one in which both participants experience profound growth. In this way she reflects back a passion through a sort of affective resonance.

> *… he said…that what he found in me was a great conversationalist and that we were able to talk through lots of things…. he actually said he always felt very empowered to do this and that.… for both of us the*

*discussions were always enjoyable, were always an exchange…whatever the content (he) was trying to address we would end up in conversation about that … he was very forthcoming…there was a... kind of mutual interest in terms of him being interested in what I was able to offer as an instructional designer and my interest in his content and so there was always an exchange.*

During the research conversation with Maria, we were invited to the course launch in the theological college, which was framed by a formal ceremony of worship and celebration. The instructor talked very movingly about his transformed teaching practices and his acceptance of the Internet as "an enabler of peace and community".

## Final Thoughts

At the beginning of this paper we framed instructional design as an active practice based on community, practical reasoning, personal perspective, and semantic innovation-- involving memory and leading to action. Exploiting the metaphor of instructional design as conversation has implications for both personal and social action. Understanding this process through conversation has implications for both professional and methodological change in our field, because the narrative conversation has moral, emotional, aesthetic and intellectual dimensions, and design is all of these.

More than a decade ago, Murphy and Taylor (1993) described their experiences, as faculty members, in a course development project. Their aim "in telling the tale is to show that the development of learning materials does not take place according to the kinds of models that one typically comes across in most instructional design textbooks." Arguing that such models "restrict rather than foster the kinds of creative processes" necessary for effective design, they referred to the emotional and intellectual complexity of design by describing the process of "confusion, conflict, ambiguity, and uncertainty"(45).

The reality is that this "messiness" (c.f. Schön, 1987) should not be seen as a problem to be overcome, but as a stimulating and creative environment in which relationships, rather than content, are at the center of the action. Connelly and Clandinin (1990) refer to the central task of narrative as representing "people (that) are both living their stories in an ongoing and experiential text and telling their stories in words as they reflect upon life and explain themselves to others." For us this is both the central task of instructional design and the power of narrative to reflect that. The stories we've included here demonstrate the kinds of things we can learn when we use conversation as a lens into our practice. An instructional design process in which faculty and designer work toward the "imagined future" of the designed learning environment is a "matter of growth" that "involves retelling stories and attempts at reliving stories" (4).

Narrative implies relationships with moral dimensions—trust, reciprocity, reflexivity, plurivocality--that leads to critical reflection and has profound practice implications. Instructional designers in higher education workplaces use narrative to assist faculty clients tell the instructional story; they have thousands of stories to share. All we have to do is ask, and develop a mindset that values what we hear.

## References


Braden, R.A. (1996, March-April). The case for linear instructional design and development: A commentary on models, challenges and myths. *Educational Technology, 36*(2), 5 – 23.

Campbell, K. (1994). *Collaborative instructional design: A transformative social activity.* Unpublished doctoral dissertation, University of Alberta.

Campbell, K., Schwier, R.A., & Kenny, R.F. (2005). Agency of the instructional designer: Moral coherence and transformative social practice. *Australasian Journal of Educational Technology, 21*(2), 242-262.

Cobb, P. (1996). Where is the mind? A coordination of sociocultural and cognitive constructivist perspectives. In C.W. Fosnot (Ed.), *Constructivism: Theory, perspectives and practice.* New York: Teachers College Press.

Cole, A. (1991, March). *Interviewing for the life history*: *A process of ongoing negotiation.* Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.

Conle, C. (2000). Narrative inquiry: Research tool and medium for professional development. *European Journal of Teacher Education, 23*(1), 49-63.

Connelly, F.M. & Clandinin, D.J. (1990). Stories of experience and narrative inquiry. *Educational Researcher, 19*(5), 2-14.

Dick, W., Carey, L., & Carey, J.O. (2005). *The systematic design of instruction* (6th ed.). New York: Allyn and Bacon.

Elbaz-Luwisch, F. (1997). Narrative research: Political issues and implications. *Teaching and Teacher Education, 13*(1), 75-83.

Ewing, J.M., Dowling, J.D., & Coutts, N. (1998). Learning using the World Wide Web: A collaborative learning event. *Journal of Educational Multimedia and Hypermedia 8*(1), 3-22.

Garrison, D.R. (1993). A cognitivist constructivist view of distance education: An analysis of teaching-learning assumptions. *Distance Education, 14*(2), 199-211.

Glaser, R. (1991). The maturing of the relationship between the science of learning and cognition and educational practice. *Learning and Instruction, 1*(2), 129-144.

Goodson, I. (1995, April). *Storying the self: Life politics and the study of the teacher's life and work*. Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Gudmundsdottir, S. (1998, February). *How to turn interpretive research into a narrative?* Invited lecture at Oulu University, Finland. Retrieved July 14, 2003 from the World Wide Web at http://www.sv.ntnu.no/ped/sigrun/publikasjoner/narroulu.html.

Hannafin, M.J., & McDermott Hannafin, K. (1995). The status and future of research in instructional design and technology revisited. In G. Anglin (Ed,). *Instructional technology: Past, present, and future* (pp.314-321). Englewood, CO: Libraries Unlimited.

Herda, Ellen A. (1999). *Research conversations and narrative: A critical hermeneutic orientation in participatory inquiry*. London: Praeger.

Hlynka, D., & Belland, J.C. (1991). *Paradigms regained: The uses of illuminative, semiotic and post-modern criticism as modes of inquiry in educational technology*. Englewood Cliffs, NJ: Educational Technology Publications.

Johnsen, J.B., & Taylor, W.D. (1995). Instructional technology and unforeseen value conflicts: Toward a critique. G.J. Anglin (Ed.) *Instructional technology: Past, present, and future* (pp. 94-99). Englewood, CO: Libraries Unlimited.

Jonassen, D., Dyer, D., Peters, K., Robinson, T., Harvey, D., King, M., & Loughner, P. (1997). Cognitive flexibility hypertexts on the Web: Engaging learners in making meaning. In Khan, B.H. (Ed.) *Web-based instruction* (pp. 119-133). Englewood Cliffs, NJ: Educational Technology Publications.

Kanno, Yasuko (1997, March). *Researcher-Participant relationship in narrative inquiry*. Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.

Kenny, R.F., Zhang Z., Schwier, R.A., & Campbell, K. (2005). A review of what instructional designers do: Questions answered and questions not asked. *Canadian Journal of Learning and Technology, 31*(1), 9-26.

Koper, R. (2000). *From change to renewal: Educational technology foundations to electronic learning environments*. Inaugural address of the Educational Technology Expertise Center, Open University of the Netherlands.

Lyons, Nona, & LaBoskey, Vicki Kubler (2002). Why narrative inquiry or exemplars for a scholarship of teaching? In Lyons, Nona & LaBoskey, Vicki Kubler (Eds.), *Narrative inquiry in practice: Advancing the knowledge of teaching*. (pp. 11-27) New York, NY: Teachers College Press.

McEwan, H. (1997). The functions of narrative and research on teaching. *Teaching and Teacher Education, 13*(1), 85-92.

Merrill, M. David; Drake, Leston; Lacy, Mark J.; Pratt, Jean, and the $ID_2$ Research Group (1996). Reclaiming instructional design. *Educational Technology*, September/October, 5-7.

Murphy, D., &. Taylor, G. (1993). A tale from the mud. pp. 55-76. In M.S. Parer (ed.), *Developing Open Courses.* Centre for Distance Learning, Monash University Gippsland Campus, Churchill, Victoria, Australia.

Noddings, N. (1991). Stories in dialogue: Caring and interpersonal reasoning. In C. Withering, & N. Noddings (Eds.*), Stories Live Tell: Narrative and Dialogue in Education* (pp. 157-170). New York: Teachers' College Press.

Rogoff, B. (1990). *Apprenticeship in thinking*. New York: Oxford University Press.

Russell, T. L. (1999). *The "No significant difference phenomenon"*. Retrieved May 3, 2005 on the World Wide Web: http://www.nosignificantdifference.org/

Saettler, Paul. (1990). *The Evolution of American Educational Technology*. Englewood CO: Libraries Unlimited.

Schön, D. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions*. San Francisco: Jossey-Bass.

Schwier, R. A., Campbell, K., & Kenny, R.F. (2004). Instructional designers' observations about identity, communities of practice and change agency. *Australasian Journal of Educational Technology 20*(1), 69-100.

Shotter, John, & Logan, Josephine (1988). The pervasiveness of patriarchy: On finding a different voice. In Mary McCanney Gergen (Ed.), *Feminist thought and the structure of knowledge* (pp. 67-86*)*. New York: New York University Press.

Taylor, W D., & Swartz, J.D. (1991). Whose knowledge? In D. Hlynka & J.C. Belland (Eds.), Paradigms regained: The uses of illuminative, semiotic and post-modern criticism as modes of inquiry in educational technology (pp. 51-64). Englewood Cliffs, NJ: Educational Technology Publications.

Vrasidas, C. (2001). Constructivism versus objectivism: Implications for interaction, course design, and evaluation in Distance Education. *International Journal of Educational Telecommunications, 6*(4), 339-362.

Willis, J. (1998, May/June). Alternative instructional design paradigms: What's worth discussing and what isn't? *Educational Technology, 38*(3), 5-16.

# Knowledge communities: a critique of current notions of "community"

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**Ecology of meanings: Communication and community.**

The word "community", as most people know, comes from the Latin *communitas*. *Communitas* means "being in state of communion". Etymologically, the origin of the word "community" carries the strong religious meaning of "being connected with God". It seems reasonable to state that this word, in the human and social sciences literature, could be understood as related to the idea of "collective" (Levy, 1974) or "connected" intelligence (de Kerckhove, 1997). However, this "connectedness" is difficult to define because people can "connect" different: in a natural or instituted way. As social beings, humans are dependent on each other and nothing can be achieved in isolation. Following this line of thinking I could state that even when an individual is eating his / her breakfast alone, for example, he / she is connected to all those who made this meal possible: the farmers who planted the cereals and those who raised cows and chicken, the workers who did the harvest, milked the cows and collected the eggs, the people who transported those products to the supermarkets as well as the employees who put them in the shelves and sold them. This is, indeed, a *community* in the original sense: all those people are in a state of communion, are connected (Dalai Lama, 1999). I call such a community "natural" because the person who eats the meal is not *necessarily* communicating intentionally but is acting as a participant of a chain of causes and consequences bounding people in the social fabric of life, in which communication is not being done only through an alphabetical "language" but also through media of another nature. The most apparent media, in this case, are money or the economy of food production and consumption, and the power attached to the public and private bureaucracy of the organizations involved in the trade (Habermas, 1987). Different levels of actions are, thus, embedded in this process: commercial (the logic of money exchanges and the power of organizations) as well as symbolic (the values attached to the food). Therefore, this process happens in an *ecological* context – material and spiritual - of the dialectical struggle for survival that confronts the social groups that make, transport, sell and consume (or better said, "mediate") eating objects. A concrete example of the above explained chain that links communities is hurricane Katrina that wiped out the livelihoods of millions of people in Louisiana, Mississipi and Alabama (August, 2005). The disruption of life as it was conceived by those people is related to the material lost of everything they had. This conjuncture, as a result, damaged communities not only materially: their ways of communication became increasingly violent and produced what the government called "lawlessness", when most people living under those conditions would just call "survival". The supposedly lack of seriousness and responsibility from the part of a Federal government that seems to have invested the material resources needed to face domestic catastrophes in Irak, lacking the will of intervening right from the beginning in the "war" zone of the Mississipi delta, are some of the interwoven material and spiritual aspects of a dynamic ecology of meanings.

In this paper, we propose the notion of *ecology of meanings* as a theoretical solution for integrating the psycho-social processes of the human species studied by the social and human sciences into the larger ecology of nature in order to explain, in another level, relationships between knowledge, learning, communication and technology. Every ecological structure is composed of a number of systems opened to the environment, functioning dynamically and permanently in the search for equilibrium. In the case of food production systems given above as example, this search for equilibrium can be found in the provisional solutions given to problems by people, which go on changing along the commercial chain (which product for which price under which mark to satisfy what market, etc.). In the case of the survivors of hurricane Katrina search for equilibrium can be found in the numerous ways people tried to survive (by evading the city when possible, by "looting" markets to get food and water, by crying their hopelessness to the TV cameras, etc.), levels of government tried to respond (the mayor swearing at the federal government in a late desperate cry aiming to get attention to the poor people dying on the streets of New Orleans, the president asking for "patience" while recognizing that the help provided was not "acceptable" and defending his policies telling the American people that the nation was sufficiently wealthy to "both" keep troops in Irak and helping the victims of hurricane Katrina), and the resulting human and social adjustments being done to deal with the complexities of such a disaster. These human ecologies of problem-solvers – one fictitious and another a terrible reality – have both (1) logical components (the logic of the exchanges) that structure how the communication process - organic needs, money, business, food markets or convoys, power, etc. – function (through which medium or media[1]), and (2) spiritual values that express cultural, religious and moral meanings concerning what each context.

The "natural" actions of such communities (meaning spontaneous reactions to a chain of causes and consequences) do not exclude, evidently, the intentionality of the individual actors or organizations in their problem solving efforts. A farmer, for example, could decide to lower the price of a product which will soon rot and need immediate commercialization. When the American government decided that it was reasonable to send help to the victims of the 2005 tsunami in Indonesia in two days while deciding to take five days to do the same in Louisiana, Mississipi and Alabama, it took an "institutional" action that was at the core of how communities "naturally" reacted to the chain of causes and consequences triggered by the landing of hurricane Katrina in the American South. These actions do not mean, necessarily, "awareness" of pertaining to a community.

Communities can also be instituted. People can participate in collectives such as churches, councils, clubs, etc, "instituted" by the norms of organizations. In this regard, the advent of the Internet and its "searching" (intentional) possibilities offers many examples on how individuals, groups and organizations intentionally "institute" communities: from educational institutions that impose online activities as a part of the curriculum to individuals that enable online groups through organizations (Yahoo, MSN, etc.) such as groups of adolescents playing online games together from a distance or alcoholic people searching for the help of others in special websites offering person-to-person and / or collective support. All these are indeed "instituted" communities, but of another kind. When people decide to participate in those communities, the process is not "natural" but "institutionalized" because the person who is acting is necessarily engaging in a previously given structure. Although one could argue that the same happens with "natural" communities, putting forward the argument that when a citizen is bound to its neighborhood as a result of a choice of living in it (and by definition any choice would not be "natural"), the fact is that in any neighborhood we could find an organized set of norms to be *necessarily* followed as we found in a school in which students *should* to this or that (including using communication technologies). Educational institutions *require* through its hierarchy of power that a number of activities *be compulsorily done* in order to the school authority have the *institutionalized right* to provide a school bulletin *certifying* that the student has effectively (for example) communicated online and "learned".

Acting and communicating cannot be separated (Piaget, 1977a; 1950; Habermas, 1987). Ecological organic-symbolic systems such as the human ones can be *more or less* natural or *more or less* institutionalized, provided that we do not find them in pure forms. The notion of *ecology* that we adopt integrates logical and meaning systems, and cannot be naïvely understood as strictly empiricist or strictly informed by experience. *Ecologies of meanings* are on-going processes that have embedded empirical facts integrated in logical reasons that have possibilities and find its actualization through communication. In the examples cited above, physical and symbolic action can be considered more "natural" because, to exist, those communities, *by communicating*, generate chains of causes and consequences that bound people together in the social fabric *more* through their subjectivities (the phenomenological living experience) than through institutionalized organizations. Conversely, physical and symbolic action can be considered less "natural" when, to exist, communities, *by communicating*, generate chains of causes and consequences that bound people together in the social fabric *under* the norms of institutions and the Law in general (the constraints of the social world). Such norms and bylaws (as imposed expressions) are exercised (or not) through personal "authority" or social codes that act as instances of communicative media such as "money" that activate mechanisms of "social control", "power exercise", "knowledge management", etc., that subordinate language communication (Habermas, 1987). As in the case of "institutionalized" communities, the meaning processes of "natural" communities are triggered by dialectical contexts of *social unbalance* which strike individuals to fight for equilibrium *through* communication. Ecologies of meanings stand for a theoretical proposal of how communication unfolds in contextual unbalanced systems that integrate the phenomenological experience of living with the constraints of the social world that could be structurally represented as *logic of the exchanges carrying spiritual values*.

**Networked conviviality: Participation, engagement and knowledge building**

Dichotomizing "logic" and "values" that evolve through communication medium or media (as different as money, power, speech and / or multimedia *languages*) is central for a ecology of meanings because it represents the problem of cognitive structures vis-à-vis affective and moral values attached to communicational exchanges. Taking

[1] I use the term "medium" to define *one* material and / or symbolic communication object that carries operatory quantities and qualities of an ecological system (logical and meaning systems) , and "media" to material and / or symbolic *integrated* communication objects.

part of natural or institutionalized communities demands people to respond cognitively (meaning "logically", "reasonably"), affectively and morally to the social demands of collective and individual actions. These actions can be ones of *naturally* being part of a network of people, or one of *institutionalized participation*. Natural or institutionalized participation can, from the point of view of individuals is here called *conviviality*. *Conviviality* is defined as the process through which communities *intentionally* evolve. Given that natural and institutionalized participation cannot be found in pure forms but are *mostly* one or another, different *levels* of intentionality can be found, leading to a grater or lesser social involvement by the means of communication. *Conviviality* involves (1a) participation and engagement, and (2a) knowledge building, which can be either of (A) lower, (B) regular or (C) higher order levels.

The interrelated notions of (1) participation and engagement express the interests, needs and goals that are involved in the communication exchange within a community. Participation and engagement obey a logic of exchanges that dialectically evolves upon time. This *operatory* logic of exchanges is the mechanism through which interwoven affective and moral values that express culture are communicated. It creates and / or re-creates knowledge, which is the *content* of the logical operatory structure. This leads to the notion of (2) knowledge construction as the co-elaboration of thinking objects such as ideas and opinions that might or might not be carried through arguments. For example, when a hypothesis is formulated by someone (having or not subjacent the logical operator "if-then"), a contestation by someone else can result (based on any other logical operator such as "no", "either-or", if-then", etc.). Complementarily, the *content* of knowledge construction is the affective and moral values of argumentation that takes place in the communication process. When this process takes place in computer-mediated environments, we call it one of "knowledge-building" (Scardamalia, 2002).

We argue that networked conviviality through (1net) participation and engagement and (2net) knowledge building is a suitable notion for understanding the cognitive and the affective and moral values that are in computer-mediated communication processes. These integrated notions allow the researcher to determine whether a communication act is mostly done in contexts like those that Piaget call "egocentric" and Habermas "strategic" (instrumental reason, teleological acting) or mostly in "collaborative" contexts in the sense given by Piagetian "cooperation" (descentration) and Habermasian "inter-understanding". This idea of collaboration as Piagetian cooperation and Habermasian inter-understanding demands, necessarily, a logic of exchanges in which consensus is searched with a view of providing reasonable answers able to validate ideas: "Interunderstanding stands for communication with a view of a *valid agreement*." (Habermas, 1987, page 396, original italics preserved, translated by myself). (1) and (2) are applicable to any kind of communication, and (1net) and (2net) to networked communication. The problem is only one of identifying the prevalent *level* of the exchange (A, B or C).

In this paper, we focus on the communication process of networked communities. In the case of communities that are built on the Internet, the distinction between teleological and communicative action is particularly useful to understanding interaction (through conferencing systems, chats, etc.) because communication, in these cases, occur in "places" that can be recorded in textual and multimedia databases. Recording allows an empirical verification of the reasons behind the statements made by people taking part of a communication exchange while the affective and moral aspects can, at least, being identified[2]. These recordings are referred to as *objects of knowledge* (Popper, 1994; Scardamalia, & Bereiter, 1994). Such objects of knowledge cannot be taken as the mediation itself, be through a singular medium or plural media. The communicative actions through which society and culture come into existence cannot be strictly confined to verbal *language*, as Vygotsky suggested, or to the idea of *mediating object*, as proposed by his followers (Luria, Leontiev, Cole, & Engeström). There are other circumstances of communicative action that are, sometimes, apparently "languageless", such as body language and its regulatory organic processes, or the image dimension of cinema, television and multimedia. In addition, there are also "languages" related to *money* and *power* as pointed out by Habermas (1987) that can be used as means to achieve goals. For instance, money has a very clear and concrete (although abstract) language. How can it be that many people write and speak very little and effectively communicate power, control and dominance upon others? Communicative circumstances evolve as *both* organic and symbolic ever-changing *places* of knowledge objects (that can be physical and symbolic "materials" such as cash as well as moral, cultural and spiritual values that emerge as thoughts) that are operationalized along time in social life through communication. I call these physical and symbolic places

[2] Our research, done in many different community contexts (educational, health, workplace, cultural, etc.) has shown that affective and moral *reasons* for communicative behaviour can only be assessed through online discourse if "outspoken" (i.e. clearly written) by the online community participant (Campos, 2004a; 2004b; 2004c; 2003; 2000; Campos, Laferrière, & Harasim, 2001). Otherwise, the researcher can only *suppose* what those reasons are, and decide to use other methodological tools to discover them (such as interviews).

*configurations of meanings* (Campos, 1998)[3]. Configurations of meanings must be understood not only as logical systems (the cognitive structures of intelligence) in which intelligences interconnect through communication (Levy, 1994; de Kerckhove, 1997) but also as the intertwined systems of meanings that define the phenomenological circumstances of people's lives, that are attached to those structures, and that evolve over time (idea of *history*) as a result of ecological interaction. In the human experience *language* always implies many different "languages", and Vygotsky was simply wrong[4] in elevating verbal language as *the* human mediation artifact[5].

**The community mess**

We tried to make apparent a number of distinctions in the previous sections for a reason. (1) First, following the contribution of Habermas, I propose understanding community participation as more *natural* or more *institutionalized*. . (2) Secondly, concerning genetic and cognitive psychology with regards to intentional processes, I distinguish between the *unintentional* and *intentional* level of mostly natural or institutionalized networked communities to propose a different approach for categorizing them. The risks of establishing such "levels" are known: the discussions about consciousness are conflicting because this subject has not yet achieved any kind of consensus among philosophers and cognitive scientists. One of the problems is the difficulty of integrating the cognitivist view with the universe of values and the role of affectivity. However, our proposal of "levels" is indicative and not static. (3) Thirdly, following genetic epistemology, we distinguish between the *logical* mechanism of exchanges that operates moral (normative knowledge) and / or cultural (psycho-social historical knowledge) *values* for didactic reasons though we know that they are complementary in the living process of human beings. Genetic epistemology might not be "fashionable" nowadays but it is coherent, something that most contemporary empiricist cognitive theories, applied to networked mediated communication, are not. (4) Finally, I distinguish *participation / engagement* and *knowledge building* as complementary and co-implicative notions that allow us to understand networked community processes epistemologically and pragmatically: their rationales should be understood as evolutionary *theoretical praxis*[6].

These four distinctions allows to unveil the precarious state of reflection about community processes that led to the mainstream use of a sort of unofficial classification (that sounds as a professional categorization) to define communities of "interest", "learning" and of "practice". These notions have been used in the context of the increasing application of technology in human communication. The idea of <u>community of interest</u> has been around for some time (Clodius, 1996; 1997) and has its origins in the early works of Rheingold about virtual communities. Rheingold defines communities as "social aggregations that emerge from the Net when enough people carry on those public discussions long enough, with sufficient human feeling, to form webs of personal relationships in cyberspace" (2000, second edition, page XX). Clodius, referring to participants, adds "shared interests and self-identification of belonging to a group" (1997). This sense of purpose - the "interest" – is at the core of the idea of any state of communion. People gather together in communities on the base of common interests, developed progressively in the communication process. The reader will soon realize that the other "definitions" of community are just this.

The notion of <u>learning community</u> was introduced in education (and then spread out to other fields) and its genesis can be hardly traced. It is certain, though, that its adoption by so-called "socio-constructivists" was a reaction to a renewed effort to respond to traditional teaching processes based on the functionalist paradigm of information transmission. Researchers and educators using this term have usually in sight the process of co-development happening in the ZPD – zone of proximal development described by Vygostky (1979)[7]. The use of this

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[3] In my doctoral thesis I used the term *symbolic configuration*. *Configuration* is a term than implies itself the idea of logical structure. I am using now the predicate *of meanings* instead of *symbolic* because the first appears to be more in line with the human phenomenological experience while the latter is, most of the times, arbitrary (ex: the American flag as a symbol).

[4] Or, to be fair and grateful for his contribution to knowledge: "partially right".

[5] I understand this idea as being in line with that of a new instance of communication of the collective intelligence in the knowledge society that is being presently proposed by Pierre Levy, and that advances significantly the way people have been thinking about communication. (Levy, P. Personal communication, Laboratory on Collective Intelligence, University of Ottawa, 27 October 2004).

[6] I would like to remind the reader that *praxis* in Plato was *bios theoreticos*, or the *praxis* of the philosopher. When community discussions are at stake, it is rather paradoxical to formulate that the core of their activity is *practice* given that the referents of discourse (what is said, discussed, debated) are *reasons, i.e. abstractions* and not the objects themselves or their relationships.

[7] The notion of ZPD was conceived to explain the leg between the child's actual developmental level and the potential developmental level that the child could achieve with the help of older children. It is fundamental to understand that Vygotsky never used the idea of ZDP to refer to adulthood.

notion led educators and researchers in the search for renewed pedagogies to focus on social rather than on individual processes, to defend context-based approaches to education (situated learning) and reject universals. The multiple "socio-constructivist" approaches developed after Vygotsky's death add to the already vague model proposed by him (and that became vaguer with the interference of other group members of the Moscow School in his writings and the difficulty of validating the meaning of a number of notions presented in the translations done thereafter). Although Vygotsky could not be described as a radical revolutionary, his interpretation of dialectical materialism was not in opposition with main communist ideas of his time. However, it seems that his view has been washed out from its subjacent revolutionary *praxis*, becoming just "situated", reinforcing the typical a-criticism of neo-behaviorist cognitivism[8].

The notion of communities of practice resulted from one of the socio-constructivistic re-interpretations of learning according to which it "is a process of participation in communities of practice, participation that is at first legitimately peripheral but that increases gradually in engagement and complexity" (Lave, & Wenger, 1991). This re-interpretation was further developed by Wenger to explain organizational processes and developed as a theory of social learning. According to Wenger, communities of practice are "a locus of engagement in action, interpersonal relations, shared knowledge, and negotiation of enterprises… (that are)…the key for real transformation – the kind that has real effects on people's lives" (1998, page 85). Such a generic definition is not at odds with that of communities of interest and that of learning communities, which makes the distinction entirely meaningless.

It is important to discuss the notion of *praxis* in Wenger (whatever it is) because his theory became very well-known and widespread used on the basis of an epistemological mess. The interest on this notion, according to him, resides on the wish to present counterarguments to cognitive scientists that do not take into account as fully as he would like, social practice as "the key to grasping the actual complexity of human thought as it takes place in real life" (Wenger, 1998, footnote 6, page 281). Wenger discusses praxis very briefly by drawing from Marx to Wittgenstein. He easily jumps from author to author without ever solving critically some serious epistemological conflicts. He lists, among several others, Marx, Bourdieu, Engeström, Habermas, Vygostky and Wittgestein, as having influenced his theory. He also lists, concerning the "situatedness" of learning, phenomenologist and empiricist authors alike without providing a serious critical theoretical integrative explanation. One example of this mess comes from authors cited by Wenger: Cole and Engeström. Although the subjacent notion of *praxis* used by these so-called vygotskian socio-constructivists (Salomon, 1993) seems to be in line with the critique presented in the first thesis about Feuerbach (text in which Marx states that the main default of materialist approaches is that they do not take into account human activity as *praxis*; Marx, & Engels, 1982), the activity system theory proposed by Cole and Engeström, based on reinterpretations by followers of Vygotsky, has no revolutionary purpose whatsoever.

In his proposal of communities of practice, Wenger writes that they have "real effects on people's lives" (1988, page 85). It relies, surprisingly, on *psychological* effects and not on social effects, which seems not to be consistent with the premise of his theory, which does not consider – at least implicitly – the possibility of any kind of strictly individual learning. Although social contexts are always present, some kinds of learning *are* indeed *totally* individual. For example: if a person learns how to ride a bike alone, although we could call the bicycle the "social", this learning is not social at all. Wenger also writes that communities of practice "hold the key to real transformation" (1988, page 85). Given that "communities of practice" have been mostly implemented in companies, this statement sounds not only pretentious but a lie. Any transformation washed out of practices able to change structures of authority (power) within the capitalistic enterprise and the system that produces inequalities among employees cannot carry such a name. Such a "transformation" does not promote real but cosmetic change, or strategic change[9]. This theory is now being used by companies to keep themselves up and running while employees build the illusion that they could matter as much as the CEO does, which is a practice of deceit. It would be naïf to believe in transformations carried out by "communities of practice", which are just institutionalized endeavours in which subjectivity is caged and inter-understanding is subordinated to instrumental goals. Admitedly, at a micro

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[8] I must clearly state here that in spite of the general understanding that the Cognitive Sciences are in total opposition with behaviourism due to the belief that mental processes can be scientifically studied, they adopt the experimental paradigm as their main "objective" method of assessing thinking processes. I believe that a theory shows its real epistemology through its *method* and not through its declaration of principle (which, in the case of the Cognitive Sciences, was one of proclaiming themselves as a movement against behaviourism). Most socio-constructivists never rejected entirely Cognitive Science research *methods*, integrating them with qualitative research, arriving to an unsustainable empiricist epistemological compromise between "universal" and "situated" learning (Anderson, J. R., Reder, L. M. et Simon, H. A., 1996; Greeno, J. G., 1997; Anderson, J. R., Reder L. M. et Simon, H. A., 1997). Such a compromise is at odds with the Kantian-Hegelian philosophical tradition of dialectic materialism, and therefore, most self-announced"socio-constructivists" are just incoherent empiricists.

[9] Wenger, McDermott and Snyder (2002) have recently assumed that communities of practice are to be used strategically *by* the organisation for *their* benefit but considering the "learning benefit" for the participants as essential for their existence.

level small enterprises collectively ran and collectively owned could be less cynical in the integration of such tool. Wenger's notion of *praxis* is certainly not the same that of Cole and Engeström and that of Vygotsky[10]. It is not, either, in line with the epistemological standings of authors as distant one from another as Wittgenstein and Habermas (although the latter takes into account some considerations of the Philosophical Investigations in his critique of functionalist reason)[11]. Wenger's epistemological status is, in fact, unclear. Result: the notion of community of practice as a social learning theory is untenable. It is *not* a theory because it has *no method* and a *flawed* epistemological foundation.

Social scientists, differently from pedagogues, provided more consistent theories. One example is Habermas theory of communicative action because it merges the phenomenological dimension of existence to the workings of the social system through communication, evolving due to learning as understood by Piaget, taking critically into consideration both achievements of the natural and the social sciences. The introductory discussion on communities presented above reveals the difficulty to integrate such processes from a psychological and sociological perspective, relating them to ontogeny and phylogeny. Summarizing: If people "learn" in communities of "interest" then this community is also a learning one. If they establish a "practice" of negotiation of meanings then they are also a community of practice (understood as *bios theoreticos*). If people involved in a learning community have "interests", then this should be considered a community of interest. If this "learning" community has "practices" of engaging in common activities, then it is a community of practice that "learns" or a learning community that has a "practice". To be engaged in a common "practice", people must have an "interest" as well, and then a community of practice should also be named a community of interest. This mess leads anywhere. We want to provide here a glimpse of a tentative integrative solution for this problem applicable to the traditions of both the social (sociology, anthropology, political science and communication) and the human sciences (psychology and education) by trying to build a communication theory based on Habermas and Piaget.

**Knowledge as the distinctive character of communities**

We propose categorizing communities from the point of view of knowledge, relying on the evolution of the Kantian and Hegelian tradition that, in the social sciences led to the theory of communicative action (Habermas), and in the human sciences led to epistemological constructivism (Piaget). I argue here that these traditions are the result of specific scientific trajectories that have more in common than apparently one could suppose. By pointing to this theoretical parallelism (already highlighted by Habermas concerning Piaget's epistemology), we would like to defend the thesis that it is through configurations of meanings that the mind, through its (multi-language) communicative action, deals with its body, its phenomenological subjectivity, and the culturally anchored norms of the social world. Human ecological systems are organic and mental, and fundamentally *meaningful*. On another dimension, the symbolic processes of interaction among configurations of meanings communicated by different minds (rational assimilation and accommodation of meanings leading to adaptation, i.e. conceptual change) are an integrative but *logically anterior* part (or a moment) of the *praxis* of the human species. Reason structures passions and reflections about moral behavior, and not the contrary[12]. We argue that this understanding, foundation of ecology of meanings as a theoretical proposition, can lead to acceptable arguments to treat culture and nature altogether by the means of deepening our understanding on the unique communication found in the human experience and the resulting forms of communities.

We proposed elsewhere (Campos, 2003) one taxonomy of knowledge networked communities that would overwrite the notions of communities of interest, learning and of practice, in the context of an evolutionary ecology of meanings. This taxonomy results from research and reflections about community experiences using methods such as discourse analysis, ethnographic intervention, and clinical observation. Although this classification could be applied to any kind of communication context, our focus here is on communication mediated by computer technologies. We believe that this classification is a first development towards a theory in line with the integrative revision of critical theory proposed by the Habermas of the theory of communicative action in which rationality is

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[10] The model of behaviour, according to Vygostky is from the Stimulus to the Response (S→R), mediated by language (L). The activity theory proposed by Leontiev replaced S by Subject and R by Object, linking both by a bidirectional arrow (S↔O) mediated by MA: mediating artefact. This was the basis for Cole's and Engeström's work. The serious epistemological (and political) results of this change are obvious because the model proposed by Vygotsky has an implicative cause-consequence *leitmotiv* (→) that could, according to Marxism, be interpreted differently.

[11] Although the contributions of Wittgenstein, a logical positivist, to the study of language are extraordinary, one should ask how his philosophical reflections on the empiricist basis of meanings could be in line with the critical view of the rationality of action developed by Habermas.

[12] In fact, the inversion is seen as pathologies.

studied through a renewed discourse analysis that goes beyond Austin's and Searle's empiricism, and that it is more adequate to the study of communities than the notions of interest, learning and practice. We have been analyzing discourse based on the Piagetian sociological proposal of the logic of exchanges that partially inspired Habermas in his conceptualization of communication as a core instance of rationality[13], relating levels of participation and engagement, and knowledge building. We identified three main epistemological-communicative levels of progressive relationships that can be found in communities that we call "of knowledge"[14]:

**Co-presence**

Co-presence is when people engage in contexts in which the actors' intentionality is mainly egocentric or a result of imposition or trade. The result is representations that are mainly individual, inter-personal relationships that are established through interactions in the community that do not go beyond contact making ("hi there"), and learning that does not go beyond assimilation. Learning is a complex process of adaptation that implies assimilation and accommodation of concepts (Piaget, 1977b). In co-presence there are weak communicative meaning configurations (because there are no or meaningless responses) able to produce the necessary friction to move participants towards debate (argumentation), thought evolution, and search for inter-understanding. In such a context, the level of communication characteristic of a community could be classified as low, given that the exchanges do not trigger further reflection, leading to a valid accord among its members. The level of co-presence characterizes what we could call the publishing mode. Communities of "interest" such as those built around most discussion lists in which people just publish information and hyperlinks and "talk to themselves", "learning" communities such as those built around discussion forums used by professors to inform students about course content in which no discussions are made and few comments are published without response, and communities of "practice" in companies in which most messages are used just to draw the attention of others on a given subject, could all be classified as having a lower level of knowledge building. Relationships in these publishing or broadcasting communities are ones of co-presence and nothing else. They could, at the most, also be classified as a teleological because instrumental reason (egocentric, strategic) is what is mostly at stake.

**Cooperation**

In a networked context of cooperation15, intentionality is still mainly egocentric or a result of a context of imposition or trade. However, the self-centered goals of the community actors are reached through activities that engage more clearly the other participants. As a consequence of this interaction, the configurations of meanings that impulse the community into the practice of discussing – as always is the case with our minds - have at times more "individual" goals and at other times more "social" goals. However, intentions remain mainly personal and egocentric, or instrumentalized to achieve the goal defined by the imposing authority or norms of the trade. In this case, participants are not really interested in helping one another but to achieve set goals. Interpersonal relationships are, thus, "cordial" but most of the times competitiveness is what is really at stake. Such kind of "social" learning, built in cooperative situations is one in which the individual is still bound to more assimilatory than accommodative processes, and if – and when – accommodation happens, the resulting conceptual change is not shared and cannot be found in the discourse (it rests in the mind of the participating individual and hence can not be traced through discourse analysis but only through other methods). Cooperation characterizes the collegial mode. Communities of "interest" such as, for example, those in which participants search for information about an illness and get it from other participants, "learning" communities such as those built around discussion lists used by professors in which teams of students have to answer appropriately some questions about the course content to get points, and communities of "practice" in organizations in which employees discuss the use of the most appropriate materials to be used in a road, for example, could all be classified as having a medium level of knowledge building. Relationships in such cooperative communities are collegial. They could also be classified as a teleological as well because instrumental reason (egocentric, strategic) is what is mostly at stake.

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[13] I would like to thank my graduate students Jonathan Petit and Mathieu Chaput who drew my attention to Habermas.

[14] The method for identifying the levels is based on analyses of progressive discourse built on the Piagetian logic of exchanges in which logical forms subjacent to human discourse are considered together with affective and moral values (Campos and Tomi, 2004; Campos, 2004).

[15] Although the choice of using the word *cooperation* in this context could be confusing for Piagetians, I do not adopt it in the sense of Piaget. Piagetian cooperation is *collaboration* in this proposal, thus the next level as the reader will soon realize.

**Collaboration**

Collaboration is achieved when community participants engage intentionally in joint efforts to achieve common understanding of a given subject matter. Participants solve problems together to advance the present state of knowledge not for themselves. Intentionality, in this case, is mostly centered on the others and not on the self or on a strategic goal. The solution is to be discovered somewhere in between the participants' configurations of meanings. As a result, even if individual representations are a material for building configurations of meanings – as they will always be - the object of discussion is essentially built around what representations could be built together (social). In such a situation, interpersonal relationships suppose honest and authentic *mutual implication*. In this case, participants go beyond heteronomy[16] and authority, if exercised (be that of money, position, status, etc.), is dissolved or diminished in an inter-understanding process in search of a valid rational agreement among participants. In autonomous processes like these, people accept the possible inequality as not relevant to the purpose (Piaget, 1977). Community processes in situations of autonomy (democracy) are necessarily shared, the resulting mainly accommodatory learning is collectively built, and authorship of ideas impossible to be claimed by individuals (Scardamalia, & Bereiter, 1994; Scardamalia, 2002). A learning process leading to conceptual change is necessarily accommodatory: participants engage in in-depth inter-understanding, co-interpretation and co-construction of explanations concerning ideas that emerged in the communication process. At this level, communities achieve higher levels of communication through collaboration, characterizing the knowledge building mode of <u>interpretive or knowledge building communities</u> or. Communities of "interest" such as the WELL referred by Rheingold (2000) had moments of true collaboration. "Learning" communities and communities of "practice" that are institution independent (or that are able to go beyond the constraints of authority within institutions, ruling their processes independently of external constraints) can also achieve a state of authentic knowledge building if they go beyond authority as a means to transform it ("revolution"). Only at this level, in which partners achieve a process of what Habermas (1987) calls inter-understanding (or Piagetian "cooperation"[17]) communities would be exercising communicative reason in order to achieve valid agreements based on consensus or accepted majority, and able to critically transform the world through democratic means. They could be classified as <u>democratic</u> communities.

## Conclusion

We presented a proposal based on an integrative view of cognitive and social studies aiming to explain communication processes as related to communities. The theoretical proposal of ecology of meanings defends that both communication and resulting communities, as the core of the meaning human experience, can be better understood as ecologies that evolve historically solving perpetually the problems posed by the existing apparent contradictions between the phenomenological experience of living and the demands of locating in and adjusting bodies and minds to the rules and regulations of society. To make our point, we introduced a draft of a critique (that we intend to develop more extensively in future writings) about notions of community that are being used nowadays that we consider insufficient and inadequate as classificatory categories. In addition, we discussed epistemological conflicts subjacent to those categories, and proposed that communities be classified according to the level of knowledge building and communication: publishing or broadcasting, and collegial communities that mostly share egocentric and teleological functionalist reasons, and interpretive or knowledge building communities that mostly share communicative reason.

[16] Heteronomy stands for situations in which there is a clear ruling authority while autonomy stands for situations in which power is democratically shared.
[17] See note 15.

**References**


Anderson, J.R., Greeno, J.G., Reder, L.M., & Simon, H. (2000). Perspectives on Learning, Thinking and Activity. *Educational Researcher, (29)*4, 11-13.

Anderson, J.R., Reder, L.M., & Simon, H. (1996). Situated Learning and Education. *Educational Researcher, (4)*5, 5-11.

Campos, M. N. (2004a). A Constructivist Method for the Analysis of Networked Cognitive Communication, and Assessment of Collaborative Learning and Knowledge Building. *Journal of Asynchronous Learning Networks 8*(2), 1-29. Retrieved August 8, 2005, from: http://www.sloan-c.org/publications/jaln/v8n2/v8n2_campos.asp

Campos, M. N. (2004b). Health, Knowledge, and Networked Communication. *Academic Exchange Quarterly, 8*(3).

Campos, M. N. (2004c, October). The Logic, Affectivity and Ethics of Electronic Conferencing Teaching Strategies in Post-secondary Mixed-mode Courses. *Proceedings of the International Convention of the AECT - Association for Educational Communications and Technology*, Vol. 1, pp. 158-165, Chicago, IL.

Campos, M. N. (2003). The Progressive Construction of Communication: Towards a Model of Cognitive Networked Communication and Knowledge Communities. *Canadian Journal of Communication, 28*(3), 291-322.

Campos, M. N. (2000). The Hypermedia Conversation: Reflecting Upon, Building and Communicating Ill-defined Arguments. *Interactive Multimedia Electronic Journal of Computer-Enhanced Learning, 2*(2). Retrieved July 11, 2005, from: http://imej.wfu.edu/articles/2000/2/04/index.asp

Campos, M. N., Laferrière, T., & Harasim, L. (2001). The Post-secondary Networked Classroom: Renewal of Teaching Practices and Social Interaction. *Journal of Asynchronous Learning Networks, 5*(2). Retrieved August 8, 2005, from: http://www.sloan-c.org/publications/jaln/v5n2/v5n2_campos.asp

Clodius, J. (1997). Creating a Community of Interest: "Self" and "Other" on DragonMud. *Paper presented at the Combined Conference on MUDs*. Jackson Hole, WY. Retrieved July 11, 2005, from: http://www.dragonmud.org/people/jen/mudshopiii.html

Clodius, J. (1996). Ethnography on the Internet: Community Formation on DragonMud. *Paper presented at the Annual Meeting of the AAA - American Anthropological Association*. San Francisco, CA.

Cole, M., & Engestrom, Y. (1993). A Cultural-historical Approach to Distributed Cognition. In G. Salomon (Éd.), *Distributed Cognitions: Psychological and Educational Considerations*, 1-47. Cambridge: University Press.

Dalai Lama (1999). Sagesse ancienne, monde moderne. Paris: Fayard.

Greeno, J. G. (1997). On Claims that Answer the Wrong Questions. *Educational Researcher, 1*(5), 5-17.

Habermas, J. (1987). *Théorie de l'agir communicationnel*. Vols. 1 and 2. Paris: Fayard.

Kerckhove, D. (1997). *Connected Intelligence: The Arrival of the Web Society*. Toronto: Sommerville House Publishing.

Lave, J., and Wenger, É. (1991). *Situated Learning. Legitimate Peripheral Participation*. Cambridge: University of Cambridge Press.

Lévy, P. (1994). *L'intelligence collective: Pour une anthropologie du cyberespace*. Paris: Éditions La Découverte.

Marx. K., & Engels, F. (1982). *L'idéologie allemande, précédée de Thèses sur Feuerbach*. Paris: Éditions Sociales.

Piaget, J. (1977a). *Études sociologiques*. Paris: Droz.

Piaget, J. (1977b). *La naissance de l'intelligence chez l'enfant*. Nêuchatel-Paris: Delachaux et Niestlé.

Piaget, J. (1950). *Introduction à l'épistémologie génétique*. Paris: Presses Universitaires de France.

Popper, K. (1994). *Knowledge and the Body-mind Problem. In Defense of Interaction*. London: Routledge.

Rheingold, H. (2000). *The Virtual Communities: Homesteading in the Electronic Frontier*. Cambridge (MA): The MIT Press.

Scardamalia, M. (2002). Collective Responsibility for the Advancement of Knowledge. In B. Smith (Ed.). *Liberal Education in a Knowledge Society*, pp.67-98. Chicago: Open Court.

Scardamalia, M., & Bereiter, C. (1994). Computer Support for Knowledge-building Communities. *The Journal of the Learning Sciences (3)*3, 265-283.

Vygotsky, L. S. (1979). *The collected works of L.S. Vygotsky* (edited by Robert W. Rieber and Aaron S. Carton). Vol. 1. New York: Plenum Press.

Wenger, E. (1998). *Communities of practice: learning, meaning and identity*. Cambridge: Cambridge University Press.

Wenger, E., McDermott, R., & Snyder, W. M. (2000). *Cultivating communities of practice: A guide for managing knowledge*. Boston : Harvard Business School Press.

# Cueing Strategies and Instructional Message Design

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In computer-based instruction, the way the computer screen is perceived and the way the information on it is presented can impact its instructional effectiveness (Card, Moran, & Newell, 1983; Grabowski, 1995; Winn, 1993). There is a trend that computer will be involved more in the teaching and learning process since the "demographic changes among students, rising education costs, and new technology" (Frey, Yankelov, & Faul, 2003, p. 443).With the advanced integration of computer in the teaching and learning process, an issue about how to design and deliver instructional message on the computer screen starts to cause professionals' attention. Instructional designers must consider how message form and structure influence information process (Winn, 1993) and make the instructional materials minimize cognitive processing burdens so that mental efforts spent on processing task relevant information so as to enhance learning performance. Researchers (Grabowski, 1995; Winn, 1993) emphasize that the form of the message affects what information is attended to and perceived by learners, especially in the early stage of information processing. Gagne's (1985) theory regarding the condition of learning suggests that the internal processes of learning can be influenced by external events. Dick, Carey, and Carey (2001) also address that in instructional design model, using cues to search the information which was stored in memory is one of the essential functions for the condition component of behavior objectives. The provision of cueing strategies, as external events, may direct the attention of the learner by providing clues as to what aspects of the materials to attend to in a succeeding learning.

**Introduction of Cueing Strategies**

Researchers have begun to identify the elements of the message which are important in facilitating learning achievement during instructional message design process (Lamberski & Mayers, 1980). Studies of message design have suggested that the message should be clearly defined and set forth to provide optimum instructional effectiveness and efficiency in the learning process (Lamberski & Mayers, 1980). In order to guarantee the efficient learning to occur, "… the stimulus material for learning must be available and clearly perceivable by the learner" (Dwyer, 1978, p. 158). Instructional design must find a way to magnify or emphasize the critical features in the instructional message (M. Fleming & Levie, 1978). Previous researchers (Ausubel, 1968; Rothkopf, 1966) found that positive learning was affected by using strategies to direct learners' attention to relevant information. Since learning from computer screen delivered message is basically an individual or independent type of learning experience, attention directing learning strategies should help learners to identify relevant information which should be learned.

Inserting cues in the instructional text provides a mechanism for helping learners to organize complex information, since the use of cues can direct or focus students' attention on areas that are important to the instructional goals and objectives (Dwyer, 1978). This type of instructional strategies has been shown to compensate for students who have perceptual deficiencies in comprehend visual information (Dwyer, 1978). Flemming and Levie (1978) stated, "one of the most obvious manipulations of the learning environment is that of modifying the instructional stimuli to be presented" (p. 112). One of the principles they proposed of controlling attention in instructional situations is that "instructional messages can control the effective stimulus either by adding or subtracting cues or by making cues more or less salient (prominent, noticeable)" (p. 112). They believe that "learning is facilitated where critical cues are salient (dominant, apparent, conspicuous) (M. Fleming & Levie, 1978, p.115). They also points out that if cues which were added in the instructional message were familiar to the learners and they functioned to direct attention to the relationship between the new knowledge and the previous knowledge, they can facilitate learning.

Researchers have defined cueing from different perspectives. Rieber (1994) views cueing as any action that directs a learner's attention to the important/relevant stimuli. Goldstein (1981) describes cueing as a type of rehearsal strategy which involves the presentation of a word associate to be utilized for the retrieval of items in recall. Turcott (1986) defined cueing as a technique whereby individual stimuli or elements within a visual array are made distinct from each other. He stated that a cueing device refers to the specific attribute such as color, arrows, or shading which is used to make specific element distinct to the viewer. Partee (1984) defines a cue as "a verbal or visual strategy by which the perceiver's attention is focused upon perceptual information (p. 12). Dwyer (1978) has defined cueing as "the process of focusing learner attention on individual stimuli within the illustration to make the essential learning characteristics distinct from other stimuli" (p. 158). Researchers (Brown, 1978; Brown, Lewis, & Harcleroad, 1973) in instructional message design have named cues in instruction as *indicating cues* (e.g. arrows, directions to pay attention to, to notice certain parts of an instructional sequence, and the use of color codes, etc.). Brown (1978) mentioned that the *indicating cues* have commonly referred to in the literature as 'attention-directing techniques' or merely *cues*. Cues also have been named as attention-getting devices (Norman, 1969) or attention gaining technique (Dwyer, 1978). F. M. Dwyer's definition of cueing emphasizes more on the effects of cues utilized in visualized instruction, while this article intends to discuss cues in computer screen delivered text message. Therefore, the definition that employed in this study will be: cueing strategy is the attention-directing strategy to focus learners' attention on specific information within text message on computer screen so as to improve students' learning performance in computer-based instruction.

Cues have been categorized as verbal cues and visual cues (T. H. Anderson & Armbruster, 1985). Verbal cues include instructional objectives, advance organizer, adjunct questions, and signal phrases. Visual cues include typographic cuing achieved by manipulating the type face, type styles, underlining, capitals, color of text, etc. Allen (1975) summarized the literature on visual cues and reported that "relevant cues which emphasize material to be learned within an instructional communication may increase the learning of that material for all [intellectual] ability group." (p. 151). Dwyer (1972; 1978) states that visual cues are attention-directing techniques used to focus the learners' attention on certain stimuli or the critical aspects of instructional material.

Bloom (1976) provides several important views about cues for instructional designers. First, cues have to do with their meaningfulness. The cues must be understood and comprehended by the learners. If cues are familiar and have been used by the learners before, they are more likely to be easily learned in a new context. Secondly, learners may different in learning from particular cues, such as some students are easily to learn using verbal cues or others may prefer to visual cues. Researchers and instructional designers have been spent much attention on finding the best "one" form of presenting cues to facilitate learning. Finally, Bloom shows that the trend of the development of new technologies might provide variety of instructional methods to help learners to secure the cues they need for their learning.

**Functions of Cueing Strategies**

Dwyer (1978) reported that the ability to focus attention on relevant cue is fundamental to learning that during instruction, the primary function of cues is to direct students' attention and reduce the amount of time necessary to acquire the desired information which is to be learned. He continued to state that cueing strategies have been employed to improve students learning and these strategies has been identified as "being effective in attracting and sustaining student attention for extended period of time … which have been very effective in focusing, isolating, and structuring information being transmitted (p. 159).

F. M. Dwyer suggested that there are two types of functions of instructional cueing strategies (1978). The first type of function is to facilitate students to extract and concentrate on the intended instructional stimuli from their overall perceptual field; while the second function of cueing strategies is to provide elaborated relevant information or stimuli to help learners to make complete understanding of the information which they are perceiving. Gagne (1985) proposed a descriptive theory of strategy consisting of nine events of instruction. He assumes that attention gaining is the initial event of instruction. There is a perception that learning could be enhanced by eliminating many of the extraneous stimuli which may interfere with that learning (Dwyer, 1972, 1978). Within the environment, a large amount of information input into human system in constant, due to the limitations of the capacity of human system to process all available stimuli simultaneously, "the perceptual system must be highly selective" (Dember & Warm, 1979, p. 125). During this process, attention plays an important role in selecting key information from the complex environment, so " the concept of attention is the focusing of awareness" (Dember & Warm, 1979, p. 125) and some stimuli are attended to while other stimuli are disregarded (Moore, Burton, & Myers, 2003). This process has been identified as selective attention and defined as "the ability to attend voluntarily to some attributes of the stimulus array and to ignore other attributes" (Enns & Girgus, 1985, p. 319). It would be argued that if cueing strategies provide a good way to gain the attention of a student then cues would direct a student to attend to the most critical features of a computer-based instructional screen text display and allow important instructional information to be emphasized. Meanwhile, the attention-gaining cues also can serve as an organizational function to facilitate learners to make relationship between ideas more apparent. Researchers (Taylor, Canelos, Belland, Dwyer, & Baker, 1987) support this belief and reported that attention indicating strategies can improve learning.

Gagne (1985) states that elaboration is one of the crucial processes to the encoding and retrieving processes. He addressed that elaboration is a process whereby supporting information is added to the information being learned. Effective elaborations serve to link related propositions to stimulate retrieval of the learning context (Reder, 1982). Reder (1979) also supports the idea that elaborative encoding helps integrate new information with prior knowledge. He summarizes the list of forms of elaborations: addition of details to information, clarifying ideas, explaining and contrasting two or more concepts, making inferences, visualizing an image of material to be learned, making analogies to relate new ideas to familiar ideas, or associating new material with previous knowledge or experience. Elaborative processing often leads to improvements in learning performance (Aderson & Reder, 1979). Stewart (1988) also identified several functions of cueing strategies that: (1) as an instructional strategy, cueing needs to enable and facilitate the readers to recognize the expected learning goals and implement appropriate methods to finish the task; and (2) cueing needs to represent the structure and organization of the text and activate the learning schema.

Based on the theoretical and empirical literature review, cueing strategies are expected to help students to see relationships between and among facts, concepts, and procedures and facilitate higher-order information processing to increase achievement.

## Theoretical Background of Cueing Strategies

In order to understand the functions of cueing strategies in instructional process, it is important to be aware of its cognitive theoretical background-information processing theory. Cognitive information process is a branch of cognitive psychology that considers how people perceive, process, and act on information and focus on attention, perception, and memory (Ausubel, 1968). Cognitive psychologists have offered numerous explanations about how people mentally process information. Gredler (2001) addresses that information-processing theory discusses the "basic steps in the way individuals obtain, code, and remember information, is the central theory of the cognitive perspective" (p. 169). The nature of cognitive process can be extremely helpful to instructional designers not only to understand what they want students to learn, but also how learners can be effectively learn it (Ormrod, 2003).

### Information Processing Theory and Cueing Strategies

The origin of information-processing models can be traced to Atkinson and Shiffrin's (1968) model of memory, which was the first suggests that memory consisted of a sensory register, a short-term and long-term store. This multistage model presents a single, long-term store for human memories (Gredler, 2001). According to Atkinson and Shiffrin, learners are assumed to receive information from the environment and then transform it for storage for future retrieve. Sensory memory helps learners to organize the information that they received from the environment and begin the process of recognizing and coding the information. Since information can only exist in the sensory memory for an extremely brief period about 0.5-2.0 seconds (Gredler, 2001), learners must choose to attend to the information if it is to continue on for future processing. Figure 1 demonstrates the multistage cognitive information processing (Driscoll, 2000).

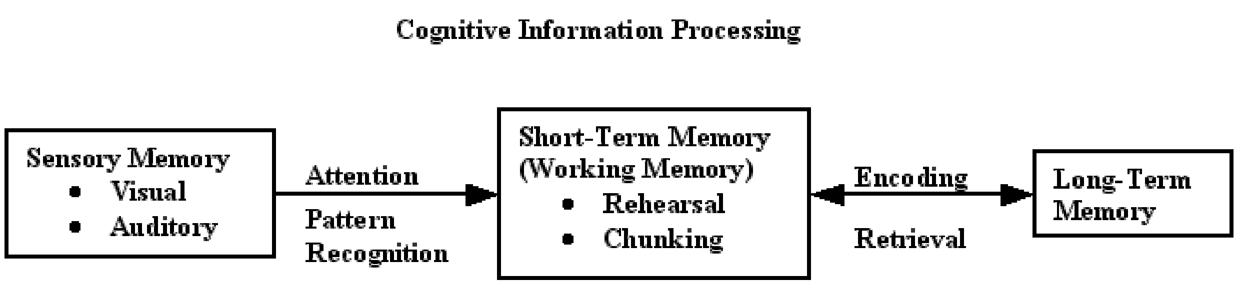


*Figure 1* Cognitive Information Processing

Short-term memory or working memory is the stage in which *attention* has been paid and permits learners to store information temporally in memory so as to make connection with previous information. Working memory is where much of the thinking or cognitive processing occurs (Ormrod, 2003). In this stage, much of the information is encoded into some meaningful form and transferred into long-term memory. Unfortunately, short-term memory is limited in its capacity and duration (Gillani, 2003). People only can attended to a small amount of information at any one time which means that attention has a limited capacity. In the period of moving information to working memory, since of the limited capacity of human attention, only a very small amount of information in one's sensory register can move on to working memory (Ormrod, 2003). Gradler (2001) emphasizes that information in short-term memory only can be maintained for about 20 seconds without rehearsed. Obviously, it is critical that students need to pay attention to the things that they are supposed to learn. Wilshire (1989) states that in the human information processing system, the major weakness is the short-term memory. He mentions that in order to design an effective instruction, recognizing the limitations of short-term memory and the need for providing appropriate retrieve cues is very important. G. A. Miller (1956) presents the idea that short-term memory could only hold five to nine chucks of information (seven plus or minus two), where a chunk is any meaningful unit. The unit of chunk could be digits, words, chess positions, or people's faces. The concept of chunking and the limited capacity of short-term memory became a basic element of all subsequent theories of memory (Owens, 2002).

Long-term memory is the last step in information processing which makes learners remember and apply information long after it has been originally learned. Klatzky (1975) described long-term memory as "storehouse" (p. 12) with unlimited capacity for storing information. She mentioned two important hypotheses about long-term memory which are worth noting. The first one is that long-term memory is a permanent store, although sometimes people cannot remember everything. The forgetting phenomenon has been described as a retrieve problem that the information is there, but people cannot get it. Driscoll (2000) reports that the process of retrieve can be greatly affect by the cues available to learners at the test that "whatever cues are used by a learner to facilitate encoding will also serve as the best retrieve cues for that information at test time" (p. 103). Another hypothesis by Klatzky is that "many different types of information about items must reside there … the variety of information that can represent an item" (p. 13). Klatzky (1980) defined long-term memory as a mental dictionary of concepts and their associations to each other. A characteristic of information that is stored in long-term memory is that it must have meaning and it must be integrated with related prior knowledge. She suggests that the more meaningful the information, the more it likely to be remembered. R. M. Gagne (1985) believes that information stored in long-term memory is organized as schemas. A schema is an organized body of knowledge about a specific topic which helps the learner to relate pieces of information to existing information. They are influential in how new information is interpreted and stored in long-term memory. Information in long-term memory is believed to be stored indefinitely (Rumelhart & Ortony, 1977).

Gredler (2001) emphasizes that there are several essential components of learning which are: (a) the organization of information to be learned; (b) the learner's prior knowledge of the instructional contents; and (c) the process involved in perceiving, comprehending, and storing information. Be aware of these essential components of learning can assist instructional designers in their design process so as to increase learning performance. Norman (1969) states "the capacity of the human to deal with incoming information is severely limited. It is as if at some stage of the analysis of incoming information only a small portion of the incoming signal is selected for further processing" (p. 4). In a summary of the instructional value of the immediate effects of attention-getting devices, he concluded that these devices are to make the learners: (1) perceive, (2) conceive, (3) distinguish, (4) remember, and (5) shorten reaction time. It is clear that strategies to focus student attention and psychological aspect of visual and verbal information processing, storage, and recall are intertwined and extremely important to assist learning.

**Cognitive Processes**

In order to understand the cognitive reason for using cueing strategies, it is important to analyze the cognitive processes which supports the use of cueing strategies. Cognitive processes have been identified as perception, attention, encoding, storage, and retrieval (Labant & Dwyer, 2002). M. L. Fleming (1987) emphasizes that perception, attention, and learning are intertwined together practically and theoretically.

*Perception.* Ausubel (1968) defined perception as an awareness of an object or even prior to the cognitive processing of that object or event. Perception is a selective process (Ausubel, 1968; Burbank & Pett, 1989; M. Fleming & Levie, 1978). The amount of information to which people received is unlimited, but the total information processing capacity is limited. Perception must be selective since people only can attend to a limited amount of information at once (M. Fleming & Levie, 1978). Ausubel (1968) states that this selection process is based on individuals' experiences, expectations, goals, and their individual differences that people scan the available information and select to certain part of the information for processing. In order to limit the amount of information presented, instructional designers should use only pertinent information and visual or verbal cues to focus attention on key points (Burbank & Pett, 1989). Burbank and Pett continually recommend that:

Perception is organized, so arrange material in keeping with the subject matter. Use arrows, numbers or other cues to direct the learner's perceptions. Perception is influenced by expectations, so use appropriate formats and cues such as headings, or to aid learner in knowledge what to expect. (p. 529)

Alessi and Trollip (1991) point out that perception may be facilitated by presentation design factors such as: "detail and realism, the use of sound versus visuals, color, characteristics of text such as its size and font, animation, and position of screen elements …" (p. 11).

*Attention.* This literature focuses discussions on attention value of a cue. Attention is an important cognitive process which allows learners to selectively address particular stimuli for successful learning (Rieber, 1994). All human learning is depending on the learners to attend to stimuli and correctly perceiving them (Alessi & Trollip, 1991). Learners are selectively focus on information they think is important and ignore information they considered unimportant.

Attention in learning has been long recognized by cognitive researchers (Driscoll, 2000). Norman (1969) in discussion of the principles of memory and attention in human information processing, noted that the effects of attention are perceive, conceive, distinguish, remember, and shortens 'reaction time '. Information must first be noticed in order to be remembered in long-term memory. So to pertain to their learning goals, learners selectively attend to certain stimuli. An important aspect of instruction is in structuring the learning environment so that the learner's attention can be focused (Bruning, Schraw, & Ronning, 1995).

Researchers provided several theoretical models of attention which explain how information be focused on in information processing. Broadbent's (1958) filter model of attention describes how learners select a message to process information. It proposed that selective attention acts like a filter to block some information and lets only certain types of information pass to the processing unit. Filter model asserts that attention was a limited capacity channel that determined the serial processing of the perceptual system (Broadbent, 1958). Between the large capacity sensory memory and the further processing unit, there is only one single channel that transmits information. So there is only a small amount of available information is selected for the further processing. Broadbent stresses that a particular message can be selected and attended to on its physical basis. However, later studies have indicated that attention as based solely on physical characteristics of the stimulus is not true (Klatzky, 1975; Treisman, 1964). Klatzky (1975) indicates that learners might select messages based on semantic content also. Treisman (1964) argues that the learners would attenuate and not filter out certain message based on their physical properties. She proposed that attention more like the attenuator, which turns down the volume of the unattended channels instead of blocking them out. She explained that all incoming signals are go through a preliminary test which not only examine their physical characteristics, but also analyze their contents. The test determines which information will be attended to and which one is not. After this preliminary test, attention would be directed to one of the channels. In 1973, Shiffrin and Geisler (cited in Bourne Jr., Dominowski, Loftus, & Healy, 1986) presented a unlimited capacity model. They argued that the attentional "bottleneck" is only a memory phenomenon and it does not exist prior to short-term memory. They proposed that:

> There is no limit on our capacity to recognize stimuli coming from different channels at the same time, and the process of recognizing a stimulus arriving on one channel does not disturb the process of recognizing a second stimulus arriving at the same time on another channel. (p. 61)

Reiber (1994) addresses that there are two kinds of attention. One is made subconsciously, such as sensory input, the other is made consciously such as selective attention which refers to people focus on one set of information while ignore or block other incoming information on purpose. Kahneman (1973) introduced another model of attention which support Rieber's opinion of attention that in addition to unconscious processes, attention can be consciously focused. The model initiates the idea that attention can be view as a learning strategy which can be improved.

Researchers (R. C. Anderson, 1982; Van Dijk & Kintsch, 1983) have proposed a selective attention theory which indicated that important text elements are better learned and recalled because extra attention is allocated to them. The following is the explanation of the selective attention theory by R. C. Anderson (1982):

(1) Text elements are processed to some minimal level and graded for importance.
(2) Extra attention is devoted to elements in proportion to their importance.
(3) Because of the extra attention, or a process supported by the extra attention, important text elements are learned better than other elements. (p. 292)

The theory predicts "a positive relationship between text element importance, attention focused on those elements, and eventual learning" (Reynolds & Shirey, 1988, p. 82). Reynolds and Shirey also address that inserting cues in the text can make particular text elements become important.

Driscoll (2000) described attention as a state, a resource, or a process. Attention as a state occurs "when a learner maintain an attitude of expectation, alert to information and heedless of distractions" (p. 276). Those features exist in learners who are interested in what they are learning. For students who are not interested in the instruction or suffer from the incapability of focusing on attentions are easily distracted from a learning task. "Attention as a resource refers to a learner's capability of selectively allocating more attention to one of several simultaneously occurring events … attention as a process involves selecting particular information for future analysis and interpretation over other, available information" (Driscoll, 2000, p. 277). Learner's ability of attention is a cognitive development process. Young learners are easily to focus on attention on one thing to another. Meanwhile, they are also easily drawn their attention to irrelevant objects and events. But as young learners become older, their ability to focus attention on a particular task and less likely to be distracted by irrelevant occurrences becomes better (Dempster & Corkill, 1999).

Gaining attention has been listed as the first of the nine events of a successful instruction (R. M. Gagne, 1985). Knowledge cannot be obtained unless the learner is in some way oriented to incoming information. Keller's (cited in Driscoll, 2000) model of motivational design suggests the first process of instruction is gaining attention of learning and engaging them in the learning activity before any instruction and learning occur. Klatzky (1975) states that when the incredible amount of information impinges on the sensory memory, some of the information is important and some is not. Since memory system cannot recognize all of the information at once and pass it to the short-term memory, attention acts to filter out the less important information and select the more important ones for future processing. McKeachie (1988) states that learning strategies, aimed at helping learners' attention process, can influence how much attention is paid and how much information reach short-term memory for future process.

All of these models and theories explained attention in different views and provided valuable guidelines to help practitioners to have a good understanding on some phenomena of attention in information processing. In addition, Norman (1969) also asserts that "one thing that must of certainty be true of the study of attention is that it cannot be divorced from the study of other cognitive phenomena" (p. 37).

*Encoding.* The process of encoding occurs in short-term or working memory which is the step to transfer the information from short-term memory into long-term memory. Driscoll (2000) describes encoding as a process which relates incoming information to the previous existed concepts or knowledge in order to make the new information easily memorable and meaningful. Mayer (1988) suggests, "learning strategies aimed at the process of encoding process can influence how fast information is encoded and how much is encoded" (p. 16). In other words, these strategies are important because the manner in which information is treated in short-term memory determines its value at a later time. Hodes (1994) lists three categories of encoding strategies: repetition, organization, and elaboration. Repetition refers to rote memorization where information is simply repeated. Organization refers to organizing information into meaningful units for increased retention. Hodes noted that elaboration could be verbal and nonverbal where learners construct statement or mental images about the underlying meaning of the information.

*Storage*. Storage is the process by which new information is integrated in various ways with previous known information. Chunking has been viewed as an effective strategy to increase short-term memory storage capacity (Klatzky, 1975). The function of long-term memory is to store information for later use (E. D. Gagne, Yekovich, & Yekovich, 1993). Long-term memory storage includes rehearsal, meaningful learning, elaboration, organization, and visual knowledge (Omrod, 1998). Frase (1975) found the benefit of elaborative processing with text materials for long-term storage. Frase stresses that subjects who had been given advanced organizer as an elaborative process did better to test questions than subjects in control group without advance organizer. Learners' memory for text materials would be improved by elaborative processing which include strategies, such as previewing, questioning, reading, reflecting, reciting, and reviewing (Thomas & Robinson, 1972). Furthermore, researchers (Pressley, McDaniel, Turnure, Wood, & Ahmad, 1987) address that the most critical feature of elaborations is whether the elaboration can focus learners' attention on the appropriate instructional material for encoding into long-term memory. In addition, learners learn and remember new information more readily when the information is organized. Organization involves making connections between the parts of the new information in order to make the learning more relevant and improve the long-term memory storage (Gredler, 2001).

*Retrieval.* Mayer (1988) describes retrieval as the process of transferring knowledge from long-term memory to short-term memory. The process of retrieval in long-term memory can be described as an indexlike mechanism (Bourne Jr. et al., 1986). Making multiple connections with the learner's existing knowledge allows for better retrieval of newly learned information (Ormrod, 1995). Researchers (J. R. Anderson, 1995; Ormrod, 1995) listed some reasons of the failure to locate information in long-term memory leads to retrieval failure: (a) lack of a relevant retrieval cue, (b) lack of multiple connections between various knowledge segments in long-term memory, (c) Infrequent practice or infrequent use of stored information can also lead to retrieval failure, (d) interfering material, and (e) memory decay. People reply on cues to retrieve information from long-term memory (Bourne Jr. et al., 1986). Tulving and Thompson (1973) demonstrate that when providing the right retrieval cues, learners can perform better recalls in their learning process. Tulving (1974) stresses that memory must be viewed as a joint function of stored information and the information provided to the subject at retrieval, such as retrieval cues. Continually, Tulving (1983) indicates that retrieval cues can be viewed as the particularly salient or significant "aspects of the individual's physical and cognitive environment that initiate and influence the process of retrieval" (p. 171). For a given retrieval cues to be effective, it must be encoded with the original event and have some sort of connections with the target item which it is suppose to cue (Bourne Jr. et al., 1986).

Mayer (1982; 1984) addresses three primary functions of cognitive process which are: (1) to guide selective attention towards certain information in the text; (2) to foster the establishing of internal connections among ideas from the text; and (3) to foster building external connections between ideas in the text and learners' existing previous knowledge.

Information processing theory provides the theoretical base for understanding the effects of cueing strategies in learning. By analyzing these relationships, instructional designers will get a better understanding on employing effective instructional strategies to accommodate student's needs so as to enhance learning.

### Cueing Strategies and Academic Achievement

Various cueing strategies have been identified in the literature as methods for focusing attention which include auditory cue/music or narrator, pictures, animation, diagram, arrow, underline, labeling, color coding, text size or fonts, motion, shading, texture, questions, concept maps, and advanced organizer, etc. (Burton, Moore, & Holmes, 1995; Dwyer, 1978; Higgins & Cocks, 1999; Levie & Lentz, 1982). Most studies on the effect of cueing strategies to academic achievement were conducted to examine the effectiveness of directing attention to the specific information with visuals in designing instructional message (Downs, 1989; Downs & Jenkins, 2001; McIntyre, 1981). The research yielded mixed results. Most of the studies had positive results (Beck, 1987; Dinnel & Glover, 1985; Dwyer & Moore, 1992; Goldstein, 1981; Higgins & Cocks, 1999; Levie & Lentz, 1982; Martel, 1992; Mayer, 1989; McIntyre, 1981). However, some also had negative or non-significant research findings (Owens, 2002; Pienkowski, 2002; Worley & Moore, 2001).

Although a great deal of research explored the effects of cueing strategies that complement visual imagery in facilitating student achievement, the effectiveness of cueing strategies in computer screen delivered text message has not been widely investigated. Future research needs to be conducted to clarify this issue.

### Instructional Message Design

Researchers have begun to identify the elements of the message which are important in facilitating learning achievement during instructional message design process (Lamberski & Mayers, 1980). Grabowski (1991) described message design is a process of "planning for the manipulation of the physical form of the message" (p. 206). Here, the message works as a medium to communicate a sender and a receiver. Studies of message design have suggested that the message should be clearly defined and set forth to provide optimum instructional effectiveness and efficiency in the learning process (Lamberski & Mayers, 1980). In order to guarantee the efficient learning to occur, "… the stimulus material for learning must be available and clearly perceivable by the learner" (Dwyer, 1978, p. 158). Fleming and Levie (1978) have defined instructional message design as "the process of manipulating, or planning for the manipulation of, a pattern of signs and symbols that may provide the conditions for learning (p. xi). Instructional design must find a way to magnify or emphasize the critical features in the instructional message (M. Fleming & Levie, 1978). Previous researchers (Ausubel, 1968; Rothkopf, 1966) found that positive learning was affected by using strategies to direct the learners attention to relevant information. Fleming and Levie's definition and explanation of instructional message design "limited messages to the pattern of signs or symbols that modifies the cognitive, affective or psychomotor behavior" (Seel & Richey, 1994, p. 31). According to the interests of this article, instructional message design can be defined as the process of manipulating the learning conditions that encompasses the modification of the pattern of a signs or symbols (words or pictures) which has been viewed as the media to communicate learning. Usually this process will be conducted by the teachers or instructional designer before the instruction.

Researchers (Heines, 1984; Soulier, 1988) addressed that about 80 to 90 percent of the information was presented by text in computer-based instruction. Although with the development of computer technologies and integration of multimedia into the curriculum, instructional message can be delivered by using graphic and animation as well as text, the majority of instructional materials in computer-based instructional learning environment are still rely on text. This emphasizes the important effects of the computer screen delivered text message design on students' academic performance.

How information is constructed by the reader to gain comprehension from text materials is an important goal for teaching and learning (Bennett, 1989). Text design has been identified as one of the factors which influence learners' comprehension of the learning information. McConaughy (1985) suggests that one of the essential aspects of text comprehension is the ability to attend and focus on important or critical relevant materials within the text and to exclude the nonessential materials. Bennett (1989) follows the same reasoning and states that information comprehension process is an interactive and assimilative process between the learner and text which depends upon the cues used by the learner to gain meaning from the text. In order to increase greater comprehension, instructional designer should look at the text design and learners differences. R. C. Anderson (1982) concluded that text message should be designed to allow readers to: assimilate textual information, facilitate selective allocation of attention, enable inferential elaboration, allow for orderly searches of memory, facilitate editing and summarizing, and permit inferential reconstruction.

Well designed text can be used to help learners to organize and locate information and facilitate information to be transformed and comprehended during information processing (Hannafin & Hooper, 1993). Burbank and Pett (1989) provides a number of principles and guidelines for designing text message and instructional content. They suggests that effective instructional design should include: “1) use variations in size, color, brightness, and shape or employ novel visuals to attract attention; and 2) to hold attention, be certain that the material presented is meaningful to the learners ”(p. 528). According to Burtank and Pett’s (1989) suggestions on text design, instructional designers can improve students’ learning achievement by: 1) using a list or outline of the content to assist learners to organize information; 2) using bullets, numbers or white space to separate and attend on key items; 3) using red or blue color to attract attention; and 4) using color to provide structure, or emphasize relevant cues and to distinguish critical items from irrelevant ones. They also state that when developing textual materials, it is better to consider the characteristics of the audience, the information to be presented, and the way the audience will process the information (Burbank & Pett, 1989).

The question of “how text can be effective presented on computer screen” requires professionals to look at the text attributes in depth. Meanwhile, by analyzing and modifying text attributes, instructional designers should be able to find effective instructional strategies to enhance readers’ comprehension since learning from text message not only just pass reading, it requires learners’ active text processing (Duchastel, 1982). According to online information which was retrieved from the Monron City Schools’ website (2005), text attributes refer to font, size, style, and color. Those attributes of text can be manipulated in a computer-based environment within an instructional message. Meyer (1975) has identified that in the text to emphasize how ideas are related and which ideas are most important, text structured can be manipulated to influence free recall performance by inserting cues, or signals. Signaling or cueing content and structure has been demonstrated to facilitate low or average learners’ recall performance (B. J. F. Meyer, Brandt, & Bluth, 1980). Pace (1982) summarized a general principle for the design of text that text message designer should facilitate readers to acquire new information by highlighting important ideas and reduce the density of the information load. The explicit techniques which designers used to capture and focus attention during reading include “linguistic, spatial, and typographic cues to the form, function, sequence, content, and importance of segments of a passage” (Jonassen & Kirschner, 1982, p. 123). During this design process, several aspects need to be considered: the nature of the target audience, such as their cognitive/learning style, the expected outcomes of the text message, and certain text characteristics affect perception of the information (Jonassen & Kirschner, 1982).

## Conclusion

To design effective learning materials, the instructional designers need to ask those questions: How does the human mind work? How do people process information? And how can we adapt instructional strategies to aid human cognition? In approaching the design of instructional text message, the instructional designers have to have a clear understanding of the process of how people learn and what are the variables which can affect this process. They should provide learners with stylistically appropriate cues to organize the content and direct learner’s attention so as to improve learning performance.

## References

Aderson, J. R., & Reder, L. M. (1979). An elaborative processing explanation of depth of processing. In L. S. Cermak & F. I. M. Craik (Eds.), *Levels of processing in human memory* (pp. 385-403). Mahwah, NJ: Erlbaum.

Alessi, S. M., & Trollip, S. R. (1991). *Computer-based instruction: methods and development* (2th ed.). Englewood Cliffs, NJ: Prentice Hall.

Allen, W. H. (1975). Intellectual abilities and instructional media design. *AV Communication Review*, *23*, 139-170.

Anderson, J. R. (1995). Cognitive psychology and its implication. In (4th ed.). New York: Freeman.

Anderson, R. C. (1982). Allocation of attention during reading. In A. Flammer & W. Kintsch (Eds.), *Discourse processing* (pp. 292-305). New York: North-Holland.

Anderson, T. H., & Armbruster, B. B. (1985). Studying strategies and their implications for textbook design. In T. M. Duffy & R.Waller (Eds.), *Design usable texts* (pp. 159-178). Orlando, FL: Academic Press.

Atkinson, R. C., & Shriffin, R. M. (1968). Human memory: A proposed system and its control processes. In J. Spence (Ed.), *The psychology of learning and motivation* (Vol. 2). New York: Academic.

Ausubel, D. P. (1968). *Educational psychology: A cognitive view*. New York: Holt, Rinehart and Winston.

Beck, C. R. (1987). Pictorial cueing strategies for encoding and retrieving information. *International Journal of instructional Media, 14*(4), 332-345.
Bennett, L. T. (1989). Visual literacy: A factor of text design and reading instruction. In R. A. Braden, D. G. Beauchamp, L. V. W. Miller & D. M. Moore (Eds.), *About visuals: Research, teaching and applications* (pp. 53-58). Blacksburg, VA: Virginia Tech University.
Bloom, B. S. (1976). *Human characteristics and school learning*. New York: McGraw-Hill.
Bourne Jr., L. E., Dominowski, R. L., Loftus, E. F., & Healy, A. F. (1986). *Cognitive processes* (2th ed.). Englewood Cliffs, NJ: Prentice-Hill.
Broadbent, D. E. (1958). *Perception and communication*. London: Pergamon.
Brown, J. W. (1978). *Educational media yearbook*. New York: R. R. Bowker.
Brown, J. W., Lewis, R. B., & Harcleroad, F. F. (1973). *AV instruction: Technology media and methods*. New York: McGraw-Hill.
Bruning, R. H., Schraw, G. S., & Ronning, R. R. (1995). *Cognitive psychology and instruction*. Upper Saddle River, NJ: Merrill and Prentice Hall.
Burbank, L., & Pett, D. (1989). Designing instructional materials: Some guidelines. In R. A. Braden, D. G. Beauchamp, L. V. W. Miller & D. M. Moore (Eds.), *About visuals: Research, teaching and applications* (Vol. 527-534). Blacksburg, VA: Virginia Tech University.
Burton, J. K., Moore, D. M., & Holmes, G. A. (1995). Hypermedia concepts and research: An overview. *Computers in Human Behavior, 11*(3/4), 345-369.
Card, S. K., Moran, T. P., & Newell, A. (1983). *The psychology of human-computer interaction*. Hillsdale, NJ: Lawrence Erlbaum Associates.
Dember, W. N., & Warm, J. S. (1979). *Psychology of perception* (2nd ed.). New York: Holt, Rinehart and Winston.
Dempster, F. N., & Corkill, A. J. (1999). Interference and inhibition in cognition and behavior: Unifying themes for educational psychology. *Educational Psychology Review, 11*, 1-88.
Dick, W., Carey, L., & Carey, J. O. (2001). *The systematic design of instruction* (5th ed.). New York: Addition-Wesley Educational.
Dinnel, D., & Glover, J. A. (1985). Advance organizers: Encoding manipulations. *Journal of Educational Psychology, 77*(5), 514-521.
Downs, E. (1989). *The effects of cueing strategy, level of information, and motion condition on children's interpretation of implied motion in pictures.* Unpublished doctoral dissertation, University of Florida, Gainesville, FL.
Downs, E., & Jenkins, S. J. (2001). The effects of grade level, type of motion, cueing strategy, pictorial complexity, and color on children's interpretation of implied motion in pictures. *The Journal of Experimental Education, 69*(3), 229-242.
Driscoll, M. P. (2000). *Psychology of learning for instruction* (2th ed.). Needham Heights, MA: Allyn & Bacon.
Duchastel, P. C. (1982). Textual display techniques. In D. H. Jonassen (Ed.), *The technology of text: Principles for structuring, designing, and displaying text* (pp. 167-191). Englewood Cliffs, NJ: Educational Technology.
Dwyer, F. M. (1972). *A guide for improving visualized instruction*. State College, PA: Learning Services.
Dwyer, F. M. (1978). *Strategies for improving visual learning: A handbook for the effective selection, design and uses of visual learning materials*. State College, PA: Learning Services.
Dwyer, F. M., & Moore, D. M. (1992). Effect of color coding on visually and verbally oriented tests with students of different field dependence levels. *Journal of Educational Technology Systems, 20*(4), 311-320.
Enns, J. T., & Girgus, J. (1985). Developmental changes in selective and integrative visual attention. *Journal of Experimental Child Psychology, 40*, 319-337.
Fleming, M., & Levie, W. H. (1978). *Instructional message design: Principles from the behavioral sciences*. Englewood Cliffs, NJ: Educational Technology.
Fleming, M. L. (1987). Displays and communication. In R. M. Gagne (Ed.), *Instructional technology: Foundations* (pp. 233-260). Englewood Cliffs: NJ: Lawrence Erlbaum.
Frase, L. T. (1975). Prose processing. In G. H. Bower (Ed.), *The psychology of learning and motivation, Volume 9* (pp. 1-47). New York: Academic.
Frey, A., Yankelov, P., & Faul, A. (2003). Student perceptions of web-assisted teaching strategies. *Journal of Social Work Education, 39*(3), 443-457.
Gagne, E. D., Yekovich, C. W., & Yekovich, F. R. (1993). *The cognitive psychology of school learning*. New York: Harper Collins.
Gagne, R. M. (1985). *The conditions of learning* (4th ed.). New York: Holt, Rinehart, & Winston.

Gillani, B. B. (2003). *Learning theories and the design of e-learning environment*. Lanham, MD: University Press of America.
Goldstein, D. (1981). *The effects of cued rehearsal strategies and manipulation of materials upon recall in severely retarded students.* Unpublished doctoral dissertation, Georgia State University, Atlanta, GA.
Grabowski, B. L. (1991). Message design: Issues and trends. In G. J. Anglin (Ed.), *Instructional technology: Past, present, and future* (pp. 202-212). Englewood, CO: Libraries Unlimited.
Grabowski, B. L. (1995). Message design: issues and trends. In G. J. Anglin (Ed.), *Instructional technology: Past, present, and future* (2th ed., pp. 222-232). Englewood, CO: Libraries Unlimited.
Gredler, M. (2001). *Learning and instruction: Theory into practice* (4th ed.). Upper Saddle River, NJ: Merrill Prentice Hall.
Hannafin, M. J., & Hooper, S. R. (1993). Learning principles. In M. Fleming & W. H. Levie (Eds.), *Instructional message design: Principles from the behavioral and cognitive sciences* (2th ed., pp. 191-231). Englewood Cliffs, NJ: Educational Technology.
Heines, J. (1984). *Screen design strategies for computer-assisted instruction*. Bedford, MA: Digital Press.
Higgins, N. C., & Cocks, P. (1999). The effects of animation cues on vocabulary development. *Reading Psychology, 20*(1), 1-10.
Hodes, C. L. (1994). Processing visual information: Implications of the dual code theory. *Journal of Instructional Psychology*, *21*(1), 36-42.
Jonassen, D. H., & Kirschner, P. A. (1982). Introduction to section two: Explicit techniques for structuring text. In D. H. Jonassen (Ed.), *The technology of text: Principles for structuring, designing, and displaying text* (pp. 123-136). Englewood Cliffs, NJ: Educational Technology.
Kahneman, D. (1973). *Attention and effort*. Englewood Cliffs, NJ: Prentice-Hall.
Klatzky, R. L. (1975). *Human memory: Structures and processes* (2th ed.). San Francisco: W. H. Freeman and Company.
Klatzky, R. L. (1980). *Human memory* (2th ed.). New York: Freeman.
Labant, J. C., & Dwyer, F. (2002). The effect of varied verbal rehearsal strategies on immediate and delayed retention of varied learning objectives. *International Journal of Instructional Media, 29*(1), 93-100.
Lamberski, R. J., & Mayers, B. E. (1980). *The efficiency of a color or black/white code in learning and test materials.* Paper presented at the annual meeting of the American Educational Research Association, Boston.
Levie, W. H., & Lentz, R. (1982). Effects of text illustrations: A review of research. *Educational Communications and Technology Journal, 30*(4), 195-232.
Martel, C. (1992). *Effects of graphic cueing strategies in text-based instruction on comprehension and retention.* Unpublished master's thesis, Concordia University, Montreal, Canada.
Mayer, R. E. (1982). Instructional variables in text processing. In A. Flammer & W. Kintsch (Eds.), *Discourse processing* (pp. 445-461). Amsterdam: North-Holland.
Mayer, R. E. (1984). Aids to prose comprehension. *Educational Psychologist, 19*(1), 30-42.
Mayer, R. E. (1988). Learning strategies: An overview. In C. E. Weinstein, E. T. Goetz & P. A. Alexander (Eds.), *Learning and study strategies: Issues in assessment, instruction, and evaluation* (pp. 3-22). San Diego: Harcourt Brace Jovanovich.
Mayer, R. E. (1989). Systematic thinking fostered by illustrations in scientific text. *Journal of Educational Psychology, 81*(2), 240-246.
McConaughy, S. (1985). Good and poor readers comprehension of story structures across different input and output modalities. *Reading Research Quarterly, 20*, 219-231.
McIntyre, W. A. (1981). *The effects of visual cue elaboration on cognitive tasks with different modes of presentation.* Unpublished unpublished doctoral dissertation, Boston University, Boston, MA.
McKeachie, W. J. (1988). The need for study strategy training. In C. E. Weinstein & E. T. Goetz (Eds.), *Learning and study strategies: Issues in assessment instruction, and evaluation* (pp. 3-10). San Diego: Harcourt Brace Jovanovich.
Meyer, B. J. F. (1975). *The organization of prose and its effects on memory*. New York: American Elsevier.
Meyer, B. J. F., Brandt, D. M., & Bluth, G. J. (1980). Use of top-level structure in text; key for reading comprehension of ninth graders. *Reading Research Quarterly, 16*(1), 72-103.
Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 63,* 81-97.
Monron City Schools. (2005). *Educational resources: Guides and tutorials*. Retrieved February 27, 2005, from http://monroe.k12.la.us/mcs/

Moore, D. M., Burton, J. K., & Myers, R. J. (2003). Multiple-channel communication: The theoretical and research foundations of multimedia. In D. H. Jonassen (Ed.), *Handbook of Research for Educational Communications and Technology: A Project of the Association for Educational Communications and Technology* (2nd ed., pp. 979-1005). New York: Simon & Schuster Macmillan.

Norman, D. A. (1969). *Memory and attention; an introduction to information processing*. New York: Wiley.

Omrod, J. E. (1998). *Educational Psychology: Developing learners*. Upper Saddle River, NJ: Prentice-Hall.

Ormrod, J. E. (1995). *Educational psychology: Principles and applications*. Englewood Cliffs, NJ: Prentice-Hall.

Ormrod, J. E. (2003). *Educational psychology: Developing learners* (4th ed.). Upper Saddle River, NJ: Pearson Education.

Owens, R. (2002). *An investigation to explore the effects of cueing strategies that complement animated visual imagery in facilitating student achievement of different educational objectives.* Unpublished doctoral dissertation, The Pennsylvania State University, University Park, PA.

Pace, A. J. (1982). Analyzing and describing the structure of text. In D. H. Jonassen (Ed.), *The technology of text: Principles for structuring, designing, and displaying text* (pp. 15-27). Englewood, NJ: Educational Technology.

Partee, G. L. (1984). *The instructional effect of varied layout and design formats in facilitating student achievement of different educational objectives.* Unpublished doctoral dissertation, The Pennsylvania State University, State College.

Pienkowski, N. (2002). *The effects of cueing learners to a transfer problem prior to instruction.* Unpublished doctoral dissertation, Virginia Polytechnic Institute and State University, Blacksburg, VA.

Pressley, M., McDaniel, M. A., Turnure, J. E., Wood, E., & Ahmad, M. (1987). Generation and precision of elaboration: Effects on intentional and incidental learning. *Journal of Experimental Psychology, 13*(2), 291-300.

Reder, L. M. (1979). The role of elaborations in memory for prose. *Cognitive Psychology, 11*, 221-234.

Reder, L. M. (1982). Elaborations: When do they help and when do they hurt? *Text, 2*, 211-244.

Reynolds, R. E., & Shirey, L. L. (1988). The role of attention in studying and learning. In C. E. Weinstein, E. T. Goetz & P. A. Alexander (Eds.), *Learning and study strategies: Issues in assessment, instruction, and evaluation* (pp. 77-100). San Diego: Harcourt Brace Jovanovich.

Rieber, L. P. (1994). *Computers, graphics, and learning*. Madison, WI: Brown & Benchmark.

Rothkopf, E. Z. (1966). Learning from written instructive materials: An exploration of the control of inspection behavior by test-like events. *American Educational Research Journal, 3*(4), 241-249.

Rumelhart, D. E., & Ortony, A. (1977). The representation of knowledge in memory. In R. C. Anderson, R. J. Spiro & W. E. Montague (Eds.), *Schooling and the acquisition of knowledge* (pp. 99-136). Hillsdale, NJ: Erlbaum.

Seel, B. B., & Richey, R. C. (1994). *Instructional technology: The definition and domain of the field*. Washington, DC: Association for Educational Communications and Technology.

Soulier, J. S. (1988). *The design and development of computer based instruction*. Newton, MA: Allyn & Bacon.

Stewart, A. (1988). *Towards a theory of instructional text design.* Paper presented at the Annual meeting of the Association for Educational Communications and Technology, New Orlean, LA.

Taylor, W., Canelos, J., Belland, J., Dwyer, F., & Baker, P. (1987). *The effects of program embedded learning strategies, using an imagery cue strategy and an attention directing strategy, to improve learning from Microcomputer Based Instruction (MCBI).* Paper presented at the annual meeting of the Association for Educational Communications and Technology, Atlanta, GA.

Thomas, E. L., & Robinson, H. A. (1972). *Improving reading in every class: A sourcebook for teachers*. Boston: Allyn & Bacon.

Treisman, A. M. (1964). Monitoring and storage of irrelevant message and selective attention. *Journal of Verbal Learning and Verbal Behavior, 3*, 449-459.

Tulving, E. (1974). Cue-dependent forgetting. *American Scientist, 62*, 74-82.

Tulving, E. (1983). *Elements of episode memory*. Oxford: Oxford University.

Tulving, E., & Thompson, D. M. (1973). Encoding specificity and retrieval processes in episodic memory. *Psychological Review, 80*, 352-373.

Turcott, S. D. (1986). *The effects of cueing strategies, method of presentation, and locus of control on student achievement on a criterion task.* Unpublished doctoral dissertation, Boston University, Boston.

Van Dijk, T. A., & Kintsch, W. (1983). *Strategies of discourse processing*. New York: Academic.

Wilshire, D. T. (1989). Effectiveness and efficiency of elaboration using computer-assisted instruction. In R. A. Braden, D. G. Beauchamp, L. V. W. Miller & D. M. Moore (Eds.), *About visuals: Research, teaching and application* (pp. 466-480). Blacksburg, VA: Virginia Tech University.

Winn, W. (1993). Perception principles. In M. Fleming & W. H. Levie (Eds.), *Instructional message design: Principles from the behavioral and cognitive sciences* (2th ed., pp. 55-126). Englewood Cliffs, NJ: Educational Technology.

Worley, G. M., & Moore, D. M. (2001). The effects of highlight color on immediate recall on subjects of different cognitive styles. *International Journal of Instructional Media, 28*(2), 169-179.

# Instructional Design Strategies for Intensive Online Courses

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**Abstract**

*Some may think that a summer online course is just a condensed version of a regular semester online course. If the instructor compresses a 15-week course content into a five-week time frame and the students triple their time and efforts studying online, the results of learning should be the same. In fact, due to the time constraint, different instructional strategies should be used for the design and delivery of the short- and long-term online courses in order to retain the quality of learning without reducing the amount of instruction. This paper presents a blended approach combing constructivist and objectivist instructional strategies for the design of an intensive summer online course based on a support-oriented model. The results of course evaluation revealed that students had a very positive learning experience with the course and were highly satisfied with their learning outcomes.*

## Introduction

With the widespread concepts of life-long learning and just-in-time training, many academic institutions are rushing headlong into the e-learning arena and are offering a variety of online programs and courses not only during regular semesters but also during summer sessions to meet the needs of students.

Some may think that a summer online course is just a condensed version of a regular semester online course. It works the same way as face-to-face classroom instruction. If the instructor squeezes a 15-week course content into a five-week time frame and the students triple their time and efforts studying online, the results of learning should be the same. In fact, due to the nature of online communication, the asynchronous mode in particular, both teachers and students usually invest much more time in a course taught online than in the same course taught in a traditional classroom (Palloff & Pratt, 1999). Thus, compressing the course content and extending the study hours may not be an effective approach for teaching and learning an intensive online course. How to retain the quality without sacrificing the quantity of learning is a challenge to instructional designers and instructors of intensive online courses. This paper presents a blended approach combing constructivist and objectivist instructional strategies for the design of an intensive summer online course based on a support-oriented model.

### Constructivist vs. Objectivist instruction

Over the past two decades, instructional design paradigms have shifted from objectivism to constructivism (Bonk & Cunningham, 1998; Cooney, 1998; Vrasidas, 2000; Tam, 2000). During the same time, the development of Internet technology has expanded learning environments from traditional classrooms to online and changed the nature of teaching and learning experiences. This change is leading instructional designers to adopt constructivist learning theories to the design of online learning environments.

The positive value of employing constructivist theories in the design of online learning environments has been supported by educational literature (Hannafin, Land, & Oliver, 1999; Moallem, 2003; Morrison; 2003; Palloff & Pratt, 1999, 2001). Cognitive constructivists believe that knowledge is constructed by the learner through an internal process of interpreting the world based on the learner's prior knowledge and experience (Jonassen, 1992). Social constructivists view learning, rather than as a purely internal cognitive processing of information, as a social construct of knowledge via interaction which is mediated by language or social-cultural dialogue (Bonk & Cunningham, 1998; Dewey, 1938; Vygostsky, 1978). This school of theorists believes that the context in which the learning occurs is foremost to the learning itself (McMahon, 1997); thus instruction should involve authentic learning tasks replicating real-world context and activities to optimize knowledge application (Jonassen, 1999; Savery & Duffy, 1996).

Jonassen (2004) concluded that learning, in order to be meaningful, must involve authentic learning tasks requiring cognitive information processing and knowledge construction within the context of collaboration and social interactions. Harasim (1990) noted that the online environment is particularly appropriate for collaborative learning because it emphasizes group interaction. Through group collaboration and interaction, social isolation can be reduced if not prevented (Hughes, Wickersham, Ryan-Jones, & Smith, 2002). Active, authentic, practical, and meaningful are some of the advantages of constructivist-based instruction.

In contrast to constructivists, objectivists believe that knowledge exists independent of the learner. Learning means a change in the learner's behavior or cognitive structure (Lakoff, 1987) and learning is an independent effort of individuals rather than collaboration and interaction among peers. Thus, objectivist-based instruction emphasizes the appearance of observable and measurable behavior in individual students.

Objectivist instructional design theories, derived from behaviorist and cognitive psychology, advocate systematic planning of instructional materials and learning activities so that students can follow the prescribed steps to obtain the desired learning outcomes. With detailed and well-structured instruction and feedback based on dichotomous right/wrong judgment of the student's response, the objectivist instructional approach has been traditionally used for the design of classroom and televised instruction and computer-based individualized learning. This approach grants to instructors the control of components of learning such as students, environment, materials, activities, and time. Efficiency and predictability are part of the strengths of objectivist-based instruction. The following table compares the characteristics of constructivist and objectivist instruction:

Table 1: Comparison of characteristics of constructivist and objectivist instruction

| Constructivist instruction | Objectivist instruction |
|---|---|
| Student-centered | Instructor-centered |
| Ill-structured | Well-structured |
| Less detailed | More detailed |
| Subscribed (active learning) | Prescribed (passive learning) |
| Contextual | Out of context |
| Multiple perspectives | Single perspective |
| Collaborative interdependent learning | Individualized independent learning |
| Less efficient | More efficient |
| Goal-free evaluation | Goal-based evaluation |

There is an increased interest among teachers and instructional designers in adopting the constructivist philosophy of teaching and learning in the design and delivery of online courses. However, in a constructivist learning environment, in order to successfully promote active and meaningful learning, the instructor as a learning facilitator has to coach, scaffold and monitor students' knowledge construction; provide immediate feedback; form and norm groups; encourage collaboration, interaction, and multiple perspectives; and assist in learning reflection and interpretation. These activities require a great commitment of time and energy from the instructor. Students engaged in constructivist learning also have to spend a lot of time and effort not only on learning and interaction but also on managing logistical tasks such as coordinating with other group members. Compared to objectivist-based instruction, constructivist-based teaching and learning require more time and effort from both the instructor and the students (Cavanaugh, 2005; Hughes, Wickersham, Ryan-Jones, & Smith, 2002; Rajandran, 2003).

There would less likely be a problem if a constructivist-based online course were offered during the regular semester. Students have more time to work collaboratively with their peers to construct knowledge and to solve assigned problems through synchronous and asynchronous communication. However, it would be a challenge for the instructor to implement the same constructivist-based instruction in an intensive summer course.

If time is the essential factor affecting the successful completion of a constructivist-based intensive online course, instructional designers may consider using a blended approach, which combines the strengths of constructivist and objectivist methods of teaching and learning for the design of the course. Thus, meaningful learning can be achieved efficiently.

## Conceptual framework

### Technology and support

Online learning requires a certain level of technological knowledge and skill. Inadequate technological skill and technical difficulties not only can result in anxiety, frustration, confusion and disorganization for the student but it can also impede the communication and interaction process, thus hindering group collaboration (Ge, Yamashiro, & Lee, 2000; Ragoonaden & Bordelrau, 2000). The impact of technology problems is more serious and urgent in an intensive than a regular semester online course because the short time span of the intensive course leaves little room for technical problem-solving and skill fostering. To efficiently develop students' competence and comfort with technology, designing an easily accessed, user-friendly technical support system should be the foremost consideration for the design of an intensive online course.

**Learning and supports**

As noted by the constructivist theories, meaningful learning must be student-centered and involve authentic learning tasks requiring cognitive information processing and knowledge construction via collaboration and social interaction (Jonassen, 2004). Jonassen and Howland (2004) also indicated that providing the learners with meaningful and consequential tasks can help form and foster learning communities (p.72).

Since the nature and complexity of a task has a direct influence on group collaboration and communication, selecting a learning task is one of the most critical considerations for online course design. Constructivist-oriented tasks have the potential to promote meaningful learning, interpersonal and teamwork skills, and higher level thinking skills, but they demand more time for learning and collaboration. On the other hand, objectivist-oriented tasks require less time and social support and thus can be achieved more efficiently but the learning is less meaningful.

To maximize successful online learning, a learning support system offering rich resources, guidance and assistance from the instructor, experts, and peers should be provided. In addition, a social support system must be made available so that members of the learning community trust each other and feel comfortable in sharing knowledge, feelings, experiences, values and goals.

In all, there are three major components involved in online learning: technology, content, people (instructor, students, experts, etc.). Students (Ss) construct knowledge by interacting with people and content through the use of technology to complete the learning tasks. To optimize learning outcomes, each component must be sustained by it own support system - technical support system for technology, learning support system for content, and social support system for people. The selection of instructional design strategies should reflect a balanced consideration between time constraints and meaningful learning. With these thoughts in mind, a support-oriented learning environment was conceptualized (see Figure 1) to guide the design of an intensive online course.

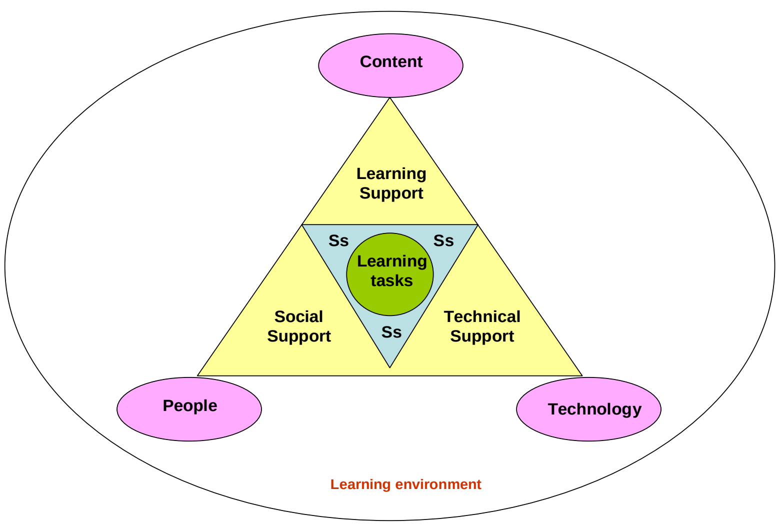


Figure 1: Conceptual framework for support-oriented online learning environment

**About the course**

The course was a three-credit 100% online course for graduate education majors regarding the integration of technology in the K-12 curriculum. The course was originally offered as a regular semester online course by a university in the north-central region of the United States. However, to meet the demand for the course, the course was redesigned to fit into a five-week summer session schedule which was then offered in both short summer sessions in addition to the regular semester offering. The course was housed in an online course management system (CMS) developed by the university. The CMS offered course design and communication tools and online technical support resources.

## Course design specifications

The summer course design was based on the same instructional goals for the regular semester course. However, to adapt to the shorter time frame, the course redesign used a blended approach combing constructivist and objectivist views of learning for the design of learning tasks, activities, and the three support systems (technical, learning, and social) with an aim at meaningful and efficient learning in a supportive environment.

### Instructional design principles based on the blended approach

- Meaningful learning - Adopting the constructivist approach, this course used authentic problem-based learning tasks associated with practical context so that the learning experience can be applied to the real world.
- Efficient learning - Applying the objectivist approach, the course design increased scaffolding by providing more clear and detailed guidance and instruction and assigning group-supported individual projects rather than group projects to accommodate time-limit.
- Supportive learning - Instructional strategies based on constructivist and objectivist approaches were employed for the design of technical, learning and social supports so that students would feel comfortable with the technology, content, instructor and fellow students.
  - Technical support -
    - Providing easily-accessed user-friendly technology resources such as job aid, FAQ, university technology helpdesk contact information, and CMS tech support site.
    - Providing efficient technical training.
    - Creating an "S.O.S." forum for the class members to ask and receive help from the instructor and other students regardless of technical or learning issues.
  - Learning support
    - Selecting meaningful, practical and feasible tasks requiring a reasonable amount of cognitive challenge.
    - Using group-supported projects.
    - Providing rich instructional resources such as worked examples, FAQ, Internet resources, online library, online experts, online and offline instructor office hours.
    - Providing more structured instructional materials and instructional guidance whenever needed.
  - Social support
    - Forming a collaborative online learning community using the following strategies:
      - Informing students of the value of collaboration.
      - Assigning grade to team contribution.
      - Helping develop group norm, i.e. appropriate netiquette, online communication, value of collaboration, and group role and responsibility.
      - Embedding collaboration and interaction in group-supported projects.
      - Encouraging collaboration and interaction among group members to gain multiple perspectives and solutions.
      - Providing opportunities for social presence and interaction.

### Pre-instructional (Orientation)

Given the time constraint of an intensive course, preparing the students for online learning prior to formal instruction is critical and has a direct impact on the success of online learning, especially for those who are new to online learning. A course orientation was offered to build students' readiness for online learning (Hughes et al. 2002). The strategies used for the design of course orientation included the following:

- provide meaningful and efficient technical training
- provide an easily-accessed user-friendly technical support resources
- embed orientation assignments in technical training
- provide knowledge about collaboration and interaction
- familiarize students with the course, instructor, and students
- initiate learning community building

*Comfort and trust with technology (an example of technical support system)*

In addition to the online course management system (CMS) support site provided by the university, the instructor employed objectivist instructional strategies to design the following easily-accessed and user-friendly resources to be included in the technical support system:

- A step-by-step "how-to" job aid for each of the tools required by the course.
- A customized online technical training module focusing only on the communication and production tools needed by the course. This saved students' time from completing the entire CMS tutorial.
- A pre-instruction survey regarding their technical skill and professional background.

*Comfort and trust with instructor and other students (an example of social support system)*

As part of the course orientation activities, students were asked to study the information on the orientation page regarding how to collaborate and interact with each other using appropriate netiquette. In order to get acquainted with each other, students were required to post a self-introduction message to the "Hello!" social forum and to respond to their peers' postings and to upload their digital photo to their designated student profile page. This activity initiated the social presence and interaction of the class members as a learning community.

*Comfort with the course (an example of learning support system)*

Providing students with course expectations and content map can help organize their study plan. Informing students of the required prerequisite will help connect their existing cognitive structure with the new content information (Mohamed, 2004). This information was included in both the orientation and the syllabus pages. Students were required to read this information to get familiar with the course. Students were also asked to send the instructor their expectations of the course via CMS e-mail attachment to let the instructor know students' needs.

**Instruction**

*Learning tasks*

McGrath's Task Circumplex (1984) classifies group tasks into four categories, each containing two task types: generate (type 1 and 2), choose (type 3 and 4), negotiate (type 5 and 6), and execute (type 7 and 8).

Group and individual time spent on task and learning activities should be determined and considered when designing an online course (Barrows, 1996; Savery & Duffy, 1995). Taking the time constraint and the goals of the course into account, three types of McGrath's tasks were adapted for the design of the learning tasks: Type 1- Planning Tasks (generate action-oriented plans), Type 2- Creativity Tasks (generate creative ideas), and Type 3- Intellective Tasks (choose correct answers to solve problem). Although all three task types are suitable for group collaborative projects, task type 1 and 2 were used for group-supported individual projects while type 3 was used for individual projects.

The constructivist instructional principles used to guide the design of generative tasks (types 1 and 2) include anchoring all learning activities to a larger task, using authentic tasks in a real-world setting with meaningful context, using complex tasks requiring thinking and judging, and allowing multiple perspectives and solutions (Savery & Duffy, 1996). For the intellective tasks, objectivist instructional principles were used to prescribe clear and detailed instruction and assessment based on well-defined goals and objectives. The culminating task was a group-supported project requiring an integration of skills learned from all previous units which consisted of both generative and intellective tasks.

An example of a group-supported individual project would be creating a course plan integrating Internet and computer technology into the instruction of the course for a subject area and grade level of the students' choice. Students were asked to use the school where they were employed as the problem context if applicable; otherwise, a case scenario simulating a real-life situation would be supplied by the instructor. There were only appropriate but no standard correct answers. In order to create a meaningful and effective course plan, students had to know how to conduct an effective web search for appropriate resources to be used in the plan, devise an instrument to evaluate the quality of web resources, write the evaluation report, and develop a technology integration plan. An example of an individual project would be writing a website evaluation report which was based on the result of an absolute rating scale and some narrative comments.

*Learning activities*

Forming groups is one of the most important activities related to the success of a collaborative problem-solving experience (Bridges, 1992; Slavin, 1995 in Nelson, p. 259). Small groups of at least three and no more than six have been shown to be the most effective size (Bruffee, 1993; Johnson & Johnson, 1997; Putnam, 1997). Heterogeneous grouping promotes diversity, multiple perspectives, interpersonal skill, and team work (Nelson, 1999).

To avoid wasting time on coordinating group members and their share of work, group-supported individual projects were assigned instead of group projects. To accomplish the group-supported assignments, a learning community of the class was organized by project groups, each consisting of three to four students with different backgrounds (whenever possible) assigned by the instructor based on the results of the pre-instruction survey.

Group members were required to contribute ideas during project brainstorming discussion, and then each student worked on his/her own individual projects. In addition to instructor's review, students were also required to review and comment on other group members' draft projects to help improve the quality of the work and to learn from each other before final submission of the projects. Students were made aware that their contribution to the group would be graded. With such an arrangement, students were working on their own projects while still contributing to the group and interacting with other group members and the instructor. The learning community remained active and supportive.

**Post-instruction (Assessment)**

The assessment of students' learning product was based on the objectivist goal-based evaluation. Clear and detailed assignment specifications, including purpose of the assignment, submission procedure, due date, and rubric for grading criteria were provided. A constructivist approach, requiring the students to write a final reflection paper, was used for learning process assessment.

## Course evaluation

At the end of the course implementation, a summative evaluation was conducted to answer the following questions:

1. What were students' feelings, attitudes and opinions about their learning experience of this course?
2. How did the course designs influence students' process and product of learning?

**Data and analysis**

- Students' response to the course evaluation administered by the university (11 participations with returning rate 100%).
- Students' exit reflections
- Students' project results

The course evaluation surveyed students feelings, attitudes, and opinions about their learning experience of this course using 38 items of 5-point rating scale (4-Strongly agree, 3-Agree, 2-Undecided, 1-Disagree, 0-Strongly disagree) and 7 open-ended items. 11 students enrolled the course and the return rate for the course evaluation is 100%.

A descriptive data analysis procedure was performed to analyze students' average response rates to the course evaluation. The content of the exit reflections and open-ended items in the course evaluation were analyzed qualitatively using content analysis based on the categories of most and least valuable aspects of the course, most and least liked course activities, and the overall learning experience with the course.

**Results**

The quantitative analysis results of the closed-ended items in the course evaluation are reported in table 2.

Table 2: Results of students' feelings, attitudes and opinions about course learning experience

| Item description | Mean | SD |
|---|---|---|
| Feelings about the quality of the course | 3.60 | .06 |
| Feelings about the learning experience | 3.87 | .06 |
| Opinions about the design of learning tasks, activities & instruction | 3.68 | .26 |
| Opinions about the instructional methods used by the instructor | 3.73 | .20 |
| Opinions about the value of personal and professional development | 3.6 | .06 |
| Attitudes about group-supported collaborative learning | 3.64 | .13 |

The content analysis results are classified into the categories of most and least valuable aspect of the course, most and least liked learning activities, and overall learning experiences of the course. Table 3 reports the analysis results together with the excerpts.

Table 3: Results of content analysis of course evaluation and exit reflections

| ***Categories*** | ***Excerpts*** |
|---|---|
| Most valuable aspects of the course:<br>1. Authentic projects<br>2. Instructor's feedback<br>3. User-friendly technology | "the final project."<br>"the rubrics."<br>"Kinesthetic experience with technology and Internet projects."<br>"Instructor feedback on course project."<br>"The instructor was very helpful in holding us to where she wanted us to be!"<br>"The simple use of the computer and the Internet to accomplish what was needed for this class." |
| Least valuable aspects of the course:<br>1. Readings | "The readings to me were not very valuable."<br>"Too much lecture readings." |
| Most liked class activities:<br>1. Working on class projects<br>2. Working with group<br>3. Working with diverse students<br>4. Online discussion and chat | "I liked the projects we did."<br>"I liked learning the process for designing Internet lesson."<br>"I enjoyed taking classes with people from all over the world."<br>"I enjoyed working with a wide variety of students from different regions within the USA and even different countries."<br>"I also appreciated the diversity of the classmates."<br>"I really enjoyed the interaction of the students about our projects. It helped me to refine my thoughts."<br>"I enjoyed the online chat with my group members."<br>"I liked how groups were set up to help each other and that groups could arrange their own meeting time to do online chat discussions that suited EVERYONE'S needs." |
| Least liked class activities:<br>1. Working with CMS<br>2. Developing rubrics | "I did not like the fact that we could not access the announcements during assignments, or to upload a file was had to jump completely out and then get back in."<br>"I HATE doing rubrics." |
| Overall learning experience with this online course:<br>1. Great<br>2. Wonderful<br>3. Enjoyed<br>4. Fruitful | "The course was great overall."<br>"My learning experience was wonderful. I really learned a lot through actually doing and experiencing the things we were learning about."<br>"I learned something each lesson and did not feel my time was wasted. I will use this stuff at work."<br>"It was a good experience for me and helped me to think outside the usual box for learning something new."<br>"I learned a great deal about evaluating Web sites. I also learned how to make up my own Internet-based program which was very interesting."<br>"I am very happy with this course."<br>"I enjoyed the course work and the development of |

| | |
|---|---|
| | new items and plans.” |

**Discussion and Conclusion**

Students’ ratings on the course evaluations showed that they are highly satisfied with the course as well as their learning. The content analysis results of course evaluation and exit reflections revealed that students in general valued the authentic projects, instructor’s feedback, and user-friendly technology the most. Although a couple of students commented on the amount and the necessity of the readings in the lecture, majority of the students thought the readings aided to their understanding of the subject and built knowledge foundation for project assignments.

The class activities that the students liked the best were working on class projects, working with groups, working with diverse students, and online discussion and chat. One student disliked the access procedure of the CMS and the other student did not enjoy the development of rubrics for the lesson plan. The overall learning experience with this course was very positive across the entire class. They enjoyed the learning experience and felt they learned a lot within the short-time frame without feeling the pressure.

The quality of students’ product for each unit was assessed against a rubric in which grading criteria were clearly specified. This scaffolding strategy helped guide the students’ attention to the important aspects of the product. Eight of eleven (73%) students received an A and three (27%) received an A minus for the course grade.

In conclusion, the evaluation results support the use of a blended approach combing objectivist and constructivist instructional strategies for the design of an online course when it is pressed by time. The following guidelines may help design effective intensive online courses:

1. Ensure students’ comforts with technology, content, and people by providing technical, learning, and social supports.
2. Use the orientation activities to prepare for students’ readiness for online learning in terms of technology, instructional content, and collaboration.
3. Balance between the individual and group collaborative activities.
4. Provide learning tasks that are meaningful and manageable in a given time frame.
5. Provide clear and concise instructional content and assignment specifications.
6. Provide timely feedback and more scaffolds to assist learning.

**References**


Bonk, C. J., & Cunningham, D. J. (1998). Searching for learner-centered, constructivist, and socio-cultural components of collaborative learning tools. In C.J. Bonk & King, K.S. (Eds.), *Electronic collaborators: Learner-center technologies for literacy, apprenticeship, and discourse*. Mahwah, NJ. Lawrence Erlbaum Associates, Inc.

Cavanaugh, J. (2005). Teaching online - A time comparison. *Online Journal of Distance Learning Administration*, *8*(1), 2005. Retrieved June 14, 2005, from http://www.westga.edu/~distance/ojdla/spring81/cavanaugh81.htm

Cooney, D. H. (1998) Sharing aspects within aspects: real-time collaboration in the high school English classroom. In C.J. Bonk & King, K.S. (Eds.), *Electronic collaborators: Learner-center technologies for literacy, apprenticeship, and discourse*. Mahwah, NJ. Lawrence Erlbaum Associates, Inc.

Duffy, T. & Jonassen, D. (1992). Constructivist and the technology of instruction: A conversation, Hillsdale, NJ: Lawrence Erlbaum Associates, 1-16.

Duffy, T.M., & Cunningham, D. J. (1997). Constructivism: Implications for the design and delivery of instruction. In David Jonassen (Ed.). Handbook of research in education, communication, and technology. New York: Macmillan.

Duffy, T.M., & Savery, J.R. (1994). Problem-based learning: An instructional model and its constructivist framework. In Brent G. Wilson (Ed.) Constructivist learning environments: Case studies in instructional design. Englewood Cliffs, NJ: Educational Technology Publications.

Ge, X., Yamashiro, K., & Lee, J. (2000). Pre-class planning to scaffold students for online collaborative learning activities. *Educational Technology and Society*, *3* (3), 1-16.

Hannafin, M., Land, S. & Oliver, K. (1999). *Open learning environments: Foundations, methods, and models*. In C. Reigeluth (Ed.), Instructional design theories and models: A new paradigm of instructional theory (Vol. II), New Jersey: Lawrence Erlbaum Associates, 115-142.

Hughes, S., Wickersham, L., Ryan-Jones, D., & Smith, S. (2002). Overcoming social and psychological barriers to effective on-line collaboration. *Educational Technology & Society*, *5*(1), 86-92.

Jonassen, D. (1999). *Designing constructivist learning environments*. In C. Reigeluth (Ed.) Instructional design theories and models: A new paradigm of instructional theory (Vol. II), New Jersey: Lawrence Erlbaum Associates, 215-239.

McGrath, J.E. (1984). Groups: Interaction and performance. Englewood Cliffs, NJ: Prentice Hall.

Moallem, M. (2003). An interactive online course: A collaborative design model. *Educational Technology Research and Development*, *51*(4), 85–103.

Mohamed, A. (2004). Foundations of educational theory for online learning. In T. Anderson, & T. F. Elloumi (Eds.), Theory and practice of online learning, Athabasca University: Canada. Retrieved May 15, 2005, from http://cde.athabascau.ca/online_book/ch1.html

Morrison, D. (2003). Using activity theory to design constructivist online learning environments for higher order thinking: A retrospective analysis. *Canadian Journal of Learning and Technology*, 29(3). Retrieved March 1, 2005, from http://www.cjlt.ca/content/vol29.3/cjlt29-3_art2.html

Nelson, L.M. (1999). *Collaborative problem solving*. In C. Reigeluth (Ed.) Instructional design theories and models: A new paradigm of instructional theory (Vol. II), New Jersey: Lawrence Erlbaum Associates, 241-269.

Palloff, R. & Pratt, K (1999). *Building learning communities in cyberspace: Effective strategies for the online classroom*. San Francisco: Jossey-Bass.

Palloff, R. & Pratt, K (2001). *Lessons from the cyberspace classroom: The reality of online teaching*. San Francisco: Jossey-Bass.

Ragoonaden, K. & Bordelrau, P. (2000). Collaborative learning via the Internet. *Educational Technology and Society, 3*(3), 1-16.

Rajandran, V. (2003). A study investigating the impact of web-enhanced learning on student motivation. *CDTL Brief*, *6*(9), 2005. Retrieved June 14, 2005, from http://www.cdtl.nus.edu.sg/brief/V6n9/sec3.htm

Vrasidas, C. (2000). Constructivism versus objectivism: Implications for interaction, course design, and evaluation in distance education. *International Journal of Educational Telecommunication*, *6*(4), 339-361.

# Design of individualized instruction with learning object using Case-Based Reasoning in WBI

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**Abstract**

*This paper designs an intelligent tutoring system for individualizing instruction based on learning style. The system builds on theories from individual differences, case-based reasoning, and learning objects. The prototype is designed to give various learners having different learning styles personalized instruction which is constructed with learning objects in terms of meta-data. Case-based reasoning will be used to diagnose learners' differences and analyze the relationship between learners' achievement and preference. The design is the first step to implement the system.*

## Introduction

Adaptive learning systems as an extension of web-based instruction have been studied by many researchers (e.g., Magoulas, Papanikolaou & Grigoriadou, 2003;  Yacci, 2000 ). It aims to help learners gain their own knowledge structure by personalizing instruction based on individual differences. Individual differences are important to the design of web-based instruction because all learners do not use web-based instruction effectively (Chen, 2003). In previous studies, the construction of individualized instruction appropriate to the learner's characteristics heavily relied on a predetermined design by the researcher. Throughout these studies, the instruction available to the students was static. What has yet to be researched is whether instruction can evolve over time to be a closer match to the individual's difference.

## Theoretical framework

This system is built on a combination of three theories: individual differences, learning objects, and case-based reasoning (CBR). Many studies have been conducted to identify the relationship between learning success and individual differences, such as learning style, cognitive style, and prior knowledge (e.g., Hsu & Dwyer, 2004; Foster & Lin, 2003). Individual differences have had significant statistical effects on student learning in web-based instruction (Hsu & Dwyer, 2004; Rurke & Lysynchuk, 2000). In contrast, other studies reveal that the web has been proven to be an equally effective learning environment for students regardless of individual differences (Aragon, Johnson, & Shaik, 2000; Shih & Gamon, 2002).

To deliver appropriate personalized instruction, an instructional unit should be subdivided so that various levels of difficulty and sequences can be constructed.  The IEEE Learning Technology Standard Committee (LTSC) defines a learning object as "any entity, digital or non-digital that can be used, re-used, or referenced during technology supported learning" (LTSC, 2000). Learning objects are the smallest units within a larger instructional structure (Wiley, 2000), and they can be sequenced and combined as the main components of instruction. In addition, metadata is a resource description about content, quality or features of learning objects (Dillon, 2000). Metadata offers the cataloguing information necessary to share, use and reuse learning objects. Therefore, metadata provides the mechanisms necessary to match learning objects to an individual's characteristics.

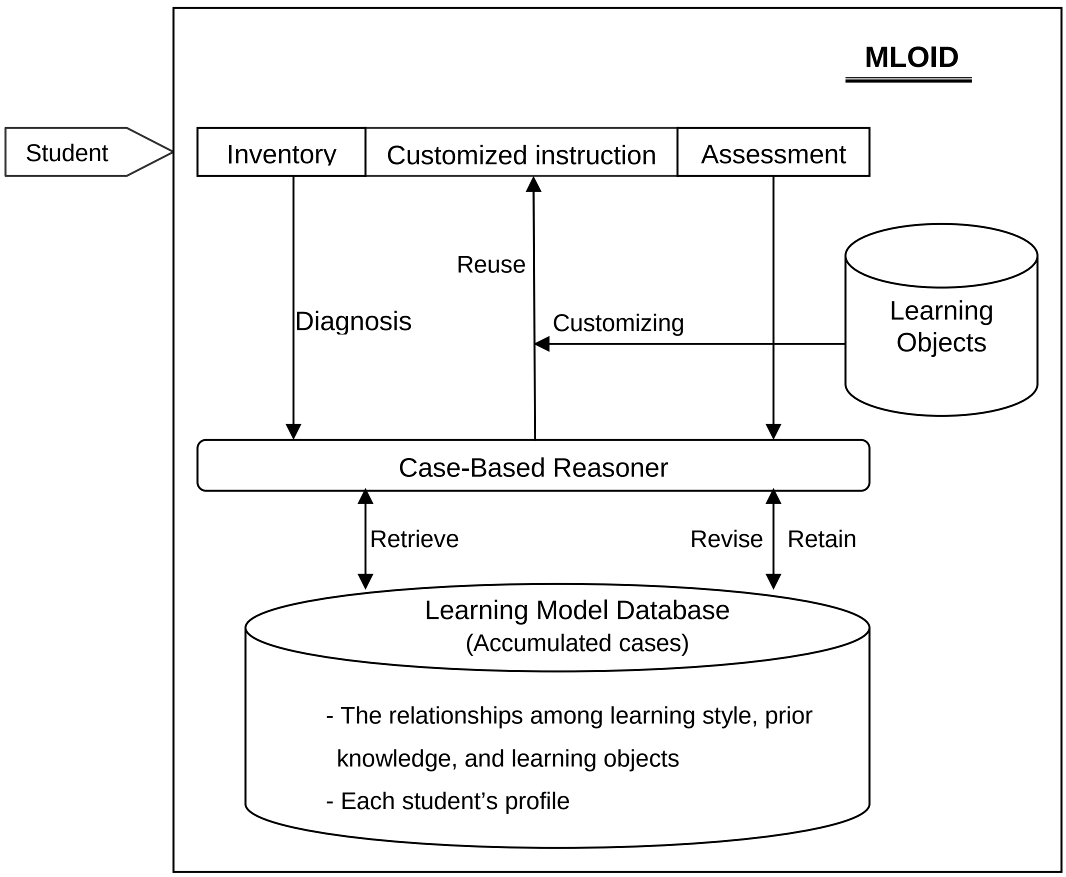
One method of building instruction using learning objects relies on CBR. CBR is based on human intuition in which new problems are often similar to previously encountered problems; therefore, past solutions may be used in the current situation. In 2002, Mamaghani described the process of CBR comprising four Re's: (1) retrieve the most similar case, (2) reuse the case to attempt to solve the problem, (3) revise the proposed solution if necessary, and (4) retain the solution as part of a new case. CBR has been applied to educational realms as an answering system in distance learning (Tsinakos, 2003), problem-solving emulation (Sormo & Admodt, 2002), and the Knowledge Innovation for Technology in Education (KITE) project (Moore, Means & Kim, 2004). The case-based reasoner can play an important role in making instruction individualized because it can make effective decisions based on previous cases.

## Prototype of the system

The proposed prototype of Matching Learning Object to Individual Differences (MLOID) system focuses on delivering the most effective instruction by using case-based reasoning (CBR) based on an accumulated database.

The instruction in the system consists of learning objects associated with metadata. The MLOID system is designed to determine a learning style of a learner and offer appropriate learning objects to a student in accordance with his learning preference and prior knowledge using case-based reasoning. All learning processes and achievement will be recorded as cases according to each learner and learning style. The case-based reasoner will use the cases as a reference to make appropriate instruction when a previous learner returns to study but also when a new learner begins to study.

The MLOID system consists of diagnosis, the case-based reasoner, the learning model database, the learning objects database, customized instruction, and assessments as depicted in figure 1. The diagnosis of learning style for MLOID determines one of four characteristics of learning styles: imaginative, dynamic, analytic, or common sense based on McCarthy's (1990) 4MAT system. Another diagnosis determines the learner's prior knowledge. The case-based reasoner refers to cases in the learning model database. The learning model database accumulates cases of students' profiles and previous customized instruction. The reasoner determines an instructional unit which is applicable to the student's learning style and prior knowledge. After an appropriate unit is selected, learning objects are retrieved as necessary to generate the customized instruction. Finally, as assessments are completed throughout the instructional unit, the student's profile is revised and retained in the learning model database.




[Figure 1] The architecture of the MLOID system

In addition to the instructional content, the aim of the MLOID is to offer a student appropriate instruction with a customized interface and navigation comprised of learning objects so it will maximize learning achievement for each individual.

In order to focus on the individualization, the system must have three basic algorithms in the case-based reasoner: matching a standard of learning style to a characteristic of various learning objects, selecting relevant levels of learning objects according to the learner's prior knowledge, and developing dynamic instructional web pages comprised of learning objects based on the previous two analyses. When a student first logs in to the system, the student is asked to answer an inventory which diagnoses a learning style and prior knowledge. The case-based reasoner analyzes the diagnoses for congruence with previous cases, and the system selects necessary learning objects. The learner receives their customized instructional unit with customized interface and navigation comprised of the learning objects.

In a basic CBR process, the system retrieves a successful learning case of learning objects that is most efficient to the characteristics detected by the diagnosis. The high ranked case is reused to make an instructional unit. After conducting the unit, the case is revised and retained by the case-based reasoner based on the result of assessment. In this step, the system accumulates not only a record of the individual's progress but also the relationships among learning style, prior knowledge, and learning objects as a new case, adding to the learner's profile. The new profile is used as a basis of reasoning to decide whether the same kind of instructional unit will be offered when the learner needs feedback or moves to next step. In addition, the accumulation of cases will be helpful in making instructional units for other individuals.

## Future work

Case-based reasoning can make a web-based instructional system evolve into effective decision-making system, referencing an accumulated database. However, there are considerations in developing the system. First, it should be thoroughly analyzed which learning style model is applicable to the MLOID system. Second, CBR algorithms of matching learning objects should be developed. Third, an effective relational structure of database is needed. Last, classifying the granularity of learning objects in metadata should be considered. Further explanation about the implications and limitations of implementation will be provided in the presentation.

## References


Aragon, S. R., Johnson, S. D., & Shaik, N. (2000, November). *The influence of learning style preference on student success in online vs. face-to-face environment*. Paper presented at WebNet 2000 World Conference on the WWW and Internet, San Antonio, TX.

Chen, S.Y. (2003). Editorial: Individual differences in web-based instruction – an overview. *British Journal of Educational Technology*. *34*(4), 385-92.

Dillon, M. (2000). *Metadata for web resources: How metadata works on the web*. Paper presented at the Bicentennial Conference on Bibliographic Control for the New Millennium: Confronting the Challenges of Networked Resources and the Web, Washington, DC.

Foster, J., & Lin, A. (2003). Individual difference in learning entrepreneurship and their implications for web-based instruction in e-business and e-commerce. *British Journal of Educational Technology, 34*(4), 455-465.

Hsu, P. S., & Dwyer, D. (2004). Effect level of adjunct questions on achievement of field independent/dependent learners. *International Journal of Instructional Media, 31*(1), 99-106.

McCarthy, B. (1990). Using 4MAT system to bring learning styles to schools. *Educational Leadership, 48*, 31-37

Mamaghani, F. (2002). Information technology knowledge sharing using case-based reasoning. *Information Systems Management, 19*(4), 13-20.

Magoulas, G. D., Papanikolaou, K., & Grigoriadou, M. (2003). *Adaptive web-based learning: Accommodating individual differences through system's adaptation*. British Journal of Educational Technology, *34*(4), 511-27.

Moore, J. L., Means, T., & Kim, B. (2004). *Applying case-based reasoning principles within a technology integration learning environment*. Retrieved November 28, 2004, from the University of Missouri-Columbia, School of Information Science & Learning Technologies Web site: http://tiger.coe.missouri.edu/~tile2003/others/CBRandTILE.pdf

Rurke, L., & Lysynchuk, L. (2000, April). *The influence of learning style on achievement in hypertext*. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, LA.

Shih, C. C., & Gamon, J. A. (2002). Relationships among learning strategies, patterns, styles, and achievement in web-based courses. *Journal of Agricultural Education*, *43*(4), 1-11.

Sormo, F. & Aamodt, A. (2002). Knowledge communication and CBR. *In Proceedings of 6th European Conference on Case Base Reasoning.* Aberdeen, Scotland.

Tsinakos, A. A. (2003). Asynchronous distance education: Teaching using case based reasoning. Turkish Online Journal of Distance Education, 4(3). Retrieved November 28, 2004, from http://tojde.anadolu.edu.tr/tojde11/index.htm

Wiley, D. A. (2000). *Learning-object design and sequencing theory*. Unpublished doctoral dissertation, Brigham Young University.

Yacci, M. (2000). Interactivity Demystified: A Structural definition for distance education and intelligent computer-based Instruction. *Educational Technology, 40*(4), 5-16.

# A Predictive Model of Teaching Practice, Student Characteristics and Science Problem-solving in Middle School

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**Abstract**

*Problem-based learning is increasingly being recognized as an effective approach for teaching science. Using KaAMS (Kids as Airborne Mission Scientists) – a website that provides contextualized problem-based learning lesson plans – this study examines the interrelationship between teacher characteristics and teaching practice, student characteristics (including problem-solving skills) and the rate of use of KaAMS (the number of KaAMS lessons used in a class). Based on an extensive review of literature, a model that predicts middle school student problem-solving skills based on student and teacher characteristics and teaching practice is presented.*

## Introduction

Problem-solving skills have increasingly been recognized as a desired outcome of learning that should be developed through K-12 education. According to Mayer (1989), "problem-solving skills should be learned within the context of realistic problem-solving situations. Instead of using drill and practice on component skills in isolation – as suggested by the skill-based approach – a metaskill based approach suggests modeling of how and when to use strategies in realistic academic tasks" (p. 53).

Research has established Problem-Based Learning (PBL) as a powerful and effective approach to science teaching. PBL has been found to help students develop deep understanding of content knowledge and improve their problem-solving skills by situating learners in real world problem-solving contexts (Edens, 2000; Lovett, 2002; Taconis, Ferguson-Hessler, & Broekkamp, 2001; Voss, 1989). At the same time, disadvantages and limitations of the PBL approach have been identified (Johns, 1996).

In the past few years, the web has become a popular medium for sharing PBL instruction. However, lacking the solid evidence for supporting the possibility of using the Internet as a medium for sharing PBL instruction, there is a growing need to understand the impact of web-based PBL environments in facilitating the development of problem-solving skills. As a result, this study is interested in the impact of web-enhanced PBL environments on student problem-solving skills.

There is an abundance of research in science education that investigates students' problem-solving skills. Several studies have been conducted that investigate the impact of individual student variables on student's problem-solving skills – for example studies that investigate the relationship between metacognition and problem-solving skills (Alexander & Judy, 1988). There are also studies that investigate the relationship between individual teacher characteristics and student problem-solving skills (Taconis, et al, 2001). Yet, there is currently no model in PBL literature that includes all of the above mentioned student and teacher characteristics. Consequently, in order to further understand how different variables are interrelated with problem-solving skills, this study also aim to build a predictive model in PBL that elaborates the interrelationships between various variables and problem-solving skills.

## Purpose of the Study

This study will investigate the impact of a web-enhanced PBL curriculum on student problem-solving skills. In addition, this study also aim to develop a model that relates middle school students' problem-solving skills with their characteristics, the characteristics of their teachers, teaching practice, and the rate of use of PBL curriculum.

A web-enhanced PBL curriculum, KaAMS (Kids as Airborne Mission Scientists), will be used in this study. It was developed, in collaboration with NASA, to facilitate the development of problem-solving skills in middle school students and also to inspire them to pursue careers in science, math, technology, and geography.

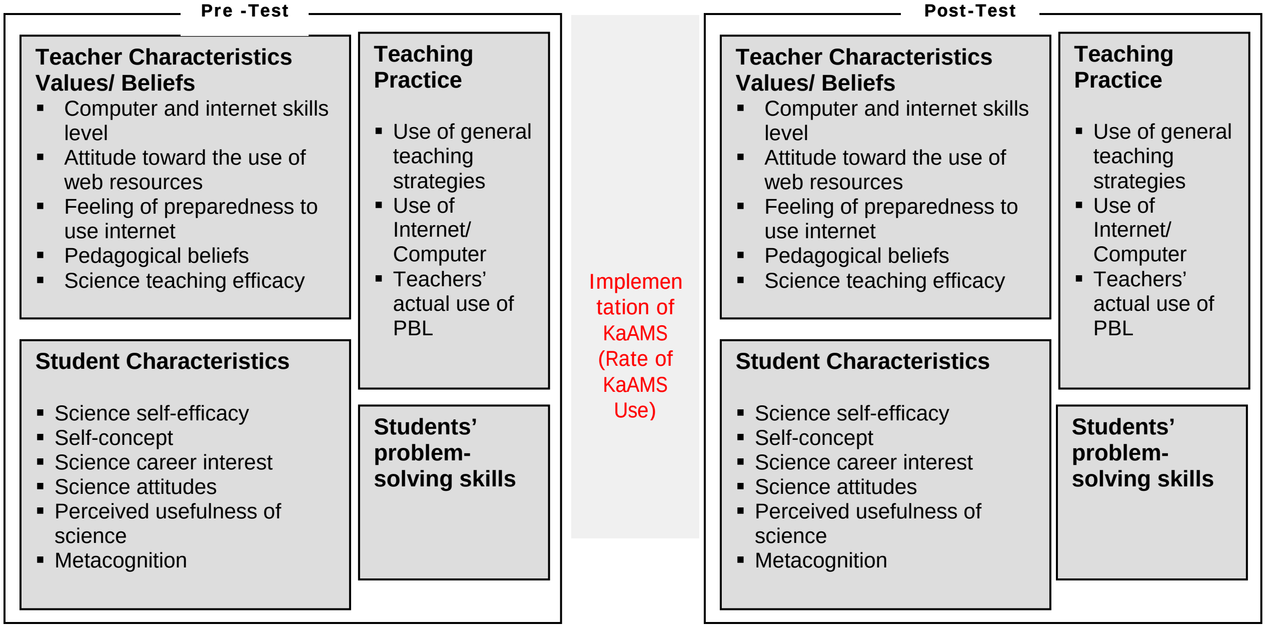
**Research Questions**

The overarching research question of this study is "***What is the relationship between the rate of use of KaAMS, teacher characteristics and teaching practice, and student characteristics including general problem-solving skills?***"

More specifically, this research investigates the following:

1. Does KaAMS have an impact on teacher characteristics (computer and Internet skills level, attitude toward the use of web resources, teachers' feeling of preparedness to use computers and the Internet, pedagogical beliefs toward PBL, teachers' science teaching efficacy) and teaching practice (use of general teaching strategies, use of Internet/computer, and teachers' actual use of PBL)?
2. Does KaAMS have an impact on student characteristics (science self-efficacy, self-concept, science career interest, science attitudes, perceived usefulness of science, metacognitive, and gender) and general problem-solving skills?

Following is the research model that includes all the variables this research will be investigating.




## Research Methodology

Our plan is to conduct this research at the national level. Middle school teachers and students from all over the country will be recruited to participate in this research. Teachers will be asked to use KaAMS curriculum materials in their classroom and complete surveys before and after the classroom trials. Students will also be asked to complete student characteristic surveys (again before and after classroom use of KaAMS).

This data will be used to develop a model that relates the rate of use of KaAMS (number of KaAMS lesson used by a teacher) with teacher characteristics, teaching practice, and student characteristics (including general problem-solving skills). Factor analysis methods and Structural Equation Modeling techniques will be used to analyze the data and build a model.

## Review of Literature

**Student Variables**

Several student characteristics that might influence student's problem-solving skills have been identified from relevant literature. These variables include science self-efficacy, science self-concept, science attitude, perceived usefulness of science, science career interest and metacognition. In this session problem-solving skills will first be introduced followed by definition of each aforementioned factor and their relationships with other variables. In addition, a diagram depicting how variables relate to each other will be presented.

**Performance on Problem-solving Tasks**

In literature, performance on problem-solving tasks is seen as a function of both *domain specific knowledge* (knowledge base: declarative, procedural, or conditional knowledge) and *strategic knowledge* (problem-solving skills base). For example, a meta analysis of problem-solving (Alexander & Judy, 1988) investigate the interaction between domain-specific knowledge and strategic knowledge. Based on an extensive review of literature (research that covers a range of age groups, domains and methodologies) they propose several hypothesis about this interaction: (a) domain-specific knowledge is requisite to the effective utilization of strategic knowledge, (b) strategic knowledge is required for acquisition of domain knowledge, (c) "ill-formed or unintelligent use of strategies can be detrimental to learning" (p. 390), and (d) "as knowledge of domain increases strategic processing is altered" (p. 391).

**Problem-solving Skills**

Problem-solving skills are defined as skills that are required to successfully perform a problem-solving task. These skills include problem representation, strategies of working out a problem, monitoring of the solution process, as well as the evaluation of the execution of the problem (Flavell, 1976)
Alexander and Judy (1988) have called problem-solving strategies a "special form of procedural knowledge that can exist in varying degrees of generality or separation from specific domains." They define problem-solving strategies as "goal directed procedures that are planfully or intentionally evoked either prior to, during or after the performance of a task" (p. 376). Voss (1989) makes the following observation about general problem-solving abilities: "It has been proposed that there are general problem-solving strategies (i.e., strategies that are applicable in a large number of contexts), and that such strategies should be taught in school." (p. 276).

**Dimensions of Problem-solving Skills**

Taconis and his collogues (2001) characterize problem-solving skills on two dimensions — general–specific on the one hand and simple–complex on the other. The authors provide the following examples:
a) General–Specific dimension: General skills are skills that "cannot be exclusively related to one specific schema in the knowledge base. …General skills can be related to the general activities of the problem-solving strategy, such as analyzing, planning, and doing calculations. Another group of general skills required in science problem-solving comprises thinking skills, such as proportional reasoning (Grayson, 1996, 1997) and skills in building an adequate mental representation out of the schemata available (Savelsbergh, 1998)." (p. 447). Specific skills are "domain specific and related to procedures belonging to a problem schema (Chi, Feltovich, & Glaser, 1981; Taconis, 1995)" (p. 447).
b) Simple–Complex dimension: "Some skills are complex – for instance, building a representation of a given situation; while others are simple – for instance, checking that no information given is forgotten" (p. 447).

**Metacognition**

The relationship between problem-solving skills and metacognition has been frequently investigated. In fact we note that some researchers view problem-solving skills as metacognitive knowledge. For example, Alexander and Judy (1988) consider met cognitive knowledge to encompass knowledge of self, knowledge of task, and knowledge of strategies. Flavell (1976) defines metacognition as "one's knowledge concerning one's own cognitive processes and products or anything related to them. …Metacognition refers, among other things, to the active monitoring and consequent regulation and orchestration of these processes in relation to the cognitive objects or data on which they bear…" (p. 232).

**Relationship between Problem-solving Skills and Metacognition**

Sternberg (1998) suggests that metacognition is an important part of the abilities that lead to student expertise. For example, he has written that expertise involves "(c) spending proportionately more time determining how to represent test problems than they do in search for and in executing a problem strategy; (d) developing sophisticated representations of test problems, based on structural similarities among problems; … (f) generally choosing a strategy based on elaborate schemas for problem strategies; … (j) accurately predicting the difficulty of solving particular test problems; (k) carefully monitoring their own problem-solving strategies and processes;" (p. 133). Sternberg argues that these aspects of expertise in problem-solving directly involve metacognition. (Mayer,

1998) distinguishes between skill, meta-skill and will. He defines meta-skill as a problem solver's ability to control and monitor cognitive processes. Mayer writes that "metacognition – in the form of metaskill – is central in problem-solving because it manages and coordinates the other components" (p. 53).

**Science Self-efficacy**

According to Bandura (1986), self-efficacy is a set of personal beliefs regarding one's capabilities in specific situations and performance domain. That is, self-efficacy is individual's beliefs of how well he or she can successfully execute actions required to accomplish some task (Bandura, 1977). These beliefs are referred to as self-efficacy beliefs, expectations or judgments. In addition, Bandura 's self-efficacy theory asserts that four major sources of information are influential in shaping and modifying self-efficacy beliefs: (a) past performance accomplishments, (b) exposure to and identification with efficacious models (various learning), (c) access to verbal persuasion and support from others, and (d) experience of emotional or physiological arousal in the context of task performance. Past performance accomplishments are generally assumed to be most influential in promoting self-efficacy given that they are based on authentic mastery experiences (Bandura, 1986).

To be more specific, Lent, Brown and Larkin (1986) found that self-efficacy contributed significantly to the prediction of science and engineering grades, persistence and range of career options. Many studies are indicated positive evidences in relating self-efficacy to various variables, especially to student achievement. Recently study is strengthened previous assumptions that the efficacy beliefs have a stronger association with academic performance when compared to self concept as well (Pietsch, Walker & Champan, 2003).

**Science Self-concept**

Self-concept is how people perceive themselves. Super (1963) defined self-concept as the "individual's picture of himself." This picture is shaped by different components such as the roles people play, the situations they are in and the functions they perform. Many research studies examine the relationship between self-concept and student learning, and some of them indicated that general self-concept is not significantly correlated with an individual's achievement when it comes to a specific academic subject (Marsh, Byrne & Shavelson, 1988).
To better explore the relationship between self-concept and student learning in a specific academic subject, academic self- concept has been developed (Shavelson, Hubner, & Stanton, 1976). Marsh (1986) provided an internal-external framework of reference model (I/E model) to explain how academic self-concept has been developed. According to this model, students form their academic self-concept by comparing their perceived performances with those of their classmates in an academic subject area (external reference). They also compared their own performances in one subject with those in other school subjects. For example, students developed their science self-concept by comparing their perceived performances in science with those of their classmates in the science class. They also compared their own perceived performances in since with in other subject area, such as math and English.

In the area of science education, a body of research has investigated how science self-concept influences student achievements as well as other science-related variables. In a ten-year longitudinal study on elementary, junior high and high school students, Simpson and Oliver (1990) found that science self-concept significantly predicted the number and type of future science courses the $10^{th}$ grade students took, which, in turn, led to students' lifelong interests and learning in science.

**Science Attitude**

Science attitude is deemed as a factor that highly affects student science learning and achievement. As a result, science attitude has been studied extensively, but there is no consensus among researchers on what science attitude is consisted of. For example, the instrument developed by Fraser (1978) has been widely used to investigate science attitude. This survey was consisted of seven scales: social implications of science, normality of scientists, attitude toward scientific inquiry, adoption of scientific attitudes, enjoyment of science lessons, leisure interest in science, and career interest in science. To further understand the concept of science attitude, Haladyna and Shaughnessy (1982) examined 49 relevant studies and identified six aspects associated with attitudes toward science in these studies. These aspects included scientific attitudes, attitude toward scientists, attitudes toward a method of teaching science, scientific interests, attitudes toward parts of the curriculum and attitudes toward the subject of science.

In a recent study, Liu, Hsieh, Cho and Schallert (2005) investigated the effect of a problem-based learning environment on middle school students' self-efficacy, attitudes and learning. The results of their study indicated a positive correlation between science attitude and self-efficacy. They suggested that science attitude is positively related to science achievement.

**Perceived Usefulness of Science**

Shell, Murphy, and Buring (1989) defined the perceived usefulness of science as “how does one perceive the importance of science for achieving various life goals”. That is, "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989).

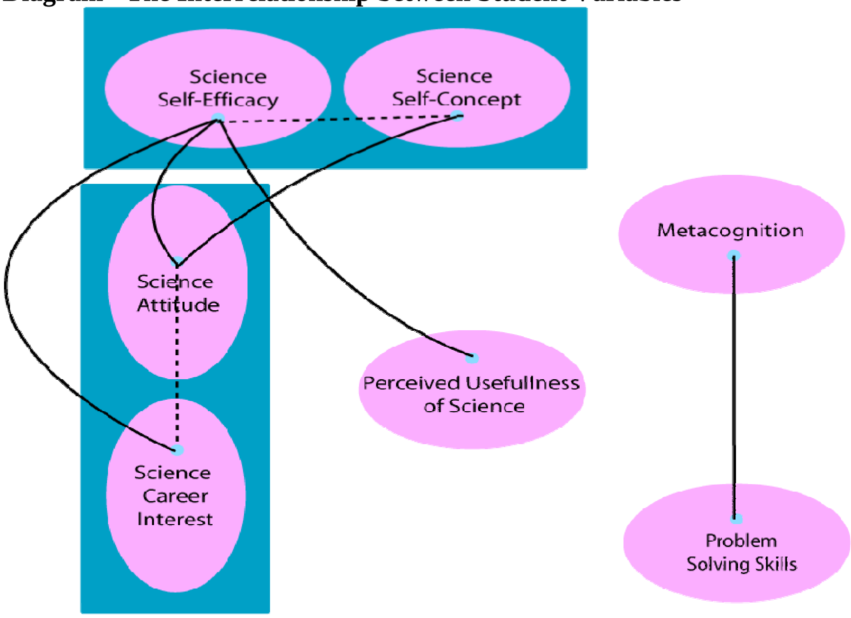
Literature showed that several factors can affect students’ perceived usefulness of science. According to Chipman and Wilson (1985), career expectations and career goals affect the perceived usefulness of mathematics, as may the adequacy of their information about the mathematical requirements of career. As expected, students' perceived usefulness of mathematics is also related to the confidence they express in their ability (Lent, Lopez, & Bieschke, 1991). Overall these studies showed that self efficacy and perceived usefulness are related to achievement.

**Science Career Interest**

Science career interest is enthusiasm or attention for a particular career in science (Super, 1984). It is a learned characteristic that can be developed through students’ participation in interactive learning events with information and people resources. The result of Koszalka’s (1999) research on science career interest in middle school students supports Super’s argument. She found that the levels of science career interest in middle school students were positively related to the richness of information through human and web resources.

To promote students’ science career interest, research indicated that efforts should be made on different aspects. When students lack interests in science, additional mandatory science courses will not likely enhance the development of their interests. Creating a classroom environment that nurtures students’ interests, curiosity and confidence in their own abilities might be more effective in encouraging the increase of career interest in science (Mason & Kahle, 1988). In Lent, et al’s (1991) study, they suggested self-efficacy was significantly related to the interests. They argued that there is a reciprocal relationship between self-efficacy and interest. Accordingly, science career interest can be promoted by enhancing self-efficacy. In addition, certain instructional and behavioral intervention strategies seem conducive to helping student pursue science courses and science-related careers (Mason & Kahle, 1988).

**Diagram - The Interrelationship between Student Variables**




**Teacher Variables**

Teachers’ teaching practices inarguably have strong influence on student learning. By performing effective teaching strategies, the teacher can contribute a lot to the development of students’ problem-solving skills and abilities. Problem-based learning uses constructivist paradigm to support its framework, so in this part of the article, we focus on some teaching practices that are significant to constructivist teaching strategies. The teaching practices of interest are use of computers and the Internet, use of PBL and use of general teaching strategies. From the literature, we identify the following relevant teacher characteristics that can influence these teaching practices: teachers' computer and Internet skills, attitude toward the use of web resources, feeling of preparedness toward the use of computer and the Internet, pedagogical beliefs and science teaching efficacy. Since one of our research goals is to see how the rate of KaAMS use will influence these variables, we expect to develop a model that suggests how to encourage teachers employ more of problem-based learning approach in their classroom.

**Use of Computers and the Internet**

Technology integration has important implications in effective teaching and learning. It is expressed through teachers' use of computers and the Internet, defined as the ways that teachers use computer/the Internet for teaching their classes or other professional activities. In this section, we discuss how teachers' use of computers and the Internet is influenced by different teacher characteristics including teachers' computer and Internet skills, their attitude toward the use of web resources, their feeling of preparedness to use computers and the Internet and their pedagogical beliefs.

Computer and Internet skills refer to teachers' knowledge and skills of using computer and the Internet for their teaching (Becker, 2001). Findings from the Teaching, Learning, and Computing (TLC) survey in 1998, a national survey of more than 4000 teachers from graders 4-12, indicate that "the ways that teachers have their students use computers are certainly affected by their own level of technical expertise" (Becker, 2001, p. 6). More specifically, "relevant prior computer knowledge may be an important pre-requisite for a teacher to make the Internet a valued resource in their classroom, and valuable in their lesson preparation activities in particular" (Becker, 1999, p. 29).

Not only teachers' computer and Internet skills influence their use of computers and the Internet, teachers' attitude as well as their feeling of preparedness toward using computers and the Internet also affect how teachers use these recourses. Attitudes toward the value of technology use in class have been shown to affect teachers' levels of technology implementation (Bigatel, 2004). Studies indicate that there are a significant positive correlation between attitudes about the advantage of teaching with technology and levels of technology implementation (Becker, 1994; Lebruto, 2001).

However, results from the Teaching, Learning and Computing (TLC) survey give us an idea that that teachers' beliefs and attitudes about technology might not be always consistent with how teachers actually feel about using technology. While nearly 90 percent teachers answered they would consider Internet as a valuable resource in the TLC survey, not that many teachers reported feeling prepared to use technology as statistics from National Center for Education Statistics (1999) has shown. The statistics found that "less than a third felt very well prepared to integrate educational technology or to address the needs of students with limited English proficiency or from culturally diverse backgrounds, or with disabilities". Teachers' use of technology is significantly related to their feelings of preparedness. For many instructional activities, teachers who reported feeling better prepared to use technology were a lot more likely to use it than teachers who indicated that they felt unprepared (Parsad, Lewis, & Farris, 2000). Addressing teachers' feeling of preparedness to use computer and the Internet is therefore very important in understanding their use of technology.

What teachers believe to be good instructional practices also affect the ways teachers use technology in their classroom. Becker (1999) found that teachers' pedagogical beliefs are one of the major predictor of teachers' Internet use and valuation.

**Use of PBL**

Under use of problem-based learning we understand the extent to which teachers use teaching strategies and techniques related to problem-based learning (e.g. use of problem as a learning task, collaboration, critical thinking, etc.).

Use of PBL is influenced by teachers' *pedagogical beliefs*. Peterson (2004) mentioned that problem-based learning could only be effective in the classroom, when the teacher departs from the traditional pedagogical paradigm of "teach, learn, practice, and assess", where "the teacher's responsibilities are to teach and to assess the learning. The students' responsibilities are to learn and to demonstrate that they have learned the required information" (p. 633). Instead the teacher becomes a problem-solver, who is actively engaged in the exploration and discovery of the solution together with the students. A problem-based classroom removes the focus from the teacher as the authority figure who knows all the answers, and puts it on students who become equal partners in the inquiry process.

**Use of General Teaching Strategies**

Use of general teaching strategy can be defined as how often teachers use a variety of teaching strategies and techniques in their classrooms (e.g. questioning, examples, small groups, concept maps). According to Grabowski, Koszalka, and McCarthy (1998), general teaching methods can be divided into the following six categories: Present, Guide, Active Learning, Collaborative, Problem-based Learning and Role-Play. We can argue that Present and Guide in this framework belong to the traditional approach and Active Learning, Collaborative, Problem-based Learning and Role-Play methods belong to the constructivist approach where students learn by doing.

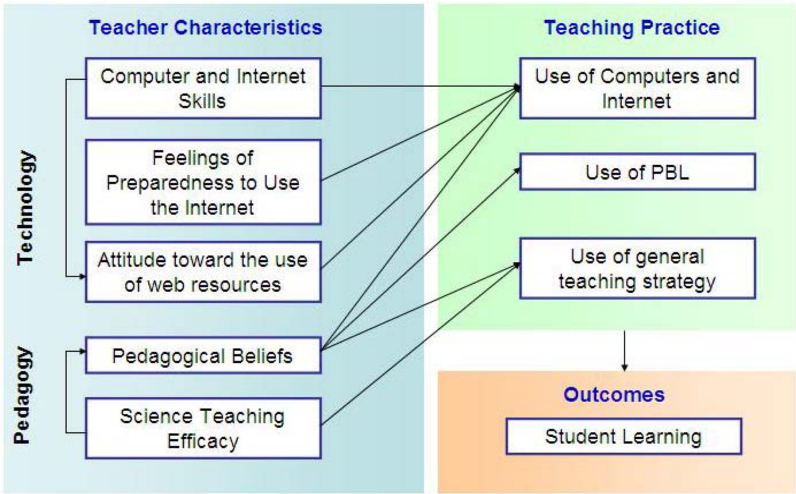
How often teachers use different teaching strategies can have strong implications on teachers' use of and their attitudes towards web-enhanced PBL in science education in middle schools. Kirby, McGee, Norris, and Blaney, (2003) stated that technical skills, attitude toward technology, constructivist teaching strategies, and constructivist teaching philosophy all influence constructivist uses of technology. By constructivist teaching strategies and philosophy we understand teaching that organizes student work around meaningful activities so that students are thoughtfully engaged with content (Ravitz, Becker, & Wong, 2000).

*Teachers' beliefs:* Teachers' beliefs about what constitutes good instructional practice. Presumably, their own instructional practices reflect, to a large extent, what they believe to be good teaching, their beliefs about good teaching reflect their understanding about how students learn (Ravits, Becker & Wong, 2000). Becker (1999) in his study on relationships between teachers' beliefs and teaching practices found that most teachers report having a balanced combination of traditional approaches and constructivist approaches in their classroom.

Teacher beliefs, practices and computer use were also an object of investigation for Riel and Becker (2000). In their study the researchers focused on the differences in teacher beliefs and practices among teacher leaders and average teachers. It was found that teacher leaders were more likely to use constructivist pedagogy and computers in their teaching. Another finding relevant to the current study was that science teachers had one of the smallest percentages across the board for reporting use of constructivist practices and computers in their classroom.

*Science teaching efficacy* is an essential factor that impact on teacher's belief system and their sense of confidence as it relates to their ability to be successful teachers (Tschannen-Moran, Hoy, & Hoy, 1998). It influences personal judgment about ability and competence in performing tasks. In other words, it influences choices of activities as well as the amount of effort expended and the level of persistence in the face of obstacles (Wingfield & Ramsey, 1999). It has been correlated with various measures or teacher effectiveness, including classroom behaviors, attitudes, commitment and relations to classroom (Evans & Tribble, 1996).

**Diagram - The Interrelationship between Teacher Variables**




**Significance of the study**

This study aims to investigate the impact of web-enhanced PBL on student problem-solving skills. In addition, a predictive model that illustrates the interrelationships between various variables and problem-solving skills will be developed. The results of this study will identify factors that predict students' successful problem-solving skills. Knowledge of these factors will enable teachers to more effectively construct learning opportunities for students. From the stakeholders' standpoint, identifying factors that predict teaching practice should help design teaching workshops for in-service teachers as well as programs for pre-service teachers. This will lead to improvement of teacher teaching practice and ultimately to improvement of student problem-solving skills.

**References**


Alexander, P. A., & Judy, J. E. (1988). The interaction of domain-specific and strategic knowledge in academic performance. *Review of Educational Research, 58*(4), 375-385.

Peterson, T.O. (2004). So you're thinking of trying problem based learning? Three critical success factors for implementation. *Journal of Management Education, 28 (5),* 630-648.

Becker, H. J. (1994). How exemplary computing-using teachers differ from other teachers: Implications for realizing the potential of computers in schools. *Journal of Research on Computing in Education*, 26(3), 291-321.

Becker, H. J. (1999). Internet use by teachers: Conditions of Professional use and teacher-directed student use. *Teaching, Learning and Computing: 1998 National Survey.* Report #1. Irvin, CA: Center for Research on Information Technology and Organizations, University of California, Irvine. Retrieved October 12, 2004 from http://www.crito.uci.edu/tlc/findings/internet-use/text-tables.pdf

Becker, H. J. (2001). *How are teachers using computers in instruction?* Paper presented at the meetings of the American Educational Research Association, Irvine, CA.

Bigatel, P. M. (2004*).* Exploring the beliefs and attitudes of exemplary technology using teachers. *Doctoral dissertation, The Pennsylvania State University, 2004. Retrieved on May 17, 2005 from http://etda.libraries.psu.edu/theses/approved/WorldWideFiles/ETD-530/thesis.pdf*

Chipman, S. F., & Wilson, D. M. (1985). *Understanding mathematics course enrollment and mathematics achievement: A synthesis of the literature. In S. F. Chipman, L. R. Brush, & D. M. Wilson (Eds.),* Women and mathematics: Balancing the equation*. Hillsdale, NJ: Lawrence Erlbaum Associates.*

Davis, F. D. (1989). *Perceived usefulness, perceived ease of use, and user acceptance of information technology.* MIS Quarterly*, 13(3), 319-340.*

Edens, K. M. (2000). *Preparing problem solvers for the 21st century through Problem-based Learning.* College Teaching*, 48, 55-60.*

Evans, E. D., & Tribble, M. (1986). Perceived teaching problems, self-efficacy and commitment to teaching among preservice teachers. *Journal of Educational Research*, 80, 81-85.

Flavell, J. H. (1976). Metacognitive aspects of problem-solving. In L. Resnick (Ed.), *The nature of intelligence*. Hillsdale, N.J.: LEA.

Fraser, B. J. (1978). Development of a test of science-related attitudes. *Science Education*, 62, 509-515.

Grabowski, B.L., Koszalka, T.A., & McCarthy, M. (1998). *Web-Enhanced Learning Environment Strategies Handbook and Reflection Tool. (11th Ed).* The Pennsylvania State University and NASA Dryden Flight Research Center.

Haladyna, T. & Shaughnessy, J. (1982). Attitudes toward science: A quantitative synthesis. *Science Education*, 66, 547-563.

Jones, D. (1996). "Disadvantages of problem based learning." Retrieved Oct.15, 2005 from http://edweb.sdsu.edu/clrit/learningresource/PBL/PBLBarriers.html

Kirby, J., McGee, S., Norris, K. & Blaney, L. (2003, April). Effectiveness of Integrating Strategies and Technology in Education Practice (InSTEP™) on Constructivist Uses of Technology. Paper presented at the annual meeting of the American Educational Research Association, Chicago.

Koszalka, T.A. (1999). The relationship between the types of resources used in science classrooms and middle school students' interest in science careers: An exploratory analysis. Unpublished doctoral dissertation, The Pennsylvania State University, University Park, PA.

Koszalka, T.A. (2002). Technology resources as a mediating factor in career interest development. *Educational Technology and Society*, 2 (5). Retrieved October 15, 2005 from http://ifets.ieee.org/periodical/vol_2_2002/koszalka.html

Lebruto, D. J. (2001). A study of intermediate elementary teachers' educational beliefs and teaching practices and the use of technology. Doctoral dissertation, University of Central Florida, 2001. Dissertation Abstracts International, 62/01.

Lent, R.W., Brown, S.D., & Larkin, K.C. (1986). Self efficacy in the prediction of academic performance and perceived career options. *Journal of Counseling psychology*, 33,265-269.

Lent, R.W., Lopez, G.F., Bieschke, K.J. (1991). Mathematics self efficacy: Sources and relation to science –based career choices. *Journal of Counseling psychology*, 38, 424-430.

Liu, M., Hsieh, P., Cho, Y., & Schallert, D. L. (2005). *Middle school students' self-efficacy, attitude, and achievement in a problem-based learning hypermedia environment.* Paper presented at the annual meeting of the American Educational Research Association, Montreal, Canada.

Lovett, M. C. (2002). Problem solving. In D. Mdein (Ed.), *Steven's Handbook of Experimental Psychology* (Vol. 2, pp. 317-362): John Wiley & Sons.

Marsh, H. W. (1986). Verbal and math self-concepts: An internal/external frame of reference model. *American Educational Research Journal*, 23, 129-149.

Marsh, H. W., Byrne, B. M., & Shavelson, R. (1988). A multifaceted academic self-concept: Its hierarchical structure and its relation to academic achievement. *Journal of Educational Psychology*. 80, 366-380.

Mason, C. L., & Kahle, J. B. (1988). Students attitudes toward science and science-related careers: A program designed to promote a stimulating danger-free learning environment. *Journal of Research in Science Teaching*, 26, 25-39.

Mayer, R. E. (1998). Cognitive, Metacognitive, and Motivational Aspects of Problem-solving. *Instructional Science, 26*(1), 49-63.

National Center for Education Statistics (1999). *Teacher quality: A report on the preparation and qualifications of public school teachers.* Retrieved on October 15, 2005 from http://nces.ed.gov/surveys/frss/publications/1999080/6.asp

Parsad, B., Lewis, L., & Farris, E. (2000). Teacher Preparation and Professional Development: 2000. *Education Statistics Quarterly, 3(3).* Retrieved October 23, 2004 from U.S. Department of Education http://nces.ed.gov/programs/quarterly/vol_3/3_3/q3-3.asp

Peterson, T.O. (2004). So you're thinking of trying problem based learning? Three critical success factors for implementation. *Journal of Management Education., 28 (5),* 630-648.

Piesch J., Walker R., & Champen E. (2003).The relationship among self-concept, self-efficacy and performance in mathematics during the secondary school . *Journal of Educational Psychology, 95(3),*589-603.

Ravitz, J. L., Becker, H. J. & Wong, Y. T. (2000). *Constructivist compatible beliefs and practices among U.S. teachers*. Retrieved October 28, 2004, from: http://www.crito.uci.edu/TLC/FINDINGS/REPORT4/

Riel, M. & Becker, H. (2000). The beliefs, practices, and computer use of teacher leaders. Retrieved October 28, 2004, from http://www.crito.uci.edu/tlc/findings/aera/

Shavelson, R.J., Hubner, J. J., & Stanton, G.C. (1976). Validation of construct interpretations. *Review of Educational Research*, 46, 407-441.

Shell, F.D., Murphy, C.C., & Buring, H. (1989). Self-efficacy and outcomes expectancy mechanism in reading and writing achievement. *Journal of Educational Psychology, 81(1),* 91-100.

Simpson, R.D., Oliver, J.S. (1990). A summary of major influences on attitude toward and achievement in science among adolescent students. *Science Education*, 74(1), 1-18.

Sternberg, R. J. (1998). Metacognition, Abilities, and Developing Expertise: What Makes an Expert Student? *Instructional Science, 26*(1), 127-140.

Super, D.E. (1963). Toward making self-concept theory operational. In D.E. Super, R. Starishevsky, N, Matlin & J.P. Jordaan (Eds), *Career development: Self-concept theory* (pp.17-32). New York: College Entrance Examination Board.

Super, D.E. (1984). Career and life development. In D. Brown & L. Brooks (Eds.), *Career Choice and Development* (pp. 192-234). San Francisco: Jossey-Bass.

Taconis, R., Ferguson-Hessler, M. G. M., & Broekkamp, H. (2001). Teaching Science Problem-solving: An Overview of Experimental Work. *Journal of Research in Science Teaching, 38*(4), 442-468.

Tschannen-Moran, M., Hoy, A.W., & Hoy, W.K. (1998). Teacher efficacy: Its meaning and measure. *Review of Educational Research, 68(2)*, 202-248.

Voss, J. F. (1989). Problem-solving and the educational process. In A. Lesgold & R. Glaser (Eds.), *Foundations of a psychology of education* (pp. 251-294). Hillsdale, New Jersey: LEA.

Wingfield, M.E., Freeman, L., & Ramsey, J. (2000, April). Science teaching self-efficacy of first year elementary teachers trained in a site based program. Paper presented at the annual meeting of the National Association for Research in Science Teaching, New Orleans, LA. (ERIC Document Service No. ED 439 956).

# Designing a Diagnostic Learning Environment in Occupational Therapy

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**Abstract**

*The problems we encounter in everyday life are complex and ill-structured. However, the problems in a class are well-structured and easily solved as long as students follow the instructions. Considering that one of the important goals of education is to help students become successful problem solvers, we, as instructional designers need to develop new instructional models and methods to support the students' problem solving. Here we suggest a design model to help students become successful diagnosis-solution problem solvers.*

## Introduction

We encounter a variety of problems in everyday life. These problems are usually ill-structured, complex and dynamic as well as domain and context specific (Jonassen, 2004). However, in many cases, our educators do not consider the characteristics of the real problems in our classes. They assume that problem solving skills can be transferred from teachers or technologies to students (Jonassen, 1999). Another common belief is that students can apply simple problem solving skills to complex problem contexts. Consequently, they have focused on knowledge delivery or sequencing of content (Jonassen, 1999) in instructional design.

However, problem solving skills are constructed by learners themselves based on the individual learner's interpretations and practices. Developing the learner's own mental models about the problems is essential to promote effective problem solving. In order to be successful problem solvers, learners should be able to manipulate and test their mental models for the problems (Jonassen, 2004).

Also, well-structured problem solving skills are difficult to transfer to complex and ill-structured problems. This is because the necessary skills to solve problems between ill-structured and well-structured problems are different from each other. Shin, Jonassen, and McGee (2003) found that students' problem solving skills for ill-structured problems are different from the problem solving skills for well-structured problems in the science domain. According to them, the domain knowledge and justification skills are significantly related to solving well-structured problems and the domain knowledge, justification skills, science attitudes, and regulation of cognition skills are significantly related to solving ill-structured problems.

We argue the constructivist learning environment (CLE) supports students to become successful problem solvers. It provides real or authentic problems and requires students to engage in problem solving processes. Also, the CLE provides related cases with the problems so that students can approach the problems in a variety of ways. By doing so, students understand different ways to approach the same problems and expand their mental models. The purpose of this paper is to present how a constructivist learning environment can be designed. We chose a diagnosis-solution problem to design a CLE. In this paper, we will present both specific processes in designing the CLE and the visual outcomes of the specific processes.

## Learning Context and Instructor's Needs

### Learning Context

This course, "Occupational Therapist: Developmental Framework", is offered by the Department of Occupational Therapy in a mid-west university. Most of the students in the class are juniors. The class is based on a block system that is similar to medical school. Each block consists of 8-10 students and is a 7-week intensive course. Lecture and laboratory coursework is designed to provide the occupational therapy (OT) student with an understanding of the process of normal and delayed development and to prepare the students to administer, score, and interpret results from common assessments intended to evaluate the development of infants and young children.

### Instructor's Needs

Many students don't know how to participate in the case study. Also, they don't know how to systemically approach the case and how to make rationale explanations about their decisions. In addition, students don't understand what experts they need to contact to solve the problem. However, the instructor wants students to know what things really happen in the field when students go out in the field as occupational therapists.

Considering the gap between students' current status and the instructor's expectation, our learning environments aimed to help students to become an effective problem solver in occupational therapy. More specifically we supported students to be a successful problem solver by providing them opportunities to manipulate their mental models for the problem, which is effective to develop mental models (Jonassen, 2004). In our learning environment students will achieve the following specific goals;

1. Students will be able to distinguish the patients' developmental processes (normal & abnormal).
2. Students will be able to understand the experts that occupational therapists interact with in the fields.
3. Students will be able to systemically approach the cases.
4. Students will be able to judge what would be an appropriate diagnostic test

**Theory Base**

The main theories used for this learning environment were activity theory, cognitive flexibility and constructivistism. We will describe how these theories have applied in our CLE based on the client's needs and characteristics of the course.

The main goal of this course Occupational Therapists (OT) 4410 was that students will be able to have their own mental models about the role of occupational therapists in the real field. Students were expected to build their own mental models about how they approach the cases and how they interact with other experts in the field.

We decided to make boundaries for this learning environment because we could not cover everything in our learning environment. We needed to know what the important elements were and how occupational therapists function in the field. In order to make boundaries for this learning environment that satisfied the learning goal, we conducted task analysis procedures using Activity theory. We chose Activity theory as a framework to analyze how first year occupational therapists function in the field for two reasons. First, Activity theory provides a framework for analyzing both individual and social levels interlinked at the same time (Mwanza, 2001). Since the occupational therapists work individually as well as with others (e.g., speech therapist, physicians, social workers), the activity theory was appropriate to analyze how individual occupational therapists function in the field. Second, Activity theory focused on "interaction of human activity and consciousness (the human mind as whole) within its relevant environmental context" (Jonassen, Tessmer, & Hannum, 1999). The Activity theory task analysis provided us specific information about how an individual functions in the field. Since students do not exactly know about their roles in the field, the analysis results will be helpful for students to understand how occupational therapists interact with other elements in the field. The most important things we found in the task analysis were that in order to be a successful problem solver in occupational therapy, students should develop their own mental models about developmental domains and body systems of the patients as well as develop mental models about other experts' roles and how other experts interact with the occupational therapists.

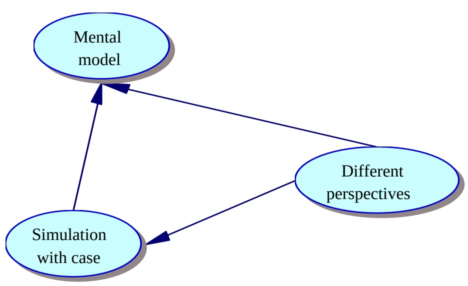


Figure 1

In order to support students' mental model development about problems, we decided to use simulation. Simulation is very effective to have students engage in the problem solving (Savery & Duffy, 1994) and help students develop their own mental models by practicing authentic problems. The simulation activities were created based on an experts' mental model about ill-structured problem solving in occupational therapy. Figure 2 represents one of the experts' mental models about problem solving. In our learning environments, students are given cases with pictures and video clips, which make the learning more authentic and engaging (Merseth, 2000).

Once students are given problems, they are asked to analyze developmental issues, identify body systems relevant to developmental domains and clinically judge the patients' concerns and strengths. Then, students are asked to choose an appropriate diagnosis test tool for further treatment. In our simulation environments, we focused on two things: problems and different experts' perspectives. First, we focused on development of cases. Our cases were generated by the expert and they all satisfy Jonassen (1999)'s recommendations of problems for authentic learning: 1) Problems should be authentic and challenging so that learners will have an ownership of the problems. 2) Problems should describe performance environments and all relevant stakeholders which make the learning authentic. 3) Problems should support student manipulation of the problems.

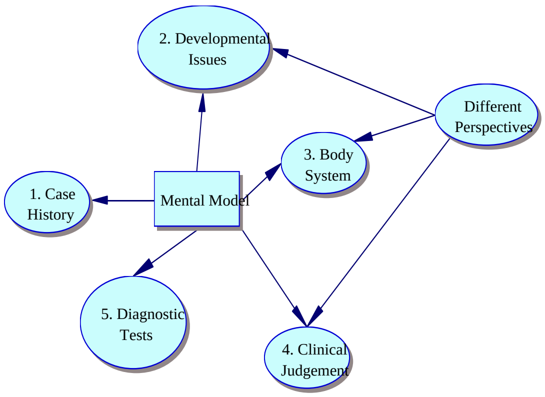


Figure 2

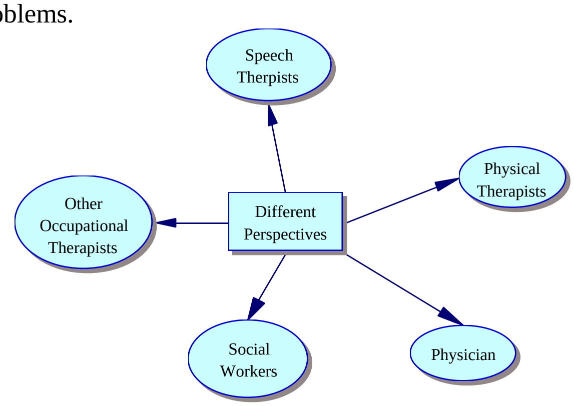


Figure 3

Second, we focused on presenting different perspectives of experts relevant to the occupational therapists: other occupational therapists, speech therapists, physical therapists, physicians and social workers. We argued presenting different perspectives is helpful for students to develop their own mental models about how occupational therapists function in the community.

Multiple perspectives will make students review their existing perception of occupational therapists and view the problems from the landscape criss-crossing perspectives (Spiro, Coulson, Feltovich, & Anderson, 1988; Spiro, Feltovich, Jacobson & Coulson, 1992). We argue that this process will promote students' conceptual change about the roles of occupational therapist as well as provide understanding about their roles in the field.

Ultimately, this will help students develop their own mental models, which are authentic. Also, multiple perspectives make it possible for students to revisit the same material over and over again. By doing so, the possibility of missing important concepts will be reduced and provide new insights about the problems (Spiro, Coulson, Feltovich, & Anderson, 1988; Spiro, Feltovich, Jacobson & Coulson, 1992). This will contribute to developing mental models which are effective for solving ill-structured problems in occupational therapy.

## Design Process

The design processes were described as follows. Although our design processes were described as linear, the actual processes were very dynamic and were similar to prototype design processes. Each design process will be described in detail.

### Analysis of client's Needs

We regularly met with the client every Tuesday at 9:45 in the occupational therapy conference room. The meetings with the client provided us with understanding about what the client wanted us to develop for her course. In the meeting we communicated with the instructor to find out what she expected from the course, what objectives she had in mind, what limitations we had, what resources the department had and how much they could support us.

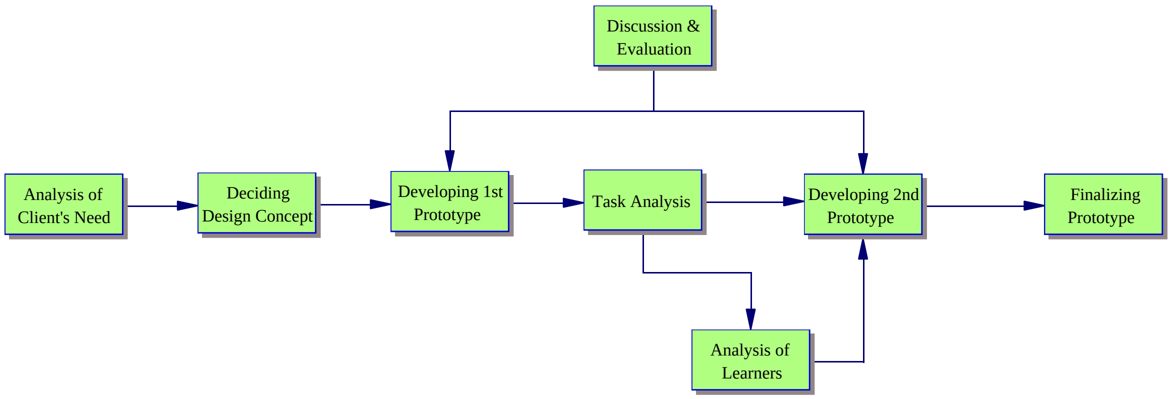


Figure 4

**Deciding design Concepts**

Based on the analysis of client's needs, we were able to articlulate design concepts for the learning environment. She wanted the students to be a good problem solver as new occupational therapists in the field. More specifically, she wanted students to have understanding about other experts in the field and to learn how the occupational therapists interact with them. In order to support this client's needs, we decided to provide students with opportunities to simulate the occupational therapist's roles with cases. Also, we supported students with different levels of case difficulty and with different relevant experts' perspectives .

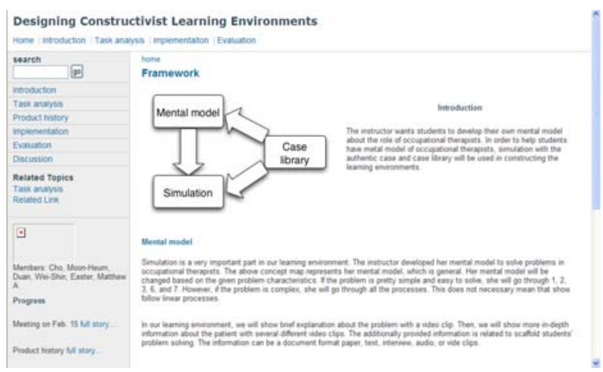


*Figure 5*

**Task Analysis**

Task analysis was essential to developing the constructivist learning environment. We conducted Task Analysis with the use of Activity Theory analysis. This is because Activity theory provided a theoretical framework for analyzing both individual and social levels interlinked at the same time (Mwanza, 2001). Based on the Activity Theory analysis, we drew boundaries for our CLE and considered what components should be integrated in our CLE: We assumed the subject in the system would be the first year occupational therapist, they would interact with other experts based on understanding of their division of labors and they had to understand what kind of insurance and social security supported their patients.

**Learners' Analysis**

To begin our analysis of learners, we observed and videotaped a class session focused on a case study. Based on the classroom observation, we were able to identify how the case study was implemented, what roles students played and the role the instructor played in the case study. The observation showed students were not familiar with case studies, and they needed more structured case studies. The rubric the instructor provided to students was not clear, and there were not enough systematic supports for students to develop arguments about their decisions.

At the same time, in order to identify students' current mental models about the problems, we conducted learner analysis by interviewing students. This process was necessary to understand the students' current mental models for this course, which then informed the researchers about the degree of scaffolding needed in the CLE. We interviewed two students with the help of the instructor: one student was struggling with the class format and the other student was not. We found both students commonly had less knowledge about diagnostic tests. Also, the struggling student displayed difficulties connecting the developmental domains of the patient and to the patient's body systems. This showed that we needed to focus on supporting students' understaning of how body systems are relevant to the developmental process and what diagnostic tests are appropriate for patients.

**Developing 2nd Prototype**

We improved our prototype based on the discussion with the group members and the client. We presented the case with via video clips to improve students' engagement in the problem and also decided to provide different perspectives with videos rather than text based narration. This decision came from the fact that providing cases with an interactive technology were particularly exciting (Merseth, 2000).

**Discussion and Evaluation**

We met with the client once a week. In addition to regular meetings, we also sent emails to the instructor, asked her questions and requested her to provide scenarios or other cognitive resources (e.g., instrument pictures). After the regular meetings, our team members had follow-up meetings. The discussions with the group members led to revisions of the 1st and 2nd prototypes. We focused on multiple navigations, considered how to scaffold students' learning and considered how students' performances would be evaluated. Lastly, we developed rubrics for students' evaluations. Since the instructor wanted to help students develop a systems approach, we developed the rubric based on the interview with her.

**Finalizing the prototype**

We finalized the current prototype. The finalized version of prototype provided three cases, different perspectives with video clips, scaffolding system, supporting evaluation of relevant body system with developmental domains and clinical judgment and choosing an appropriate diagnostic test. In particular, we focused on scaffolding students' development of multiple perspectives by prompting and asking them to make justify their decisions. In addition, same ways' scaffolding was provided in the process of clinically evaluating the body parts of the patients and choosing an appropriate diagnostic test.

**Product Description**

Considering the client's needs and the results of learner analyses, it was decided to integrate the following three components in the Constructivist Learning Environment: simulation, multiple perspectives and argument (scaffolding).

The intro page (Figure 6) started with instructor's welcome statement and the explanation of the class. Students will know the objectives of the class and what cases they will use in the class. The case study (Figure 7) starts from a normal occupational therapist's desk. On the desk, students will see case binder, telephone messages from other relevant experts (e.g., speech therapist, physician, social worker and so on) and web resources.

*Figure 6*

*Figure 7*

**Simulation**

A simulation was developed which describes how first-year occupational therapists interact with other community members and how they diagnose a patient's status based on five developmental areas: motor, adaptive behaviors, social/emotional, language and cognitive development. Also, we simulated how first-year occupational therapists choose the most appropriate test for further medical treatments. Students are supposed to approach the case using the following six procedures;

1. Analyze the family background
2. Analyze other experts' perspectives
3. Analyze patients' overall developmental processes
4. Determine what parts of the body systems are relevant to the developmental processes
5. Clinically judge and evaluate patients' strengths and concerns in terms of body parts
6. Choose an appropriate diagnostic test

**Argumentation Scaffolding**

Argumentation scaffolding was constructed to help students develop their own mental models about the problems, which are cases in this learning environment. Students are supposed to participate in all the processes in the simulation. In each step, prompt questions were provided in order to facilitate systemic thought processes in the students. A structured system approach was provided, which was the above six processes. In each step, students will be asked to make decision and provide their own rational for their decisions. For example, they will be asked, "what experts are you going to contact to approach the problem?" Once students choose the experts, they will be asked to explain why students chose those experts (See assessment to view visual picture of argumentation scaffolding)

**Multiple Perspectives:** In real situations, occupational therapists interact with other experts (physical therapists, psychologists, speech or language therapist, doctors, institutions, families and so on) when they approach the problems. Therefore, they need to understand how each expert approaches the same problems from the different perspectives. In order to support this reality in the field, other experts' perspectives are provided to students with the use of video clips.

Figure 8

## Assessment

Our evaluation method was a writing assignment. The purpose of our assignment was to have students experience expert's thinking process. Since there is mental gap between experts and novices, we scaffolded students by using prompts.

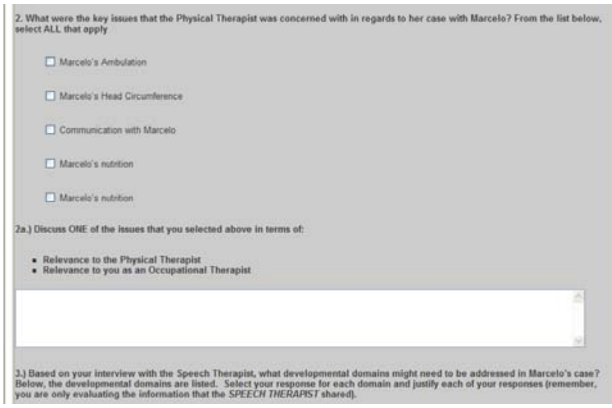


Figure 9

For example, students watched the videos in order to learn how other experts approach the problem. Essay questions and multiple choice questions were given to help students perceive what things they need to understand in the video. The essay questions asked students to make jsutifications about their arguments. At the same time, multiple questions also asked students to provide their arguments about their choices.

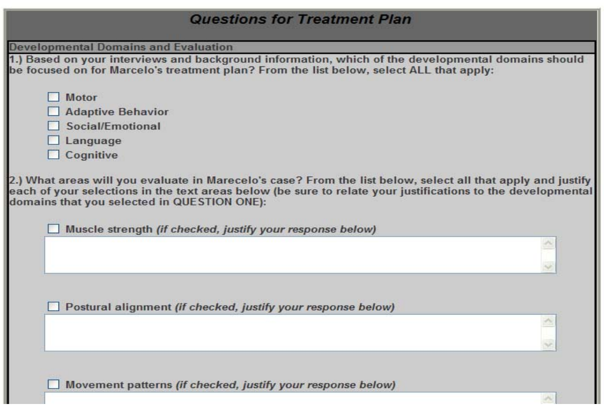


Figure 10

In addition, in the process of clinical judgment and identifying body system relevant to development domains, scaffolding was given. Students were also required to make decisions by choosing the answers and making justifications about their decisions. Since the course curriculum follows the medical block system, which is a short quarter, and the number of students in the class is small, we felt writing evaluation was appropriate.

## Discussion

We will discuss how our design model is different from traditional design models. Compared to the traditional design model (e.g., ADDIE), our model is very flexible and is a prototype centered design. Rather than waiting for all the analyses to be finished, we first developed the prototype based on small understanding and basic design concept. Task analyses, learner analyses, meetings with the client, discussions with the group members and evaluations of the prototype were conducted simultaneously to improve the 1st prototype. Regular meetings with the client and discussions with the client and group members were very helpful to improve the initial prototype. Although there had been several changes in our design, we kept our design principles we planned at first. In addition, it was helpful to develop a simple prototype and add new designs based on the discussion. Therefore, we were able to save time and energy. The client's needs could be easily applied in the prototype, which would be hard in the traditional ADDIE model.

## Limitations

There are several limitations of our design research. First, we were not able to conduct a formative evaluation and had no opportunity to revise the online CLE. If we were able to conduct the formative evaluation, we would likely identify other things we need to consider in this environment and how the online CLE can be improved. Second, it was unfortunate for us that this course was opened only in the winter semester. In order to conduct the user evaluation for summative evaluation, we needed to wait until the instructor opens the class again. Third, although it was out of our responsibility, it would be more reasonable for us to further develop the CLE to require students to provide appropriate treatments for the patients. However, the curriculum of the course only covered the intial examination of the patient selection of an appropriate diagnostic test. We were not able to develop the next process, which is important in developing diagnosis problem solving skills.

**References**


Jonassen, D. H. (1999). Designing constructivist learning environments. In C. Reigeluth (ed.). *Instructional design theories and models: A new paradigm of instructional theory*:Mahwah, NJ: Lawrence Erlbaum Associates.

Jonassen, D. H. (2004). Learning to solve problems: An instructional design guide. CA. Pfeiffer.

Jonassen, D. H., Tessmer, M., & Hannum, W. H. (1999). *Task analysis methods for instructional design.* Mahwah, New Jersey. Lawrence Erlbaum Associates, Publishers.

Merseth, K. K. (1996). Cases and case methods in teacher education. In J. Sikula (Ed.), *Handbook of research on teacher education* (2nd ed.; pp. 722–744) New York: Macmillan.

Mwanza, D., (2001), Where theory meets practice: A case for an activity theory based methodology to guide computer system design. (Tech. Rep. No. 104). United Kingdom: The Open University, Knowledge Media Institute.

Savery, J. R. & Duffy, T. M. (1994). Problem based learning: An instructional model and its constructivist framework. Educational Technology.

Shin, N., Jonassen, H. D., & McGee, S. (2003). Predictors of well-structured and ill-structured problem solving in an astronomy simulation. Journal of Research in Science Teaching, 40(1), 6-33

Spiro, R. J., Coulson, R. L., Feltovich, R. J., & Anderson, D. K. (1988). Cognitive flexibility theory. Advanced knowledge acquisition in ill-structured domains. In Tenth Annual Conference of the Cognitive Science Society (pp. 375-383). Hillsdale, NJ: Erlbaum.

Spiro, R. J., Feltovich, P. J., Jacobson, M. J., & Coulson, R. L. (1992). Cognitive flexibility, constructivism, and hypertext: Random access instruction for advanced knowledge acquisition in ill-structured domains. In T. M. Duffey & D. H. Jonassen (Eds.), *Constructivism and the technology of instruction: A conversation* (pp. 57-76). Hillsdale, NJ: Lawerence Erlbaum Associates.

# An Instructional Framework for Scaffolding Self-regulation in Online Environments

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**Abstract**

*As online learning become prevalent, supporting students' self-regulation is significantly more important. Online learning is different from face-to-face learning in that it offers a lot more learner autonomy but at the same time also demands more responsibility from them. Therefore, instructional designers and instructors should encourage students to self-regulate their learning. This paper's purposes are to distinctly define self-regulated learning in online learning contexts, suggest an instructional framework for instructional designers and online instructors to use to scaffold students' self-regulation in online learning and finally, recommend strategies to support self-regulation in online learning.*

## Introduction

As online learning becomes prevalent, supporting students' self-regulation is becoming significantly important. Online learning is different from face-to-face learning in that it offers a lot more learner autonomy but at the same time also demands more responsibility from them. In addition, online learning is usually mediated by web-based asynchronous communication tools such as discussion boards that can not provide verbal and non-verbal communication (Hron & Friedrich, 2003). Due to these limitations of online learning environments, instructors are therefore not able to offer students immediate and direct support which makes promoting self-regulated learning even more difficult.

As a way to promote students' self-regulated learning in online environments, various instructional strategies has been recommended such as embedding cognitive or meta-cognitive questions into learning materials (Shin, 1997), displaying self-reflection support tools, e.g., online journals, online time and task management tools (Cho, 2004), and giving note-taking assignments (Lim, 2002). However, these approaches have been criticized since they do not consider the learning context in which the learning takes place (Meyer & Turner, 2002). Therefore, recent research (Butler, 2002; Meyer & Turner, 2002) has begun to acknowledge the learning context as a critical factor to consider when promoting self-regulation in learning. Unfortunately, few have been able to suggest instructional approaches for promoting online self-regulation within the learning context.

According to some researchers (Meyer & Turner, 2002; Perry, VandeKamp, Mercer, & Nordby, 2002; Zimmerman, Bonner, & Kovach, 1996), an instructional approach is scaffolding. Hence, this paper's purposes are to distinctly define self-regulated learning in online learning contexts, suggest an instructional framework for instructional designers and online instructors to scaffold students' self-regulation in online learning and finally, recommend strategies to support self-regulation in online learning.

## Self-regulated and co-regulated learning

Self-regulated learners are defined as individuals who are able to effectively orchestrate cognitive, meta-cognitive strategies, resource management and motivation in learning (Zimmerman, 1990). Self-regulated learners have knowledge about themselves as learners and knowledge about learning strategies (Heo, 2000). They know how to use the learning strategies to achieve their goals depending on the learning task. They are also persistent and make efforts to master the learning with self-efficacy. Self-regulated learners take responsibility for their learning (Shin, 1997) and effectively use their learning resources, e.g., time management, seek help and structure their learning environments. They are reflective learners through self-imposed questions, such as what did I learn, what learning strategies are most suitable to achieve my goals, how much time should I spend so on and so forth.

More recently, researchers (Meyer & Turner, 2002; McCaslin & Good, 1996; McCaslin & Hickey, 2001; Perry, VandeKamp, Mercer, & Nordby, 2002) have argued that context should be considered in the self-regulated learning. Their argument is that learners co-construct knowledge through social interaction. As a result, through these interactions they co-regulate with their peers and instructors to achieve shared goals. According to Butler (2002), "it is impossible to judge individuals' capacity to self-regulate without consideration of context (p.60)" Thus, it is believed the class or group should co-regulate as a whole through negotiation and sharing.

Figure 1 displays these two types of self-regulation: individual regulation and group co-regulation. Furthermore, we can then apply this to the setting for online learning environments where the context (e.g., technology, activities, and tasks) mediate learners' self-regulation and learning outcomes. The basic assumptions in online learning environments are that knowledge is constructed through sharing and negotiation, and learning occurs through learners' interactions.

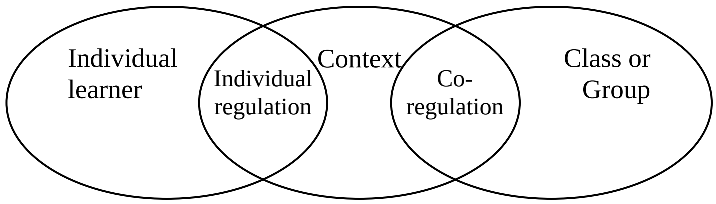


Figure 1: Model of Self-regulation

In online learning environments, individual learners not only need to engage in self-regulation but also, depending on the task and activities' nature, they are sometimes required to co-regulate with others. In other words, learners should have the capability to self-regulate as well as co-regulate with others when necessary.

**Individual learners in context**

Self-regulated learners in this situation are those who have knowledge about themselves as well as cognitive, meta-cognitive, resource management, and motivational strategies. Once they encounter problems to solve, they know what they need to do and apply what they know into the problem solving process. They will reflect on what they know and what they do not know. Then, they will set goals and specific cognitive and resource management strategies to solve problems. They regularly monitor and evaluate their learning process and change their learning strategies and goals if necessary. Self-regulated learners in this situation will give ceaseless effort to achieve their goals through self-efficacy.

**Group of learners in context**

Self-regulated learners in this situation are those who have knowledge about themselves and self-regulated learning strategies. In addition, self-regulated learners in this situation are aware they need to collaborate and co-regulate with other group members. They proactively participate in social negotiations and knowledge construction processes. They should possess the social skills to co-regulate with other members, be able to communicate, encourage, and share information in order to collaboratively work together. Through this social self-regulation process, they establish relationships with other members and contribute to the development of the self-regulation circumstances in the online learning environments.

## Self-regulation in online learning

We defined self-regulated learners in online leaning environments as those who have knowledge about themselves as learners or as independent learners and collaborators, and knowledge about learning strategies which are necessary for individual and co-regulation. They proactively participate in learning activities, namely, negotiating, sharing, and collaboration with an open mind and self-efficacy. Considering the definition of self-regulated learning and the characteristics of online learning environments, we suggest a framework explaining how self-regulated learning occurs in online learning environments.

As shown in Figure 2, in online learning environments, the fundamental components are the individual learner and the group of learners. In addition, self-regulated learning is mediated by the context and the learning processes, such as individual and/or co-regulation. The expected learning outcomes are categorized into the individual learning outcomes and the group learning outcomes. We will explain further, in detail, each element of self-regulation in online learning environments.

**Learners**

Learners are the basic components in self-regulated learning. Self-regulated learners should be able to self-regulate as well as co-regulate depending on the nature of the instructional task and activities. Self-regulated learners as individual learners have sophisticated epistemological beliefs, high cognition levels, meta-cognition, resource management skills and a strong motivation to learn. Epistemological beliefs are learners' perceptions about knowledge and learning. Learners who have sophisticated epistemological beliefs are thought to use more cognitive and meta-cognitive strategies (Hofer, 2004). They have knowledge about learning strategies and these strategies are chosen through their meta-cognition. In order to solve problems, they chose appropriate learning strategies, apply them into problem solving process and evaluate whether the application of the learning strategies are effective. Self-regulated learners are able to self-monitor how they manage time, know who to ask when they seek help and are aware of appropriate and effective strategies in learning. Once they understand the tasks and set their goals, they will persistently make efforts in the problem solving process through high self-efficacy. Self-regulated learners as a group of learners are involved in the co-regulation process. Co-regulation occurs through co-cognitive, co-meta-cognitive and co-resource management processes in order to reach common goals. During the co-regulation processes, the group of learners share meaning making, negotiate, build consensus, and co-construct knowledge. Through this meaning and knowledge making process, they establish social relationships. They know who they are amongst a group of learners and contribute to the formation of social presence in the learning environment.

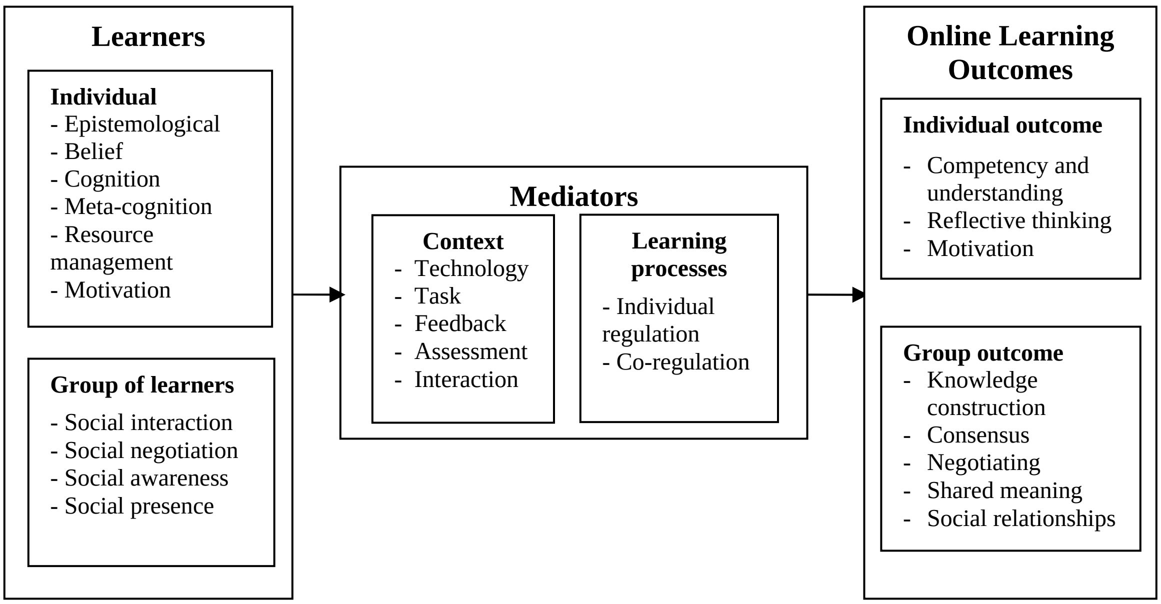


Figure 2: Framework for Self-regulated Learning in an Online Environment

**Mediators**

Context and learning process are mediators of the self-regulated learning process. Context consists of technology, task, feedback, assessment, and interaction, and the learning process consists of individual regulation, co-regulation as well as both individual and co-regulation. More specifically, the context determines the learning process. In particular, the characteristics of the tasks and assessment strongly influence the students' learning process. Web-based tools, such as, email, listservs, discussion boards, instant messenger, video and audio conferencing, 3D environments, and delivery systems provide the medium for communication. Also, in addition to interaction, feedback which is both internal and external all contributes to this mediation process. Activities come from the learning tasks and assessment and they influence the type of learning process.

**Online learning outcomes**

Learning outcomes result from the learning process. Individual outcomes are the results of individual regulation and group outcomes are results of co-regulation. Through the process of self-regulated learning, individual learners will acquire competency and understanding related to the task, be able to perform reflective thinking and also will become strongly motivated. As for the group of learners, co-constructed knowledge will result from the co-regulation process among the group as they participate in shared meaning-making, negotiation and consensus building. Last, social relationships will also develop from their interaction and collaboration.

## Scaffolding students' self-regulation

The basic assumption in self regulation learning is that students have knowledge about themselves as learners and knowledge about self-regulated learning strategies. However, not all students will possess knowledge about themselves as learners or knowledge about self-regulated learning strategies (Heo, 2000). Therefore, instructional designers should focus on how to scaffold students' knowledge about themselves as learners and knowledge about self-regulated learning strategies.

Table 1. Scaffolding Strategies to Support Self-regulated Learning

| Categories | Source | Scaffolding strategies |
|---|---|---|
| Tasks | Internal | Provide students with the opportunity to set their goals in the class |
| | | Provide students with the opportunity to set plans to reach their goals |
| | External | Provide students with a challenging topic to solve and at the same time provide students with the necessary support to address the challenge (e.g., allowing collaboration, giving time to think or providing supportive materials if necessary) |
| | | Instead of correcting a student's errors, ask students to think what could be done to solve the problems |
| | | Raise a question that would help students to solve a problem or generate an understanding that directly provides information, particularly if the acquired information involves high levels of thought or meta-cognition. |
| | | Provides opportunities to demonstrate competency and understanding |
| Assessments | Internal | Encourage self-awareness and self-assessment during the learning process |
| | External | Challenge students without threatening their self-efficacy. In online learning environments, assessment and evaluations should be ongoing, embedded in daily activities, focused on personal progress and promote an understanding that errors are opportunities to learn. |
| | | Provide peer evaluation opportunities to check the collaboration process, which consists of shared meaning-making, negotiations, and building consensus. |
| | | Have them participate in decision making processes needed to learn (e.g., choosing learning strategies, project topic, type of information necessary and selecting a collaborator) |
| Feedback | Internal | Provide students opportunities to review and reflect on themselves as learners |
| | External | Provide feedback on students' reflection |
| | | Emphasize students' attempts and students' initiation |
| | | Provide supportive emotional feedback |
| | | Emphasize the importance of errors as a process of learning |
| | | Provide encouragement and praise students' efforts spent on solving problems |
| | | Provide helpful but not critical tones |
| Interactions | Internal | Provide students with opportunities to self-talk and reflect about their learning |
| | External | Raise a controversial issue for interaction so that learners compare and contrast learning strategies using meta-cognition, cognition and reflection |
| | | Have students recognize that interaction is a process of shared meaning-making, negotiating and building consensus by explaining and modeling it |
| | | Encourage interactions among peers and between students and teachers by making the learning environments warm and nice. |
| | | Let students know there is no stupid question and every question is valuable not only to themselves but also to all the students |

We argue that scaffolding should be offered in the mediator part of our model, which is the context in this case. The context includes the tasks, assessment, feedback and interaction. We excluded technology because it is the tool used to deliver the scaffolding strategies. Under the context, scaffolding students' self-regulation can be divided into two parts: one is for scaffolding knowledge as learners, which is internal scaffolding, and the other is for scaffolding knowledge about self-regulated learning strategies, which is external scaffolding. We also suggest these two types of scaffolding should be embedded into the learning tasks and learning processes in online learning.

**Conclusion**

In this paper, we first reviewed the self-regulated learning literature. We proposed there are two types of self-regulation processes. The first type of self-regulation is the individual regulation process and the second type is the co-regulation process among a group of learners. In online learning environments, where context mediate human interaction, we argue self-regulation should be defined based on what type of learning process in which they will need to be engaged. Online learning demands students to be independent learners through individual regulation. At the same time, it demands students to be good negotiators and collaborators through co-regulation with others. Therefore, the definition of self-regulation in online learning environments should cover individual and co-regulation. Based on these assumptions, we define self-regulated learners in online environments as those who have knowledge about themselves as a learner, independent learners and/or collaborators. Furthermore, students' self-regulation can be supported by scaffolding and instructional designers and instructors should consider the context when they scaffold student self-regulation in online learning.

**References**


Butler, D. L. (2002). Qualitative approaches to investigating self-regulated learning: contributions and challenges. *Educational Psychologists,* 37(1), 59-63.

Cho, M. H. (2004). The effects of design strategies for promoting self-regulated learning skills on students' self-regulation and achievements in online learning environments. In the *Proceedings of the Annual Meeting of the Association for Educational Communication and Technology (AECT) National Convention,* October 19-23, 2004, Chicago, IL.

Heo, H. (2000). Theoretical understandings for structuring the classroom as self-regulated learning environment. *Educational Technology International*, 2(1), 31-51.

Hofer, B. K., Yu, S. L., & Pintrich, P. R. (1998). Teaching college students to be self-regulated learners. In D. H. Schunk & B. J. Zimmerman, (Eds). *Self-regulated learning; From teaching to self-reflective practice*, (pp. 57-85). New York, NY: Guilford Press.

Hofer, B. K. (2004). Introduction: Paradigmatic approaches to personal epistemology. *Educational Psychologist*, 39(1), 1-3.

Hron, A. & Friedrich, H. F., (2003). A review of web-based collaborative learning: factors beyond technology. *Journal of Computer Assisted Learning*, 19, 70-79.

Lim, C. I. (2002). The development and effects of design and implementation strategies for supporting web-based self-regulated learning. *Educational Technology Research*, 18(4), 3-23.

McCaslin, M., & Good, T. L. (1996). The informal curriculum. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of educational psychology*, (pp. 622-670). New Your: Simon & Schuster Macmillan.

McCaslin, M., & Hickey, D. T. (2001). Self-regulated learning and academic achievement: A Vygotskian view. In Zimmerman, B. J. & Schunk, D. H., 2nd (Eds.), *Self-regulated learning and academic achievement theoretical perspectives*, (pp. 227-252). New Jersey: Lawrence Erlbaum Associates.

Meyer, D. K., & Turner, J. C. (2002). Using instructional discourse analysis to study the scaffolding of student self-regulation. *Educational Psychologist,* 37(1), 17-25.

Perry, N. E., VandeKamp, K. O., Mercer, L. K., & Nordby, C. J. (2002). Investigating teacher-student interactions that foster self-regulated learning. *Educational Psychologist,* 37(1), 5-15.

Shin, M. (1997). The effects of self-regulated learning environments on achievement and motivation in problem solving. Unpublished doctoral dissertation, Florida State University, Tallahassee, FL.

Shunk, D. (2000). *Learning theories: An educational perspective*. New Jersey, NJ: Prentice-Hall.

Schunk, D. & Zimmerman, B. (Eds.) (1998). *Self-regulated learning; From teaching to self-reflective practice*. New York, NY: Guilford Press.

Zimmerman, B. J. (1990). Self-regulated learning and academic achievement: An overview. *Educational Psychologist,* 25, 3-17.

Zimmerman, B. J. (1998). Developing self-fulfilling cycles of academic regulation: An analysis of exemplary instructional models. In Schunk D. H. & Zimmerman, B. J. (Eds.), *Self-regulated learning from teaching to self-regulative practice*. New York: The Guilford Press.

Zimmerman, B. J. (1999). Commentary: toward a cyclically interactive view of self-regulated learning. *International Journal of Educational Research.* 31, 545-551.

Zimmerman, B. J., Bonner, S., & Kovach, R. (1996). *Developing self-regulated learners; Beyond achievement to self-efficacy*. Washington, DC: American Psychological Association.

# The effects of teaching nature of science on conceptual change

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**Abstract**

*Students bring misconceptions about evolution theory to the classroom before they learn the offered content. These misconceptions are not easily replaced with the correct conceptions even after a semester course. Many researchers argued teaching students about nature of science would contribute to changing their misconceptions. However, little empirical research has been done. We investigate the effects of teaching nature of science on students' conceptual change. The results show that teaching nature of science in the class does not influence students' conceptual change. Implications of this research are discussed.*

**Introduction**

Learning is a process of conceptual change (Posner, Strike, Hewson, & Gertzog, 1982). Ideally, conceptual change occurs through learner's proactive revision and reorganization of the preexisting knowledge. In this case, learners' preexisting knowledge is helpful to promote conceptual change. However, in science education, students' preexisting conceptions often prohibit students' conceptual change. In many cases, students' preexisting conceptions are recognized as misconceptions.

Misconceptions are defined as the concepts that have particular interpretations and meaning in students' articulations that are not scientifically accurate (Bahar, 2003). Common examples of student misconceptions include: 1) belief that species evolve because of their own "needs", 2) belief that "use" or "misuse" of some functions determines the form of species, 3) belief that the environments influence species evolution in short time periods (Bishop & Anderson, 1990), and 4) belief that Lamarckian concepts are appropriate to explain evolution theory (Cunnigham & Wescott, 2003). Students' misconceptions are the results of their intuitions, everyday experience, and cultural backgrounds (Vosniadou, 1992). Although students' misconceptions are naïve, they explain their misconceptions with coherent mechanism. That's why misconceptions are hard to change even after the instruction. In particular, students' misconceptions about evolution theory in biology class are not easily changed.

Many researchers (Scharmann & Harris, 1991; Qian & Alvermann, 2000) argue students' beliefs about the nature of science (NOS) are a critical factor to promote the students' conceptual change. Qian and Alvermann (1995) found the high school students who have immature beliefs on the nature of science think that scientific facts are a product of an empirical process and science exists to make human life more convenient through technology. Due to these immature beliefs on the nature of science, the students don't understand the multiplicity and complexity of the scientific disputes. Also, this rigidity of the beliefs on the nature of science hinders them from changing their misconceptions (Qian & Alvermann, 2000).

Researchers (Demastes, Good, & Peebles, 1995; Pintrich, Marx, & Boyle, 1993; Sharmann & Harris, 1991; Qian & Alvermann, 2000) argue teaching nature of science would contribute to conceptual change. Scharmann and Harris (1991) argued that understanding of the nature of science will promote the students' conceptual change. Although many researchers argued the importance of teaching nature of science, there is little empirical research to support their arguments. The primary purpose of present research is to investigate the effects of teaching nature of science on students' conceptual change. The second purpose is to identify what misconceptions non-biology-major college students have. More specifically, our research questions are

1. Is teaching students about nature of science effective for conceptual change in natural selection?
2. What misconceptions college students bring to the class?
3. What misconceptions have not been changed after the instruction?

## Methodology

### Participants

The participants for this research were undergraduate students who enrolled in Introduction to Biological Anthropology in a mid-west university. 126 students enrolled the class and most of them are non-major students. Among them, 37 students volunteered. 28 students were female and 9 were male. Also, 34 students' were between 18 to 21 years of age. Ten students were freshmen, 20 students were sophomores, two students were juniors and five students were seniors. Twelve students took one biology course in high school or college and 12, 6, and 2 students took two, three, and over four biology classes, respectively. Five students had never taken a biology class before this class.

### Learning Context

"Introduction to Biological Anthropology" fulfils a university biological science credit requirement, and a math reasoning requirement if taken in conjuction with a laboratory course. Attendance in a class is not required, but attendance in the laboratory is required. The instructor gave one hour lecture three times a week, and note summaries were available through the WebCT course management system. The curriculum covered nature of science, development of evolution theory, forces of evolution, taxonomy and primates, and paleontology.

### Instrument

In order to identify students' conceptual change, a quantitative survey questionnaire was distributed before and after students learn natural selection. The questionnaire was developed by Anderson, Fisher, and Norman (2002). The survey consists of 20 items and asks about important conceptions of natural selection such as biotic potential, variation within a population, variation inheritable, differential survival, origin of species, population stability, and so on.

### Procedures

Before students learned natural selection part, which is the fourth week of the class, we visited the classroom and explained the purpose and importance of this research. We distributed Anderson, Fisher, and Norman's (2002) conceptual inventory of natural selection to students as a pre-test. Seven weeks after students learned natural selection, we administered the conceptual inventory of natural selection again as a post-test.

### Teaching nature of science

The instructor provided students an orientation about what science is, how theory is developed, and the relationship between science and religion for a week. In addition, he reminded students what science is, how theory developments can be applied to understand natural selection and evolution theory during the semester. His teaching is based on revision of Firenze (1997)'s suggestions. Firenze suggested five process of introducing evolution theory to students; engage, explore, explain, elaborate, and evaluate. In this class, the instructor revised the Firenze (1997)'s suggestions as follows:

1. Engage: introduce some morphological, physiological, and/or behavioral adaptation.
2. Explore: form discussion groups and prompt the students with questions that are related to their misconceptions.
3. Explain: have the groups present their ideas and encourage students to provide constructivist critiques with each other.
4. Elaborate: provide feedback on the progress and effectiveness of the learning activity.
5. Evaluate: provide each student with similar problem and ask them to solve it.

## Results

Repeated Measures ANOVA was conducted to identify the mean difference between the pre and post test after the instruction. There was no significant difference between the pre and post test, $t\ (36) = -.1.636$, $p > 0.5$. This means introducing NOS does not statistically effect conceptual change. However, students' post test results ($M=15.72$, $SD=3.011$) was slightly higher than the pre test results ($M=15.25$, $SD=3.111$).

Using Anderson, Fisher, and Norman's (2002)'s instrument, we analyzed what misconceptions students had before they learn the content, and what misconceptions had not been changed after the class. The summarization is presented in Table 1. The frequencies of checking alternative concepts, which are misconceptions, are presented in pre and post test columns. Misconceptions are presented with the questionnaire items. Remember the number in the cell does not mean the number of students but the frequencies of students' having the misconceptions.

The pre-test column in Table 1 shows that non-biology-major college students in Introduction to Biological Anthropology do not have as many misconceptions about natural selection as expected. The misconceptions they had before they learn the content were "populations level off" in biotic potential; "Fitness is equated with strength, speed, intelligence or longevity" in differential survival; "Changes in a population occur through a gradual change in all members of a population" in Change in a Population in change in a population; "Mutations occurs to meet the needs of the population;" "Organisms can intentionally becomes new species over time (an organism tries, wants, or needs to become a new species)" in origin of a species and "Mutations are intentional: an organism tries, needs, or wants to change genetically". Post test column in Table 1 shows what misconceptions have not been changed after the class. The only misconception to significantly change after instruction is "changes in a population occur through a gradual change in all members of a population".

Table 1. Students' Misconceptions in Natural Selection before and after the Class

| Topic | Alternative Conceptions | Pre | Post |
|---|---|---|---|
| Biotic Potential | Not all organisms can achieve exponential population growth (11C) | 0 | 0 |
| | Organisms only replace themselves. (1A, 11A) | 1 | 0 |
| | Populations level off (1B, 11D, 1D) | 18 | 17 |
| Population Stability | All populations grow in size over time (3A, 12B) | 0 | 0 |
| | Populations decrease (3D, 12C). | 1 | 0 |
| | Populations always fluctuate widely/ randomly (3C, 12D). | 2 | 5 |
| Natural Resources | Organisms can always obtain what they need to survive (2B, 2C, 2D, 14A, 14B, 14C) | 7 | 8 |
| Limited Survival | There is often physical fighting among one species (or among different species) and the strongest ones win (5B, 15B). | 3 | 1 |
| | Organisms work together (cooperate) and don't compete (5A, 5C, 15A). | 2 | 3 |
| Variation Within a Population | All members of a population are nearly identical (9A, 16A). | 0 | 1 |
| | Variations only affect outward appearance, don't influence survival (9B, 9C, 16B). | 7 | 7 |
| | Organisms in a population share no characteristics with others (16D). | 1 | 0 |
| Variation Inheritable | When a trait (organ) is no longer beneficial for survival, the offspring will not inherit the trait (7B, 7B). | 5 | 7 |
| | Traits acquired during an organism's lifetime will be inherited by offspring. (7A, 17A) | 0 | 0 |
| | Traits that are positively influenced by the environment will be inherited by offspring (7D). | 3 | 3 |
| Differential Survival | Fitness is equated with strength, speed, intelligence or longevity (10A, 10B, 18A, 18C, 18D). | 16 | 12 |
| | Organisms with many mates are biologically fit (10D). | 7 | 1 |
| Change in a Population | Changes in a population occur through a gradual change in all members of a population (4A, 13A, 7C). | 22 | 9 |
| | Learned behaviors are inherited (4C, 13C). | 0 | 4 |
| | Mutations occurs to meet the needs of the population (4D, 13D) | 17 | 11 |
| Origin of a Species | Organisms can intentionally become new species over time (an organism tries, wants, or needs to become a new species) (8C, 8D, 20A, 20D) | 22 | 19 |
| | Speciation is a hypothetical idea (8B, 20C). | 1 | 1 |
| Origin of the Variation | Mutations are adaptive responses to specific environmental agents (6C, 15C, 19D). | 7 | 6 |
| | Mutations are intentional: an organism tries, needs, or wants to change genetically (6A, 6D, 19A, 19B). | 23 | 25 |

**Discussion**

Our research results show that teaching college students nature of science does not statistically alter conceptual change. There could be several reasons. First, the duration of NOS teaching is too short. That is, one week teaching of natural of science does not influence students' understanding of science. Considering students' misconceptions are results of their everyday life experience, cultural background, and community philosophy (Qian & Averman, 2000), one week instruction may not influence student's understanding of nature of science. Second, students did not apply the nature of science into their learning context, which is natural selection. Knowing and applying are different issues. Southerland and Sinatra (2003) distinguished understanding and accepting. According to them, if the task is controversial or complex, learners' acceptance and learners' understanding are not related. In this case, students' intentional efforts are more necessary for their conceptual change. Learning natural selection is a complex and can be controversial issue depending on persons. Therefore, learning natural selection requires students to actively participate in learning process with high motivation and appropriate deep process of learning strategies (Printrich, Marx, & Boyle, 1993). Last, students may not understand the importance of learning nature of science. If students do not value learning nature of science, they will not deep process and pay less effort to learn natural selection (Pintrich, Marx, & Boyer, 1993). Furthermore, they will not apply the nature of science into their learning context (Jonassen, Marra, & Palmer, 2002).

In this research, the instrument results showed that students' do not have many misconception about natural selection compared to previous research (Cunningham & Wescott, 2003). Students' pre test mean was 15.25. Cunningham and Wescott (2003) reported the misconceptions over 50% of the college students among 229 have the misconception that species' characteristics gradually change over time and that individuals evolve because they need to. However, in our research, we were not able to find those high rates of misconceptions. Most of students' misconceptions about natural selection in this research were at relatively low rates.

Interestingly, the misconceptions we observed were identified in previous research (Bishop & Anderson, 1990). At this point, we raise the questions, why students have similar misconceptions over time and why these misconceptions are not changed even after the class? Does this mean our educational system has not been changed over time even though a lot of different instructional strategies (e.g., constructivists learning environments, goal-based scenario, situated learning, and so on) and new technologies are integrated in science education? Discussing about this issue will be endless.

Last, our research found that students' misconceptions in natural selection are not easily changed even after the class. The results are in line with other research results (Bishop & Anderson, 1990). We found only one concept showed statistically significant change; "Changes in a population occur through a gradual change in all members of a population". Then, what is the difference between the concept changed and concepts having not been changed? More qualitative research should be conducted to identify the difference between two kinds of concepts. If we found the difference between two concepts, it will contribute to teaching natural selection and evolution theory.

**References**

Anderson, D. L., Fisher, K. M., & Norman, G. J. (2002). Development and evaluation of the conceptual inventory of natural selection. *Journal of Research In Science Teaching*, 39(10), 952-978.

Bahar, M. (2003). Misconceptions in biology education and conceptual change strategies. *Educational Science: Theory & Practice*, 3(1), 55-64.

Bishop, B. A, & Anderson, C. W. (1990). Student conceptions of natural selection and its role in evolution. *Journal of Research In ScienceTeaching*, 27(5), 415-427.

Cunningham D. L. & Wescott, D. J. (2003). *Addressing student misconceptions about human evolution*. Presented in American Association Physical Anthropology.

Demastes, S. S., Good, R. G., & Peebles, P. (1995). Students' conceptual ecologies and the process of conceptual change in evolution. *Science Education*, 79(6), 637-666.

Jonassen, D. H., Marra, R. M., & Palmer, B. (2002). Epistemological development: An implicit entailment of constructivist learning environments. In S. Dijkstra & N. Seel (Eds.), *Instructional design: International perspectives*, vol. 3. Mahwah NJ: Lawrence Erlbaum Associates.

Pintrich, P. R., Marx, R. W., & Boyle, R. A. (1993). Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. *Review of Educational Research*, 63(2), 167-199.

Posner, G. J., Strike, K. A., Hewson, R. W., & Gertzog, W. A. (1982). Accommodation of scientific conception: Toward a theory of conceptual change. *Science Education*, 66(2), 211-227.

Qian, G., & Alvermann, D. E. (1995). The role of epistemological beliefs and learned helplessness in secondary school students' learning science from text. *Journal of Educational Psychology*, 87, 282-292.

Qian, G., & Alvermann, D. E. (2000). Relationship between epistemological beliefs and conceptual change learning. *Reading & Writing Quarterly*, 16, 59-74.

Scharmann, L. C., & Harris, W. H. (1991). Teaching evolution: Understanding, concerns, and instructional approaches. Paper presented at the annual meeting of the National Association for Research in Science Teaching, Fontana, WS.

Southerland, S, A., & Sinatra, G. M. (2003). Learning about biological evolution: A special case of intentional conceptual change. In G. M. Sinatra, & P.R. Pintrich (Eds.), *Intentional conceptual change*. New Jersey: LEA

Vosniadou, S. (1992). Knowledge acquisition and conceptual change. *Applied Psychology:An International Review*, 41, 347-357.

# Computer Conferencing for Technology Integration and Digital Equity

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**Abstract**

*The Minnesota Educators and Leaders Technology Initiative (MELTI) contributes to technology integration and digital equity through computer-supported collaborative learning activities and other project activities. The computer-supported collaborative learning (CSCL) activities that include asynchronous, synchronous, and video conferencing are designed to address issues of integration faced by the MELTI participating schools. The notions of social inclusion and technology literacy play a key role in the CSCL activities design for the purpose of overcoming barriers to digital equity.*

## Introduction

Traditionally, digital divide is perceived in terms of a gap between the 'haves" and have-nots." However, recent discussions have shifted the focus to social inclusion as the key to bridging the digital divide (Cisler, 2000; Commission of the European Communities, 2001; Warschauer, 2002). Social inclusion is defined as the "process by which efforts are made to ensure that everyone, regardless of their experiences and circumstances, can achieve their potential in life. To achieve inclusion income and employment are necessary but not sufficient. An inclusive society is also characterized by a striving for reduced inequality, a balance between individuals' rights and duties and increased social cohesion." (Centre for Economic & Social Inclusion, 2002). With 98% of K-12 schools in the United States wired to the Internet (Advanced Learning Technologies, 2002), access to hardware is no longer the issue. Access to technology integration into curriculum and technology literacy has become the top priority in overcoming the barriers to digital equity in the K-12 system. Educators need to be empowered with the knowledge, skills, and institutional support in technology integration in order to help bridge the gap. Policy makers and school leaders need to provide the provisions and institutional support for a more comprehensive plan to support the cause. This paper introduces how in-service teachers (i.e., licensed teachers currently teaching in the classroom) work together to bridge the divide in the K-12 classrooms through computer conferencing and face-to-face training. The Minnesota Educators and Leaders Technology Initiative (MELTI) aims to enhance K-12 educators' technology competency and establish cadres of collaborative teaching partnership for technology integration. Computer-supported collaborative learning (CSCL) activities that play a key role in the MELTI project will be described in this paper.

## Literature Review

In the digital age, it is no longer enough to provide hardware and software to educators. Educators need professional training in the use of information and communication technology (ICT) and empowerment in the best practices in integrating technology into the curriculum. Furthermore, Warschauer (2002) contends that the traditional notion of a digital divide as the bipolar disparity in societal resources provides an oversimplified and poor roadmap for utilizing technology to bridge the gap. He maintains that there is no binary divide and social inclusion is the key in dealing with the complex issue. He advocates a model of technology for social inclusion that takes into account physical, digital, human and social resources to promote effective use of ICTs. These four areas of resources are defined in the following terms:

Physical resources encompass access to computers and telecommunication connections. Digital resources refer to digital material that is made available online. Human resources revolve around issues such as literacy and education (including the particular types of literacy practices that are required for computer use and online communication). Social resources refer to the community, institutional, and societal structures that support access to ICT" (Warschauer, 2002).

This model presents a comprehensive approach to promote digital equity that involves every sector of the society. The current practice has put much emphasis on providing physical and digital resources. Policy makers, school leaders, educators, and the community are equal contributors to the effective use of ICTs and need to be part of the overall planning of ICT integration.

In examining the barriers to digital equity in education, Fulton & Sibley (2003) have focused on the issue of access to the following resources:

- Access to up-to-date hardware, software, and connectivity
- Access to meaningful, high-quality, and culturally responsive content along with the opportunity to

contribute to the knowledge base represented in online content
- Access to educators who know how to use digital tools and resources effectively
- Access to systems sustained by leaders with vision and support for change through technology (p. 15)

Educators need to have access to high-performance technology so that they can fully utilize various digital resources and applications effortlessly. Researchers have found that 22 million Americans who live below $14,500/year lack the literacy skills to use the Internet (Lazarus & Lipper, 2000). Without increasing the literacy level, more Americans will be ignored and continue without the benefits of what Internet resources can offer them. Furthermore, educators need to have access to innovative pedagogy and good examples of teaching with digital resources. While an increasing number of school districts have recognized the importance of providing professional training opportunity for teachers, school leaders also need to be more active in participating in the process to support the change.

The model of technology for social inclusion and discussion regarding barriers to digital equity have shaped the theoretical framework in the design of computer-supported collaborative learning activities mentioned in this paper. CSCL systems are powerful media for professional development in teacher education. CSCL environments can encourage conversation (Jenlink & Carr, 1996), reflection, idea sharing, interaction, knowledge construction (Scardamalia & Bereiter, 1996), and community building (Pea, 1993). CSCL has become an integral part of teacher education. The following sections will describe how these theories are infused into the design of CSCL activities in the MELTI project.

## Background

The MELTI project is a one-year grant project that is supported by the E2T2 Grant from the Minnesota Department of Education. Two strands of training for both K-12 school leaders and teachers are provided. This paper will focus on the training for K-12 teachers. The MELTI project consists of sixteen charter schools, two public schools, and two private schools. Charter schools are independent schools designed and operated by educators, parents, community leaders, entrepreneurs and others. Charter schools are exempt from many state and local regulations. The member schools have a high number of minority students, including Hmong (Asian), African, and Hispanic Americans. School educators who participate in the initiative will complete a two-part professional development program in technology integration. The first part consists of a four-course twelve-credit graduate certificate program in learning technology at the University of St. Thomas. The second part features a capstone seminar in which participants showcase the best practices of technology integration and share experience in the implementation of technology-enriched curriculum.

The participants in the Learning Technology Program explore ways to (1) improve classroom learning through the application of innovative technologies to instruction and curriculum development, (2) understand, demonstrate and integrate essential educational technology tools, and (3) become leaders in educational change. As a result of the graduate certificate program, graduates are able to communicate, design, and implement innovations in their classrooms and communities.

Sixty educators receive free training and participate in the Learning Technology Program. There are three cohorts of twenty students each, two in the Metro Twin Cities area and one in Duluth (200 miles from the Twin Cities). They will receive a graduate certificate of Learning Technology when they complete the four courses in the program in the span of one year. The graduate program features the following courses: Introduction to Learning Technology, Internet Web Site and Educational Software Evaluation, Design and Development of Digital Media, and Integration of Technology into the Classroom. Each course addresses the International Society for Technology in Education (ISTE) National Educational Technology Standards (NETS) for teachers. All of the courses are designed based on the adult learning model and on project-based learning. The participants will devise projects with practical and direct application in the classroom.

The central themes woven into the program are the design of an e-Folio to support professional development, the employment of data-driven decision-making tools for student performance analysis, and the integration of technology into the curriculum. To fulfill the requirements for each course, participants will present an integration project using a technology tool that is to be directly applied in the classroom or community.

Participants will have access to several Web-based authoring tools, tutorials, and conferencing systems. In addition to Blackboard as the main course management system and conferencing medium, video-conferencing is also utilized for guest speakers and virtual tours. This initiative will provide the hardware and software needed for the participants to ensure that there is no digital disconnect between professional development and classroom practice. Participants will have the support of tech mentors and program advisors during the implementation process.

## CSCL Activities

Several CSCL activities are built in all four courses. Cohort members are encouraged to collaborate on various projects throughout the program. The activities are designed to address the two themes of the MELTI projects: technology integration and digital equity.

### CSCL for technology integration

Throughout the program, participants meet on a regular basis for professional development and stay connected through asynchronous communication in Blackboard. Several projects were designed to assist them with technology integration in the classroom. As of the writing of this paper, the first course has just begun. Formative and summative evaluation will be conducted during the course and at the end of the project. Here is a summary of the projects that will be carried out through the Blackboard Discussion Board and other CSCL systems:

1. Project gallery: Each student has to present an electronic portfolio with artifacts that address the ISTE standards to demonstrate their competency and progress in using technology. The artifact refers to an integration project developed in each course. It can be a PowerPoint presentation or a Web-based lesson. They will be adding new artifacts at the end of each course. The eFolio Minnesota, a free web-based portfolio authoring system for Minnesotans, is used for the participants to present the artifacts for the portfolio. The participants can choose to present either a teaching portfolio or a professional portfolio or both. The eFolio addresses are posted in Blackboard for peer review. Each participant will have to review at least two other eFolios and provide feedback.
2. Community building: In addition to the regular Blackboard course web site for each class in every cohort, a community Blackboard site is set up to provide a common space for members of different cohorts to share ideas and projects. Normally, participants would only review and critique the projects from members of the same cohort. By creating a community site, they will have a chance to see all three cohort members' accomplishments and learn from each other.
3. Video-conferencing: With the support of the grant, Web Cams are purchased to support collaboration among the cohort members. Teachers can use the video cameras in their classrooms for cross-school collaboration. For example, a 10th grade teacher can assign his or her students as the buddies for the third grade students of another cohort member in another school through video conferencing to explain a concept or present a project. The teachers are also encouraged to find international partners in other part of the globe for cross-cultural collaboration.
4. TappedIn group conferencing: Teachers are introduced to TappedIn (http://tappedin.org), an "online workplace of an international community of education professionals." They can create an office space and specialized groups for class meetings. The TappedIn environment has both synchronous and asynchronous components which are perfect for schools that do not have their own course management systems. The teachers can bring their students to meet with a class from another state to discuss specific issues such as weather or water conservation across different cultures.

### CSCL for Digital Equity

Many of the MELTI activities are designed based on Fulton and Sibley's (2003) framework of the barriers to the educational equity in a digital age. With the grant support, each participant is provided with a pen drive for data storage and coupons for purchasing software. Forty laptops are purchased and set up to provide in-class instruction. At the end of the cohort, the laptops will be dismantled and given to all participating schools. In addition to the professional development opportunity with the Learning Technology Program, onsite coaching will be provided to all schools on special topics. The grant will pay for experts to conduct workshops on a specialized topic about which the teachers from the same school would like to learn more. The computer conferencing activities are also set up for the purposes of providing a venue for teachers to strategize ways to overcome the barriers to digital equity.

1. Spotlight presentation: The participants look for ways to use various technological or Internet resources to enhance classroom teaching. They will research on the web and present to the class innovative ways of employing technology that are appropriate for their classroom. The presentation and resources used will then be posted onto the Blackboard discussion board for follow-up discussion. The diverse background of the participants will help to enhance the breadth and depth of the presentation. Some teachers have easy access to computer labs with a wealth of computer resources. Some teachers are in a one-computer classroom and have no access to a computer lab. They can provide each other with ideas on how to maximize the learning process with the minimal resources through computer conferencing.
2. Technology literacy through virtual training: As Fulton and Sibley's (2003) research has found, a lack of

time and technological skills are no longer the main barriers to digital equity. Educational beliefs also shape the types of classroom activities (e.g., teacher-centered v.s. student-centered teaching). Teachers need to have access to other teachers who excel in using technology. Throughout the MELTI projects, excellent technology educators will be invited as guest speakers to meet with the cohort members through computer conferencing systems such as TappedIn and video-conferencing to discuss the pedagogical applications of various educational technology and showcase classroom projects.

3. Technology integration clinic: During the course of the MELTI project, teachers will be able to pose questions on a specific technology integration issue and solicit responses from cohort instructors and members. The technological backgrounds of the cohort members range from advanced users of technology to novice users who have little exposure to technology applications before joining the cohort. The clinic will provide a venue for teachers who need more support to ask questions. Participants who provide the most answers will be recognized at the capstone seminar at the end of the project.

## Conclusion

The long-term impact of the MELTI project has yet to be assessed. Formative evaluation is underway and summative evaluation will be conducted at the end of the project. In the evaluation, the emphases will be placed on the teachers' experience in all of the CSCL activities. What has worked and what hasn't worked for them? What are the obstacles or contributing factors to technology integration and digital equity? The MELTI project strives to provide the member schools and K-12 educators with physical resources (e.g., the hardware and software), digital resources (e.g., relevant technology integration lesson plans on the Web), human resources (e.g., technology literacy education), and social resources (e.g., community-based learning and institutional support). Through technology enrichment, teacher professional development, and leader training, the MELTI project aspires to minimize the barriers to digital equity. The collaborative and community-based model of the MELTI project will provide K-12 educators and leaders in the consortium with the skills, knowledge, and tools to integrate technology into classroom teaching.

## References

Advanced Learning Technologies (ALTEC). (2002). *21st Century learners: The need for tech-savvy teachers*. Retrieved August 31, 2004, from http://www.pt3.org/technology/21century_learners.html

Cisler, S. (January 16, 2000). *Hot button: Online haves vs. have-nots: subtract the digital divide (San Jose Mercury News)*. Retrieved November 19, 2004, from http://www.athenaalliance.org/rpapers/cisler.html

Centre for Economic & Social Inclusion. (2002). *Social inclusion.* Retrieved November 19, 2004, from http://www.cesi.org.uk/_newsite2002/social_inclusion/inclusion.htm

Commission of the European Communities. (2001). *e-Inclusion: The Information Society's potential for social inclusion in Europe*. Retrieved November 19, 2004, from http://europa.eu.int/comm/employment_social/soc-dial/info_soc/esdis/eincl_en.pdf

Fulton, K., & Sibley, R. (2003). Chapter 1: Barriers to equity. In G. Solomon, N. J. Allen & P. Resta (Eds.), *Toward digital equity: Bridging the divide in education* (pp. 14-24). Boston: Pearson Educational Group.

Jenlink, P., & Carr, A.A. (1996, January-February). Conversation as a medium for change in education. Educational Technology, 31-38.

Lazarus, W., & Lipper, L. (2000). *Online content for low-income and underserved Americans: The digital divide's new frontier*. Retrieved November 19, 2004, from http://www.childrenspartnership.org/pub/low_income/index.html

Pea, R. D. (1993). Practices of distributed intelligence and design for education. In G. Salomon (Ed.), *Distributed cognition: Psychological and educational considerations* (pp. 47-87). Cambridge, England: Cambridge University Press.

Scardamalia, M., & Bereiter, C. (1996). Adaptation and understanding: A case for new cultures of schooling. In S. Vosniadou, E. D. Corte, R. Glaser & H. Mandl (Eds.), *International perspectives on the design of technology-supported learning environments* (pp. 149-163). Mahwah, NJ: Lawrence Erlbaum Associates.

Warschauer, M. (2002). *Reconceptualizing the digital divide*. Retrieved November 19, 2004, from http://www.firstmonday.org/issues/issue7_7/warschauer/index.html

# Enhancing Science Field Trips with a Digital Camera

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**Abstract**

*Digital cameras in the science classroom can be used as a tool to enhance field trips. Field trips are meant to provide students with important hands-on experiences to further the goals and objectives of the curriculum. Many times they turn into no more than a day away from school. These trips can add value to the curriculum by providing pre-trip preparation, structured experiences on the trip, and experiences taken back to the classroom from the trip. The digital camera can be used to develop materials to use in preparation for the trip and record aspects of the trip to bring back to the classroom for further study. Although film based technologies can provide the same opportunities, the use of the digital camera provides a hassle-free way to capture, manipulate, and present images relative to the instruction.*

Field trips are designed to provide students with important hands-on experiences to further the goals and objectives of the curriculum. Many times these trips turn into no more than a day away from school. In order to add value to the curriculum, field trips should provide valuable content information to connect what is being studied in the classroom with the out of school world. Teachers must carefully plan the experience prior to the trip to include relevant content and methodologies related to the instructional experience. There are three distinct stages of a well-planned field trip. First is the pre-trip preparation of the students, second the experience of the trip and thirdly the use of the trip experiences in subsequent instruction.

The pre-trip preparation includes an overview of the visit and tasks to be accomplished for further study after the trip. On the trip experiences should be structured so that they directly correlate with the experiences back in the classroom. The camera can be used to develop materials to use in each of these stages. Using a digital camera provides a relatively easy way to capture, manipulate, and present images to be used in the instructional process. Film based technologies can be used to provide these materials but is a much more cumbersome process. On the field trip, incorporating visual images enriches the experience by allowing the students to process information visually. This limits the need for students to write and make sketches of what was seen on the trip. Photographing with a digital camera provides images that can be viewed and/or downloaded immediately. Images can be analyzed in the field and if undesirable can either be retaken immediately or deleted. The ability to delete unwanted images and to manage storage space allows the user to get the picture they want and maximizes the number of usable pictures taken. Digital cameras save pictures in standard JPEG format, which is compatible with a wide variety of computer programs and can be directly inserted and integrated into word processing, database, desk-top publishing and presentation programs. Cost of image use, following the initial outlay of funds for a digital camera and storage device (flash card or floppy disk) is minimal. Therefore, one time funding provides equipment and materials for use over several trips and years. Eliminating continuous costs encourages teachers and student to use the camera frequently.

**Using the Camera as a Pre-trip Tool**

Using the camera to develop pre-trip activities requires teachers to produce material to provide the students with an overview of the coming experience. Pictures of the site to be visited serve as an advanced organizer or anticipatory set to the field trip. These materials can be used to prepare students to pursue problem tasks in small group investigation on the trip by providing images of actual examples of what they will see. This will help the teacher explain the tasks to be studied in the context of the trip. Presetting of the task eliminates the need to use valuable time on the trip. As these tasks are being set, they should be integrated into the content of the curriculum that the field trip is to complement. During instruction, a lesson on the specific concepts that provide the prerequisite skills necessary for a task, or observation, could include the images from the location of the trip. When working on concept development (giving examples and non-examples), images from the field trip location could be included. Use of a digital camera can provide images for first observation opportunities. Often times when we first observe something, we do not know what to look for. Using these images the student can note specifics and then on the trip they can focus on these specifics and go beyond them.

**On the Field Trip**

Using the camera on the field trip provides the opportunity to preserve aspects of the experience that can then be brought back into the classroom for further study. While on the trip students can document their investigations by taking pictures of relevant experiences. They can gather images of specific items that have been predetermined to fit into a database of information, and to look for trends, patterns and functions. Finally they can use the images to record events, not limited to those which have been predetermined, that will be used for future study when back in the classroom.

**After the Field Trip**

After the field trip the student could use the digital images taken on the trip in follow up classroom lessons to complete the tasks started in the field. The use of field manuals to identify the specific species observed and to look for similarities and differences in members of a population are examples of this type of task. Students can develop presentations of their investigations in either a show and tell experience at the primary level or a report of the study that would incorporate both text and images at the middle grades and secondary school levels. On a field trip designed to collect information for further study the images would provide an important part of the base for subsequent instruction. In tasks focusing on research of specific topics, the images provide data to either support or refute pre-field trip hypotheses and suggest other hypotheses for investigation.

## Illustrations of Three Field Trips

Three field trips that can be taken in the K-12 situation will be used to illustrate the use of the digital camera as an enhancement for the experience. At the early primary level, field trips are taken to explore the student's community and its workers; an example of a field trip to a local beekeeper will be used. The middle grades, where field trips provide students with an opportunity to simulate activities done in the world of work, the example will be a study a biological habitat of a coastal barrier island. The secondary field trip, designed to bring content into the classroom to analyze, will investigate the integration of geometry into the structural design of the community and its buildings following a visit to a city or construction site.

**Primary Grades**

At this level, social studies objectives focus on the community and the interdependence of its members, science is working on process skills such as classification and observation and the content objectives of the animal life around us, and math is working on serration and classification. The study of honey and its production is an appropriate topic and one that will capture the student's interest. The study should include the process and sequence of honey production, the care of the insects, and the distribution of the products. A pre-trip presentation of the overview will familiarize students with what they will see. There are many things the students can do and see on a trip to the bee yards, including the bees. They need to know safety behaviors to eliminate startling the bees and to reduce the chance of getting stung. Young children viewing bees for the first time may become excited, crowd around the bees to get a closer look or run away in fear. The beekeeper will smoke the bees to make them less active. Children made familiar with the purpose of smoking and what the bees and the supers look like through digital images before coming on the field trip can remain calm and take turns viewing the live bees without pushing and shoving, or showing signs of fear that may alarm the bees. On the trip, students will be given a chance to view the bees, the extraction of the honey from the supers, the bottles of honey and the wax, in addition to doing a little research on the site. One of the research tasks for students could be to investigate where the bees gather their nectar. For this task the teacher would define survey areas by loops and have the students survey the bee activity within each area. These survey areas would include a variety of flower populations and the students would tally the number of bees moving in and out of the area as part of the survey. This task requires students to be able to tally information. The prerequisite instruction on this could include a picture of an area they will see on the field trip, with bees. The students count the bees in the picture and make a tally mark for each bee seen. While the concept to be generalized is taught using many different examples including an example from an upcoming field trip makes the task on the trip familiar when the students are asked to do it.

At a primary level most of what we want the students to do is work on gathering broad-based awareness of the experience. On the trip students could take pictures of what they see to help recall the experience and set it in their knowledge base. While developing a formal database may not be conducive to every field trip topic and age range. Children could take pictures of all the types of flowers they see the bees on and use the survey data begin to sort by the number of times a bee went to each type flower. This would provide a knowledge base from which to discuss how different types of honey are formed, i.e., orange blossom, clover, and blackberry. Pictures of anything unusual that a child or teacher saw could be taken, the children can discuss the trip and determined more questions to ask on a follow-up visit by the bee keeper to the classroom. The teacher and the beekeeper could take additional pictures that may help answer theses questions after the students made the trip.

**Middle Grades**

In middle grades science, students study the knowledge base of the interdependence of the separate populations in a specific habitat. In mathematics, they use numbers to quantify trends and predict the future. An overview of the biological habitat of a coastal island provides the students with a chance to study the effects of the different types of land forms and their plant life (the beach, primary dunes, inter dune meadows, secondary dunes, the maritime forest and the marshes). The use of pre-trip visuals encourages the students when on the trip to focus in on more detail and specific variations then a first time viewing would allow. A student who knows what to look for will begin finding instances of the concept immediately. The teacher on this trip would want the students to not only note the different zones and their habitat but to also pick a specific aspect to study, such as the plant or animal populations. On the beach, one of the task groups may be assigned to study ghost shrimp populations. Photographs of the area of the beach where ghost shrimp are located, an active ghost shrimp hole, and illustrations of appropriate survey techniques prepare the students to be able to begin the study upon reaching the beach without the need for the teacher to explain the task. A group assigned the task of studying live mollusks on the beach, that has the prerequisite knowledge of identifying the footprint of a mollusk, the track the animal leaves and what the animal looks like, can begin to locate live mollusks immediately. Unfortunately, at any one visit there is no guarantee that specific shelled animals will be present but from study before the trip using pictures, the students have trained their eye so they know what to look for and can transfer this knowledge to the animals present. On a trip, pictures of biological specimens of plants, shells, animals, birds, and insects could be taken and then looked up in the field guides back in the classroom. Using a field guide with the images after the trip will encourage the students to focus on the details of the specimen and spend time gathering more information on the trip. Using the guides they can note likeness and differences in specific specimens within and across species.

Databases could be developed of such things as bird sighting, shell types, crab sighting, etc. A database for a population such as birds gives students the chance to identify patterns in size of populations, time of day the birds are seen, behavior, and migratory patterns. The information in the database could be increased by the class or individual class members who might return to the site of the field trip over the year or by using data from previous class trips. Looking at other pictures in the database would lead to a discussion of the range of the bird. For instances, if a middle grades class kept the database beyond the field trip, students could record sightings of herons in many different settings and add it to the database. Sightings included in the database could be from the Atlantic Coast, Pacific Coast, Great Lakes, inland waterways, and marshes. A group looking at live seashells, when doing a population study, can bring back information showing the a footprint of a buried mollusk, the track leading to the animal, the uncovered animal to verify the type. The group could then take pictures to document the aspects being studied of the animal (if the survey addresses size, a picture with a measuring tool would provide evidence, without having to remove) before reburying. The images provide data in instances where it is undesirable to remove specimens due to environmental restrictions, possible hazards of handling an unknown specimen, or violating state or federal law.

**Secondary**

At this level, much of what we do is only successful to the degree the student sees how it is going to help them “in life”. Chances to make connections between the classroom and the world the student will be entering are always needed. In the geometry classroom, the use of the shapes and formulas in construction could be made apparent to the students. A field trip to a city will provide examples of the role geometry plays in the design and construction of a city. Images of different building and their functions would provide the “eye” necessary to view the actual buildings. A general presentation of buildings with accompanying architectural drawings, showing the relationship of the design to the finished product provides an overview of the trip. For example, showing an image of a finished hotel / motel constructed of individual modules which were built off site and imported into the construction site as prefabricated units could be used to illustrate how geometry is necessary to determine the relationships and measurements of each unit. Students on the trip could then look for current examples of this type of construction. Students given the task of looking for buildings showing examples of the architect’s use of golden rectangles, would be shown an example from an image of a building with this feature and would then search the city for further examples. Other mathematical principles that can be illustrated include the parallel postulate, instances of geometric solids, and use of similar triangles to determine height. When on the trip, documenting geometric application is done by taking pictures of a variety of buildings to provide a wide range of shapes used. Images would replace sketches and written notes. These images would then be imported into a draw program for future instruction. Pictures imported into a draw program can be analyzed to complete the given task. This could be done by manipulating and studying the characteristics of the shapes, using a grid superimposed on an image to develop formulas for geometric aspects of the building, or to show elements of projective geometry by drawing vanishing points. A database on buildings could be developed and might include the function of the building, the dimensions (including square footage of floor space & cubic volume of usable space) image of buildings and image of the building's environment to show esthetic qualities.

**Teachers: Using Digital Images After the Field Trip**

The images also have uses that are not included in the planning of the trip. The images could be used to enhance future instruction, evaluate the objectives related to the field trip, and provide documentation of the quality of instruction provided by the trip.

Teachers can build a collection of the digital images taken on the field trip for use in follow-up activities either identified in the planning stage, when questions that were not planned occur or at a later date if questions that relate back to the experience arise. Images from several field trips could be combined to compile a resource file for use with future classes. On field trips often times unique things occur that the teacher may want to preserve for use in future classroom presentations. A bee keeper may be requeening or medicating a hive; a bird or shell might be on the beach that is unusual or not in season during the field trip; or a building under construction would offer an opportunity for taking pictures to compare later with the finished product.

Images from the trip can be used when developing evaluation instruments of the content delineated by the curricular goals and objectives for which the field trip provided instruction. At the primary level a child could demonstrate their oral skills by giving show and tell reports of pictures taken on the field trip. At the middle grades and secondary level test questions could present a visual image and ask the students to identify or discuss the situation (e.g., include the identification and the use of plants for medical use, both historically and presently). Demonstrations of a student's ability to use research tools could be documented by presenting the student with a picture of a plant or animal and have him/her use the appropriate field guide to identify the specimen and its characteristics. For instance, birds in flight are often shown in silhouette in the field guide. This is very hard for the neophyte to see and remember in the field. Looking at a picture they can begin to compare what they saw with what is shown. Teachers can have students include images in papers and reports of investigations that will be used in portfolios and other authentic assessment situations of the student. Images collected from all trips could also provide excellent documentation of the quality of instruction the teacher is providing and could be included in a portfolio of their own work when needed.

The teacher could construct a virtual reality (VR) field trip to be used as part of the advanced organizer to prepare students, to be used after the trip to debrief the student, and discussion what was and was not seen. A VR field trip could provide students who missed the trip an opportunity to participate in the planned experience. In addition it could be used to allow the parent to see what the students will experience.

As teachers use and become familiar with the camera they will find that using the digital camera frees them from the worries and expense of film based pictures, the time consumption of processing images, and expands their ability to manipulate the pictures and insert them into classroom presentations.

# Use Technology to Facilitate Work Ethic Instruction

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John Dewey claims that the goal of education is intellectual and moral development. Work ethic has become increasingly important as a result of technological development and globalization, which change the nature of American work and workplace. Greater mobility, less direct supervision, and high-discretion work environments have made it necessary for people have strong work attitude. Researches also indicate that people's attitude greatly influences if organizations is competitive in the global market. (Ali & Azim 1993). In the Workplace Know-how identified by the SCANS (The Secretary's Commission on Achieving Necessary Skills) Report 2000 for American, interpersonal skills is listed as one of the important competencies an effective worker should have. In addition, personal qualities such as individual responsibility, self-esteem, sociability, self-management, and integrity, is listed as one of the three fundamental skills and qualities. Judy and Amico (1997) believe "behave dependably" is one of the key factors for basic education t o ensue the long-term success of workforce. As a result, work ethic has become an important issue.

Work ethic is often defined as "a cultural norm that advocates being personally responsible for the work that one does and is based on the belief that work has intrinsic value." (Cherrington, 1980; Colson & Eckerd, 1991; Quinn, 1983; Yankelovich & Immerwahr, 1984) It is often related to character development and employability skills. The key components of work ethic are initiative, interpersonal skills, and dependability (Hill, 2004). In modern workplaces, employees need to take initiative, to know how to cooperate with others and to be dependable. Despite the importance of work ethic in work, few schools in America have systematic work ethic instructions. Many teachers feel it hard to teach ethics. Research is needed to identify the content and method of work ethic instruction. (Hill 2003, 2004). Dr. Roger Hill attempted to put his research in work ethic into practice to facilitate work ethic instruction. With the wide spread of Internet technology, many instructors have taken the great advantage of the convenience it bring about to facilitate teaching and learning. Dr. Hill has been trying to utilize technology to facilitate work ethic instruction. Some examples of his effort are: collaboration with John Marshall High School, the creation of a work ethic instruction site, and opening of a graduate course on work ethic.

While attending a conference, Dr. Hill met Lynn Mrotek, who had developed a Career Pathways Program with her colleagues in John Marshall High School in Milwaukee, Wisconsin. Work ethic was an important component in their Career Pathways Program, which used Comprehensive 9-12th grade career discovery curriculum. It's a funded project by Carl Perkins Grant and supplemented by district STW funds. All students in the high school participated in the program. It used project-based assessments enhanced by technology. It also integrated academic and vocational skills.

To meet the school's special needs, Dr. Hill developed a 10-day unit, which includes case studies, class discussion, and learning activities. This part was in printed form at the time it was developed. With high demand for the material, it has been transferred into electronic version and put online with a password protection.

> To supplement the unit material, Dr. Hill created Work Ethic site (URL: http://www.coe.uga.edu/workethic). Work Ethic site offers comprehensive information on work ethic. The site includes online lessons, work ethic history, Occupational Work Ethic Inventory (OWEI) and Employability Skill Assessment (ESA). Both OWEI and ESA are dada-base driven and self-scoring instruments. The 10-day unit originally developed for John Marshall High School is also on the site. In addition, there are also references for work ethic research and links to Character Counts and Thought, Word, and Deed. The Chinese version of the site is also under construction.

**The pilot test** on the 10-day unit conducted in John Marshall High School indicates that 76% students rated it helpful and 24% rated it not helpful. Some feedback related to work ethic site are: organization of the web site and self pacing of internet format were good; but there were some problems with using the World Wide Web, computer lab, computer operation, and getting to web materials; the site needed more graphics and examples and used colored text to emphasize key ideas. Some data based on email messages received has also been gathered with regard to the site. Data analysis indicates that the work ethic site has produced wide-range and very positive effects. People from many parts of the world are able to get access to the site and get direct benefit in their work or study. 99% people commented that the site was very valuable and useful. Among the population, 21.5% people said they like the whole site very much and have used information of the site for teaching, learning, training and research purposes; 42.4% people were especially interested in using the 10-day unit for instruction and training; 17.9%

people required detailed information on interpretation of the scores resulting from taking the two online tests; 15.2% people sake further advices or information on the topic from Dr. Hill. Another effort Dr. Hill made in technology integration of work ethic instruction is the opening of a graduate course "Workforce Ethics for a Technological World". This is a 3 credits course. Students meet the instructor face-to-face only at the beginning, in the middle, and at the end of semester. The rest of sessions are conducted through Horizon Wimba through which students "meet" the instructor each week. During each class session, students can listen to instructor's presentation while watching PowerPoint slides and some other materials. Student can also do individual or group presentation. In addition, students and instructor can communicate with each other either through microphone or chat. There is also WebCT discussion board open to the class. All classes are archived. Email and Instant Messenger are also available. Students submit homework through email. As a result of the powerful technology, students in this class, most of whom are working people and live far away, can take the course while working full time. All students who have taken the course like the format of the class and enjoy taking it.

In general, Dr. Hill's effort in integrating technology into work ethic instruction has been quite successful. He has tried to take full advantage of available technology and his expertise in the area of work ethic to facilitate work ethic teaching and learning. Because of technology, a remote school can get instant help and guidance from a university faculty and people can get high quality work ethic instructional materials anywhere and anytime. With technology, more people are able to get further education while working. Next step will include developing a "Plan B" for those who cannot reach the site by providing printed materials or through other ways. It's also necessary to add a link to score interpretation for OWEI and ESA tests, which will provide more convenience for test takers. Meanwhile, further development of the site including instructional units is also crucial.

**References**


Ali, A & Azim, A. (1993). Work Ethic and Loyalty in Canada. The Journal of Social Psychology. 135(1), 31-37.

Cherrington, D. J. (1980). The work ethic: Working values and values that work. New York: AMACOM.

Colson, C. W. & Eckered, J. (1991). Why America doesn't work. Dallas: Word

Hill, R. B. (2003). Key Attributes of Georgia Technical College Work Ethic Instruction. Retrieved Mar. 19, 2005 from http://www.coe.uga.edu/ORG/research/finalreport5.pdf

Hill, R. B. (2004). Introduction to Ethical Issues in a Technological World. In R.

Hill (Ed.), Ethics for citizenship in a technological world (pp. 1-19).

Judy, R. W., & D'Amico, C. (1997). Workforce 2020*:* Work and workers in the 21st centur*y.* Indianapolis, Indiana: Hudson Institute.

Quinn, J. F. (1983). The work ethic and retirement. In Barbash, J., Lampman, R. J., Levitan, S. A., & Tyler, G. (Eds.), The work ethic: A critical analysis (pp. 87-100). Madison, Wisc.: Industrial Relations Research Association.

U. S. Department of Labor (1991). What Work Requires of School. A SCANS (Secretary's Commission on Achieving Necessary Skills) Report for America 2000. Retrieved on Oct. 4, 2005 from http://wdr.doleta.gov/SCANS/whatwork/whatwork.pdf

Yankelovich, D. & Immerwahr, J. (1984). Putting the work ethic to work. Society, 21(2), 58-76.

# Adaptive Usability Evaluation of Complex Web Sites: How Many Tasks?

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**Abstract**

*Usability testing of a Web site is commonly conducted as a formative evaluation methodology in order to identify significant usability problems that need to be fixed. Usability testing can also be used to summatively evaluate the effectiveness of a Web site, i.e., to determine if it is working well for the target audience. Some debate exists as to how many tasks are needed to make a decision regarding the effectiveness of a Web site, and the question is raised: Can the number of tasks be adapted based on user performance during a usability test? This is particularly significant for Web sites which are very large and complex, and which would require a large number of usability tasks to evaluate them thoroughly. A Bayesian decision model, the Sequential Probability Ratio Test (SPRT), was investigated as an adaptive method for determining how many tasks are needed during usability evaluation of a complex informational Web site.*

*Twenty-five undergraduate students in the Indiana University School of Education were tested to determine if a part of the Web site was working well for teacher education students. Each user was tested with 20 randomly selected tasks during a one hour session. The SPRT was applied retrospectively to decide when testing of each subject could have been stopped to reach a decision of whether the site is working well for that subject. Results show that the decisions reached using SPRT are highly consistent with the decisions reached by testing the users with all 20 tasks. When the SPRT was applied, users could have stopped a usability test with an average of 12 tasks. Moreover, a decision could be reached about Web site effectiveness with 5 randomly sampled users in our study. In a summative evaluation of a complex Web sites effectiveness, the SPRT increases the efficiency of the usability testing by utilizing only as many tasks and users as necessary to reach a confident decision. However, reducing the numbers of users and tasks may be counterproductive if one is interested in identifying usability problems. In that case, more users and tasks are likely needed during formative evaluation.*

## Introduction

A usability test of a Web site is commonly conducted to either detect problems requiring improvement or to determine the effectiveness of the Web site, i.e., if it is working well for the target audience. Problem detection is more likely to occur as a formative evaluation process during the development of a Web site since developers intend to correct problems identified through usability testing. Some researchers recommend that testing five users is enough to detect most of the problems of a Web site (Nielsen & Landauer, 1993); however, this recommendation has been criticized by other researchers (Spool & Schroeder, 2001; Woolrych & Cockton, 2001), who claim that the lack of homogeneity of users and tasks often require many more users in order to identify major problems.

On the other hand, a Bayesian decision model, the Sequential Probability Ratio Test (SPRT) that was originally developed by Wald (1947), has been employed successfully in usability tests to determine the effectiveness of a Web site as a summative evaluation process (Frick et al., 2003). Wald's SPRT methods are well-known in statistics and in manufacturing quality control. The SPRT provides rules to stop testing and choose one of two discrete alternatives using *a priori* decision error rates. The purpose of this study is to determine if SPRT can be used as a valid tool to improve the efficiency of Web site usability testing by testing as few tasks as necessary to make a conclusion on the effectiveness of a complex informational Web site comprised of about 6,000 Web pages.

## Literature Review

Usability has many similar definitions but one that has broad recognition with the U.S. Government is the definition provided by the US Department of Health and Human Services (HHS, 2004): "Usability is the measure of the quality of a user's experience when interacting with a product or system — whether a Web site, a software application, mobile technology, or any user-operated device." (n.p.)

There are many other definitions and descriptions that describe the multiple attributes of the user experience in the literature, but the three most common as cited by the International Standards Organization (ISO 9241-11,1998) are:

1. Effectiveness – accuracy and completeness of achieving the goals
2. Efficiency – speed and resources expended in achieving the goals
3. Satisfaction – Does the target audience like using the system?

Since the 1980's there has been a profound shift in attention to user needs, as noted by the emergence of usability testing and usability test facilities. Usability testing has improved project quality, accelerated project delivery and provided dramatic cost savings, capturing the interest of both designers and managers (Nielsen, 1993; Shneiderman & Plaisant, 2004). During this time many usability-laboratory advocates split off from their academic roots into their own small businesses and consulting practices or joined larger firms that had usability labs. This trend has created a consulting community that provides testing for hire and currently remains an active service. With that growth and maturity has come a shift in usability procedures. Dumas & Redish (1999) point out in the preface to their revised edition of the shift to more informal testing of usability: little or no videotaping, not logging every action, and smaller groups for each test session. One reason they claim is that "more acceptance of the fact that the value of usability testing is in diagnosing problems rather than validating products" (p. xi) reinforcing that large numbers of test participants are not necessary to feel confident that enough problems have been identified. Yet there is still a need for summative evaluation of products to make decisions on when to release the product to users and the general public.

Due to the costs associated with usability testing, the practitioner community has focused on the efficiency of usability testing. Perhaps one of the first widely recognized approaches to improving usability testing efficiency was Jakob Nielsen's "Discount Usability Engineering" (Nielsen 1993), which advocated what he called "the good" usability methods which do not necessarily give perfect results versus the "best" which may result in no usability testing being performed at all. This method is based on four techniques:

- User and task observation
- Scenarios
- Simplified thinking aloud
- Heuristic evaluation

As noted by Shneiderman and Plaisant (2004), one of the more controversial aspects to the recommendation is use of only three to six test participants in a round of usability testing.

**How Many Participants are Needed?**

Much has been made in the Human Factors / Usability community in the last decade about the proper number of users needed to perform a usability test on a Web site. Much of the research in the 1990's suggested that five participants will yield 80-85 percent of the findings in a usability test (Nielsen 1992, 1994, 2000; Virzi 1990, 1992; Lewis 1994). These recommendations are based on the use of a Poisson binomial probability distribution (Nielsen & Landauer, 1993).

Two of the more popular usability testing guidebooks, the *Handbook of Usability Testing* (Rubin 1994) and *A Practical Guide to Usability Testing* (Dumas & Redish 1999) discuss how many users are needed in usability testing. Rubin noted in regard to sample sizes "to achieve generalizable results for a given target population… one may need to test 10-12 participants per condition to be on the safe side, a factor that might require one to test 40 or more participants to ensure statistically significant results." (p. 29) Rubin also noted that it is often inappropriate or impossible to use classical experimental design procedures to conduct usability tests in the fast paced development environment. Rubin supports the Virzi and Nielsen testing recommendations, but takes it one step further – recommending four participants per treatment group.

Dumas and Redish (1999), one of the more popular usability guides whose first edition was published in 1993, discussed how many people to include in usability testing as part of the whole usability testing process. Starting from a task analysis perspective, Dumas and Redish first suggested identifying user profiles and then selecting subgroups that will need to be tested. Characteristics that are important for those subgroups are then defined and the most critical characteristics in participants are selected for testing. These are used to determine the range of participants, which then has an impact upon how many participants need to be selected for usability testing.

When recommending an actual number of participants to use, Dumas and Redish (1999) cite the Nielsen & Molich (1990) along with the Virzi study (1992) that claim 3 to 5 users are enough. Dumas and Redish seem to hedge a bit by noting most of the major problems are found with 3 to 5 users but most usability tests are with 6 to 12 participants. Their recommendation of "3 participants for each subgroup is probably an absolute minimum" (p. 128) seems to indicate they feel the 3 to 5 recommendation is best applied to the sub-group level, although this is as close as they come to a specific recommendation pointing out that you have to balance time, money and information gained when performing usability tests.

More recently there have been challenges to the assumptions about 4 to 5 users being enough, (Caulton 2001; Woolrych and Cockton 2001; Spool 2001; Molich et al 2004). These studies consider the effect of sub-groups upon the homogeneity assumption, the severity of the problem and the frequency at which it might occur, and the effect of different evaluators. The latter two studies also point out potential issues that should be considered for large, commercial web sites including visiting different portions of large sites and potentially conducting different tasks. In larger Web sites the validity of the tasks chosen to test compared to the full site usability could be a greater variable than having the correct number of users.

The SPRT was developed by Abraham Wald and utilized by the U.S. government in World War II for quality control of weapons. Wald demonstrated that by making observations sequentially and applying decision rules after each observation, then about half as many observations on the average are required to make a decision versus conventional testing with predetermined fixed sample sizes. SPRT does not take into account item difficulty variability or chances of guessing like more complex models such as item response theory (IRT). However, SPRT does not require the large amount of testing in advance to determine item response functions that IRT models require (Frick, 1992).

**Application of SPRT to Usability**

Limited literature exists that addresses the number of users needed to conclude if a Web site is working well (also noted in Frick et al. 2003). Perhaps because the emphasis has been upon problem identification during development (more formative evaluation), there seems to be little research on providing evidence that a Web site is effective in allowing users to reach their goals (summative evaluation).

Frick may have been the first to apply SPRT to usability testing. A 2001 study (Frick et al.) looked into applying Wald's SPRT to Web site usability testing. By focusing on Web site effectiveness (more of a summative evaluation) instead of problem identification, the authors applied SPRT to see if the average sample size to make a decision on when to stop testing would be reduced.

This study took 31 subjects and asked them to perform 20 random tasks selected from a pool of over 330 tasks associated with the Indiana University Bloomington (IUB) Web site. Subjects were recruited on a proportional basis according to the population served by the IUB Web site. The SPRT parameters were set *a priori* at: success level=.90, failure level=.50, $\alpha$ error=.05, $\beta$ error=.05 and then applied at the task level for all 31 participants post hoc.

Application of *post hoc* SPRT would have resulted in 30 of the 31 decisions to be the same as though all 20 tasks had been put into the SPRT formula. Since the expected agreement was 90 percent (1-($\alpha$+$\beta$)), the SPRT made fewer classification errors (3.2 percent) than the expected error rate of 10 percent.

Using the same SPRT parameters and applying at the user level, the decision on Web site effectiveness could have been made after only four subjects. The study concluded that the IUB Web site was not effective with the SPRT parameters used when using the "short" SPRT test (4 users) or when it was applied to all 31 users. The study also calculated that applying SPRT would only take 12-20 percent of the testing time versus what was defined as a typical usability test (10 subjects with 15 tasks). This number should be viewed cautiously however, for if the Discount Usability Engineering procedures suggested by Nielsen are used (five users) the advantage would only be slightly less.

A second study by Frick et al. (2004) looked at specifically applying SPRT to the number of users on the IU Library Web site to determine the effectiveness of its electronic card catalog system (IUCAT). A total of 51 people were selected through a stratified convenience sample and were asked to attempt two specific but representative tasks to find holdings listed in the catalog using the search function for IUCAT. The two tasks chosen took about 10-15 minutes total, a design chosen so that more user tests could be obtained for the analysis. Participant test results were randomized to avoid possible bias from the results. The results were analyzed retroactively to determine how many participants would be needed to make a decision on effectiveness. Then various SPRT parameters were changed to see the effect upon the number of subjects needed to reach a conclusion. Utilizing baseline SPRT factors of success level=.90, failure level=.60, $\alpha$ error=.05 and $\beta$ error=.05 a decision that the search engine was effective could have been made after 12 subjects. This was the same conclusion that would have been reached within the results from all 51 participants had been used.

Next, the study looked into reducing the zone of indifference (success minus the failure level). As the zone of indifference was reduced, more subjects were needed to make a decision. Likewise when the alpha and beta error rates were reduced, more subjects were needed to make a decision in the Frick et al. (2004) study.

## Research Questions

This study intended to answer the following research question: When conducting a usability test with random task selection, how does the SPRT-based method of decision-making compare to the results of conventional usability testing? In other words, if tasks are randomly selected from a large pool for usability testing, does the SPRT method of deciding when to stop and make a decision agree with the decision that would have been reached with all tasks? A secondary question was: Can the number of users also be adapted by use of the SPRT?

## Significance of Study

Wald's SPRT was classified as a defense secret by the U.S. government during World War II due to its practical effectiveness in making product quality control decisions. By applying SPRT in usability tests, researchers do not have to predetermine how many tasks to test before the usability testing starts. Instead, decisions of when to stop testing will be reached after analyzing data accumulated from the usability testing. Often SPRT leads to quick, but highly accurate, decisions regarding the effectiveness of a product with fewer tasks to test. Therefore it may increase the efficiency of Web site usability testing.

Usability testing can be very costly in both money and time. If the SPRT proves to be a reliable method in usability testing for determination of a Web site's effectiveness, it may improve the efficiency of usability testing and lower related costs substantially.

## Methods of Usability Testing

Usability testing methodology was used to evaluate the School of Education Web site (Dumas, 1999). This approach involved having authentic users perform authentic tasks using the system, while a facilitator guided the usability session. An evaluator recorded the users' actions and comments while tasks were completed. During the testing, users were asked to perform a think-aloud protocol to help the evaluators understand their behaviors and gain insight into the design of the Web site (Ericsson, 1993).

Sessions were performed on an individual basis with each session lasting approximately one hour. Following the last session, qualitative and quantitative data were analyzed and summarized, and problem areas were identified. Participants in this study were provided with five extra credit points from their class instructors.

### Participants

Participants for the study were recruited by the researchers from School of Education classes. One of the target audiences is current Teacher Education students who are at the undergraduate level. The following demographic criteria were used as guidelines:

- Gender – approximately 75% female, 25% male
- Student status – undergraduate level students
- School of Education, Teacher Education majors

  A sample of 25 participants was obtained from 36 volunteers from four undergraduate classes

### Procedures

Participants were asked to read and sign Indiana University Human Subjects consent form which included a brief description of the usability session, the user's risks, benefits, confidentiality and the researchers' contact information. Users were then asked to fill out a brief survey which included demographic questions, such as university class standing and prior experiences with the School of Education Web site.

Tasks were completed one at a time and recorded as: 1) success, if the answer to the question was found on the Web site, or 2) failure due to expiration of 3-minute time limit, or 3) failure because the user gave up, or 4) failure, if the answer was not found even though the user thought she or he had done so. Following the session, the users were asked a series of post-session questions which helped capture their overall experience with the Web site: 1) Now that you have used the School of Education Web site, what are your overall impressions of it? 2) If you could pick one aspect of the site that you did not like, what would it be? 3) What is one feature about the site that you found positive and liked? The users' qualitative post-session answers helped the research team to better understand specific concerns users may have with the system in areas that were not tested in the session.

Sessions were performed using Internet Explorer 6.0 and the Windows XP operating system on an Intel Pentium IV computer in the School of Education IST usability lab.

### Tasks

Each user was asked to complete 20 tasks that were randomly drawn from a pool of 120 tasks generated from a prior needs analysis study. The tasks selected were ones that were considered relevant to teacher education students, as compared with those for alumni, faculty or K-12 professionals. Since tasks were randomly selected, there were very few tasks that were the same for most users. Tasks also were created in order to test users interacting with specific features of the system. Users were asked to complete as many of the 20 tasks as possible within a one-hour user session. Each user was given three minutes to complete a task. This time limitation allowed a user enough time to attempt all 20 tasks within an hour.

**Methods of SPRT**

The task data from each subject were run through the Web Tool for Sequential Bayesian Decision Making (Frick, 2003). The settings for the Bayesian Decision Making tool were as follows:

- Alternative A: Web site is working well
- Alternative B: Web site is NOT working well
- Minimum proportion of success if Alternative A is true: .85
- Maximum proportion of success if Alternative B is true: .60
- Error rate for choosing Alternative B when A is really true = Alpha error = .05
- Error rate for choosing Alternative A when B is really true = Beta error = .05

The task data were used in two ways. First, the total number of successes and the total number of failures per subject were entered to determine if the Web site worked well, did not work well or if more tasks were needed to make a decision based on all of the tasks. Next, the usability test was reenacted by entering the outcome of each task into the SPRT Web tool one item at a time for a given subject. The SPRT tool would return a determination after each task indicating if alternative A or B could be chosen, or if more tasks were needed to make a decision. If more tasks were needed, the next task result was entered. If a decision was made, then the number of tasks entered to that point was recorded along with the breakdown of the number of tasks identified as successes and failures.

Tests were run comparing the SPRT result from the overall (all tasks) test to the adaptive (task-by-task) test to evaluate the consistency between the two methods. In addition, the mean success rates across all participants for both the overall test and adaptive test were compared.

**Results**

Twenty-five subjects participated in the usability tests, 22 females and three males. The female/male split was 88 percent and 12 percent respectively, which is approximately 11 percent higher in females than the population of undergraduates in the Indiana University Bloomington School of Education in 2003 (76.7 percent female/23.3 percent male) (Indiana University School of Education, 2004).

The subjects included 11 freshmen, 11 sophomores, two juniors and one subject who did not report class rank. The subjects' academic areas of interest included Art Education (3), Early Childhood Education (3), Elementary Education (7), Special Education (4) and other (7). When asked how often the subjects visited the School of Education Web site, the following responses were marked: Very often (0), Often (2), Seldom (5), Rarely (10), Never (7) and one participant did not answer the question. This indicates that most of the participants were unfamiliar with the Web site used in the usability testing.

Table 1 shows on agreement of decisions reached from all 20 randomly selected tasks for each user and the SPRT adaptive reenactments. The value for *kappa* is 0.74 when corrected for chance agreement, with a significance level of $p < .01$ (simple percentage agreement is 22/25 or 88 percent). This means there is substantial agreement that the same result is achieved by using decisions that were made using all 20 tasks and the subsets of those that were made after reenacting the test using the adaptive SPRT. In other words, decisions reached with a subset of the randomly selected 20 tasks for each user were largely the same as decisions reached with all tasks. In 16 cases (subjects), the conclusion was that the Web site was not working well (with a maximum success rate of .60 or lower), using either the adaptive SPRT method or by using all 20 randomly selected items. In two cases, the conclusion was that the Web site was working well (with a minimum success rate of .85 or higher), using either method. In four cases, no decision could be reached at the *a priori* error rates, after exhausting all 20 items, using either method. The three cases where the decision outcome differed was when SPRT concluded the site was not working well, but the conclusion after 20 items was that no decision could be reached. See Table 1.

Table 1. *Crosstabulation: Did the Web site work overall based on the adaptive SPRT? versus Did the Web site work well with all tasks?* (*N*=25 users, *kappa* = 0.74, *p* < 0.01)

| | | *Did the Web site work well with all tasks?* | | | |
|---|---|---|---|---|---|
| | | No | Yes | No Decision | Total |
| Did the Web site work well based on adaptive SPRT? | No | 16 | 0 | 3 | 19 |
| | Yes | 0 | 2 | 0 | 2 |
| | No Decision | 0 | 0 | 4 | 4 |
| | **Total** | 16 | 2 | 7 | 25 |

The researchers observed improvements in solving tasks in some participants as their tests progressed. This led the researchers to consider that subjects were becoming more acquainted with the Web site as usability tests proceeded. Therefore, the success rate for the first half and second half of each usability test was determined. Then these figures were compared as seen in Table 2. There was an increase from the first half success rate (.56) to the second half of the test success rate (.65), and the difference was about half a standard deviation. It does appear that subjects did learn where things were located on the Web site and how it is organized, since they did perform better during the second half of the tasks. This may account for the three no-decision outcomes when SPRT concluded the site was not working for those subjects. The performance of those three subjects improved enough that it was no longer possible to confidently choose between the two alternatives (Web site works or not). For the majority, however, the learning that occurred did not affect the overall conclusion of whether the Web site was working or not at the levels specified by the Web director (.85 vs. .60)

Table 2 *Comparison of users' task success rate between the first set of 10 tasks and the second set of 10 tasks*

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| First random set of 10 | 25 | 0.22 | 0.90 | 0.56 | 0.19 |
| Second random set of 10 | 25 | 0.30 | 1.00 | 0.65 | 0.19 |

Table 3. *Number of tasks needed to stop testing with the SPRT and choose an alternative*

| **Participant Number** | **Number of tasks to stop testing with SPRT** |
|---|---|
| #1 | 6 |
| #2 | 6 |
| #3 | no decision |
| #4 | 13 |
| #5 | 16 |
| #6 | 13 |
| #7 | 14 |
| #8 | 20 |
| #9 | 9 |
| #10 | 9 |
| #11 | 5 |
| #12 | 17 |
| #13 | 5 |
| #14 | 6 |
| #15 | 6 |
| #16 | 6 |
| #17 | no decision |
| #18 | 10 |
| #19 | 13 |
| #20 | 6 |
| #21 | 17 |

| | |
|---|---|
| #22 | 10 |
| #23 | no decision |
| #24 | 5 |
| #25 | no decision |

In Table 3 the numbers of tasks required to reach an SPRT decision for each case are listed. It can be seen that decisions could be reached with as few as five or six tasks for some users, and in four other cases, no decision could be confidently reached with all 20 tasks. More tasks would have been needed for those users in order to reach a conclusion. Twenty tasks were not enough in those cases. Table 3 shows how the SPRT makes it possible to adapt the number of tasks based on the performance of users and the decision criteria established in advance.

From Table 3, it can be seen that an average of about 12 tasks were needed in our study, but the range was from 5 to more than 20 (but we stopped with those subjects since the test session would have gone beyond the hour allocated). If users are selected at random from those in Table 3, and the SPRT is applied after a decision is reached for that user, a total of 5 users would be needed to reach the decision that the Web site was not working as well as the Web Director had hoped (alternative B is chosen for the Web site). Thus, if the SPRT had actually been used in this study, we could have reached this conclusion with 5 users and an average of 12 tasks per user – and we would have reached the same overall conclusion. This is a significant reduction in time and effort in conducting such usability tests, when compared to 25 users and 20 tasks each.

## Discussion

The SPRT requires the decision maker to clearly establish the criteria that will be used in making a decision. 1) What is the minimal success rate that is acceptable to decide that the Web site is working well? 2) What is the maximum success rate that is acceptable to decide that the Web site is not working as well? 3) What probabilities are tolerable for making erroneous conclusions? For example, had the success rates been 0.60 vs. 0.40 in this study, with the same alpha and beta levels for decision error rates, then the conclusion would likely be that the Web site was working *well* – just the opposite of that found in this study. In fact, success rates on most Web sites are often less than 50 percent, according to Nielsen (2001), but he estimates that success rates have risen at a rate of 2.5 percent per year in the past few years due to increased usability evaluation that appears to be occurring (Nielsen, 2003). Thus, from this perspective, student performance in our usability tasks with this Web site were better than success rates on most Web sites. Nonetheless, the success rate was not as high as the Web Director had desired.

Furthermore, the 120 tasks chosen for this usability test were those which were chosen from a much larger list of frequently asked questions determined from prior needs analyses. The 120 tasks selected were deemed to be largely relevant for the subgroup we tested (i.e., undergraduate teacher education majors). The overall Web site is designed to address other target audiences that include: prospective students, graduate students, faculty, staff, associate instructors, alumni of the School of Education, and K-12 professionals. The large bulk of the 6,000 pages on this site were not applicable to the tasks chosen. Most of the answers to the 120 tasks could be found on the Web sites for the Office of Teacher Education, which consist of approximately 560 Web pages or roughly 10 percent of the overall Web site. Thus, no inferences should be made concerning the effectiveness of the Website for these other audiences, or for the 90 percent of other Web pages that are part of the overall School of Education Web site.

Finally, it should be noted that users in our study began their usability session at the IU Bloomington home page. These users did *not* begin at the School of Education home page, and we did *not* tell them that the answers were on School of Education Web sites, nor on the Office of Teacher Education Web sites. Thus, the participants in our study, who were largely unfamiliar with School of Education Web sites, were in essence looking for "needles in a huge haystack". Indiana University currently has in excess of one million Web pages in numerous sites, according to the person who manages the IU search engine (Percival, 2005, personal communication).

## Implications for Further Research

It is a common goal of usability testing methodology to identify problems that need to be fixed. While applying SPRT may help an evaluator determine the overall effectiveness of a Web site, stopping a user session early may result in failure to identify specific usability problems. Ultimately, the goal of usability testing is to evaluate the current state of a system, detect problems, interpret the reasoning behind the problem, and diagnose the problem with a potential solution. With the utilization of SPRT in a usability study, specific problem detection may not occur. One of the authors has since explored this issue in greater depth in his dissertation (Hebb, 2005). In further analyses of the data from this study, he found that with 5 users and an average of 12 tasks that:

> …this number of users and tasks identified 25% of known usability problems. Likewise, the Poisson-based approach identified 35% of the problems with these same 5 users but with 20 tasks per user. For over 10 years, the prevailing rule of thumb has been that 4 to 5 subjects will identify the usability problems when evaluating websites. Results from this study indicated that more subjects may be needed for identifying 80-85% of website usability problems. Results also indicated that the SPRT is more cost-effective than the Poisson model if summative evaluation and not problem identification is the goal of usability testing. (p. vi)

These findings suggest that efficiency in terms of minimizing numbers of users or tasks in usability testing is counterproductive if the goal is to identify usability problems. In the Hebb (2005) study, he identified 83 unique problems with all 25 users and 20 randomly selected tasks per user. If 10 users are chosen at random, 52 unique problems are identified (63 percent), and if 5 users are chosen only 29 unique problems were uncovered (35 percent).

It appears from Hebb's data that if problem identification is the goal of usability testing, then the five-user rule that Nielsen and Landauer have suggested may badly underestimate the number of subjects needed to identify 80 percent of usability problems. More research is clearly needed here.

It does appear from the Frick et al. (2003) study that the SPRT can be effectively used when a Website has few usability problems. In that study, the search engine for the electronic card catalog was evaluated. This search engine has evolved, been improved, and has been in use for over 15 years (even before the Web came about). In other words, if most usability problems have been fixed in a product, then the SPRT can be an efficient method of verifying product effectiveness in summative evaluation. For formative evaluation, however, fewer numbers of subjects and tasks appear to be detrimental to problem identification.

## References


Caulton, D. A. (2001). Relaxing the homogeneity assumption in usability testing. *Behaviour & Information Technology, 20*(1), 1-7.

Dumas, J. S. and Redish, J. C. (1999). *A practical guide to usability testing* (revised edition). Exter, England: Intellect.

Ericsson, K. A., & Simon, H. A. (1993). *Protocol analysis: Verbal reports as data* (Revised ed.). Cambridge, MA: MIT Press.

Frick, T. W. (1992). Computer Adaptive Mastery Tests as Expert Systems. *Journal of Educational Computing Research, 5*(1), 187-213.

Frick, T. W. (2003). Web tool for sequential Bayesian decision making. Retrieved December 8, 2004 from http://www.indiana.edu/~tedfrick/decide/start.html.

Frick, T.W., Dodge, T., Liu, X. & Su, B. (2004). How many subjects are needed in a usability test to determine effectiveness of a Web site? Paper presented at the meeting of the Association for Educational Communication and Technology, Anaheim, CA. Available online at: http://education.indiana.edu/~frick/aect2003/frick_dodge_liu_su.pdf.

Frick, T.W., Lee, J., Park, Y. J. & Pascoe, S. (2001). How many subjects and how many tasks are enough for usability testing? Unpublished manuscript, Indiana University.

ISO 9241-11 (1998). Ergonomic requirements for office work with visual display terminals (VDTs) – Part 11: Guidance on usability.

Indiana University School of Education (2004) Promoting diversity. Reterieved December 12, 2004 from http://www.indiana.edu/~ediverse/stuenrgen.html.

Hebb, C. L. (2005). Website usability evaluation using sequential analysis. Bloomington, IN: Indiana University Graduate School, Ph.D. dissertation.

Lewis, J.R. (1994). Sample sizes for usability studies: Additional considerations. *Human Factors*, 36, 368-378.

Molich, R., Ede, M. R., Kaasgaard, K., & Karyukin, B. (2004). Comparative usability evaluation, *Behaviour & Information Technology*, 23 (1), 65-74.

Nielsen, J. (1993). *Usability Engineering*. Cambridge, MA: Academic Press.

Nielsen, J. (1994). Guerilla HCI: Using discount usability engineering to penetrate the intimidation barrier. In R.G. Bias & D.J. Mayhew (Eds.), *Cost-justifying usability*. (pp. 242-272). Boston: Academic Press.

Nielsen, J. (2000). Why You Only Need to Test With 5 Users'. Alertbox, March 19, 2000. Retrieved September 12, 2004 from http://www.useit.com/alertbox/20000319.html.

Nielsen, J. (2001). Success Rate: The Simplest Usability Metric. Alertbox, February 18, 2001. Retrieved October 1, 2005 from http://www.useit.com/alertbox/20010218.html.

Nielsen, J. (2003). PR on Websites: Increasing Usability. Alertbox, March 10, 2003. Retrieved October 1, 2005 from http://www.useit.com/alertbox/20030310.html.
Nielsen, J., & Landauer, T. K. (1993). A mathematical model of the finding of usability Problems. Proceedings of INTERACHI'93 (pp. 206-213). Amsterdam, The Netherlands: ACM Press.
Nielsen, J., & Molich, R. (1990). Heuristic evaluation of user interfaces. Proceedings of the ACM CHI'92 (pp. 373-380). Amsterdam, The Netherlands: ACM Press.
Percival, P. (2005, Sept. 29). Personal communication, Indiana University Information Technology Services.
Rubin, J. (1994). *Handbook of Usability Testing: How to Plan, Design, and Conduct Effective Tests*. John Wiley & Sons, Inc. New York, NY, USA.
Shneiderman, B. & Plaisant, C. (2004). Designing the User Interface ($4^{th}$ ed.). Boston: Addison-Wesley.
Spool, J. & Schroeder, W. (2001). Testing web sites: Five users is nowhere near enough. Extended abstracts of CHI 2001, 285-286.
Virzi, R. (1990). Streamlining the design process: Running fewer subjects. Proceedings of the Human Factors Society 34th annual meeting, 1 (pp. 291-294). Orlando, FL.
Virzi, R. (1992). Refining the test phase of usability evaluation: How many subjects is enough? *Human Factors 34*, 457-486.
Wald, A. (1947). *Sequential analysis*. New York: Wiley & Sons, Inc.
Woolrych, A., & Cockton, G. (2001). Why and When Five Test Users aren't Enough. In J. Vanderdonckt, A. Blandford, & A. Derycke (Eds.), Proceedings of IHM-HCI 2001 Conference: Vol. 2 (pp. 105-108).
Toulous, France: Cépadèus Éditions. Retrieved April 2, 2004 from http://www.netraker.com/nrinfo/research/FiveUsers.pdf
U.S. Department of Health & Human Services (2004). What is Usability? Retrieved December 13, 2004 from http://www.usability.gov/basics/

# Simulating and Stimulating Systemic Change in Education: *SimEd Technologies*

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### The Need for an Educational Systems Theory

As the 'No Child Left Behind' (NCLB) legislation is being implemented, K-12 schools in America face increasing pressure to meet state standards. Successful change is imperative for schools classified as "failing," since the consequences of repeated failure can result in school closure. How, then, should changes in school systems be planned to obtain better results? What principles could be used to predict possible consequences of change strategies?

Changes in educational policies have the potential to impact a large number of students within an educational system across extended time periods. The stakes for such changes are high, since it is difficult for students to relive their educational experiences, and much more difficult to reverse negative consequences of policy decisions. Even with the best intentions of wanting to improve education, attempts to change will be based mostly on trial and error. At a time in American education where our education systems face very real and pressing problems, it may appear to be the wrong time to claim that we need good educational systems theory. But, in fact, we do.

In the decades following the publication of *A Nation at Risk* in 1983 (National Commission on Excellence in Education), considerable effort has been undertaken to improve public schooling. Reform efforts have been typically referred to as site-based management, school restructuring, and educational systems design. Researchers such as Banathy (1991), Reigeluth (1992), Frick (1991), Jenlink, Reigeluth, Carr & Nelson (1996), Caine & Caine (1997), Duffy, Rogerson and Blick (2000) and Senge, Cambrom-McCabe, Lucas, Smith and Kleiner (2000) have argued for systemic change in education. Systemic change contrasts with numerous piecemeal reform efforts that have largely failed in twentieth-century schooling. However, the rhetoric of systemic change is not likely in itself to make any real difference in schooling, since such rhetoric has been around for some time.

For intelligent action, a scientifically based theory that could explain and predict the behavior of educational systems is needed. By this, we do not refer to a learning theory, a pedagogical theory, an instructional method, a leadership theory, classroom management theory nor a curriculum theory – but an educational systems theory, a theory to describe, explain and predict whole educational systems and their transactions with societies in which they are embedded. Educational systems theory should precisely define the concepts and relationships of system elements and provide operational ways in which these can be observed and measured. Education does not have the equivalent of a Newtonian theory of physics. Educators seldom agree on definitions of terminology. We do not have well established and clearly defined terms such as mass, force, acceleration, velocity, time, gravity, etc. as in physics. In short, we lack a scientific educational systems theory.

### Development of General Systems Theory (GST)

The concept of general systems theory (GST) was first introduced by Ludwig von Bertalanffy in 1937. Bertalanffy (1968) argued that there exists a general theory that could characterize the behavior of systems, regardless of whether these are scientific, natural or social; and he proposed GST as an interdisciplinary theory that could contribute to the unity of science. System behavior results from the relationships between its components, and is not just a simple summation of its parts. The characteristics of each system component therefore cannot adequately explain how the system itself behaves.

Since then, there have been extensive contributions by others in the development of GST as a logical and mathematical theory to provide an "exact language permitting rigorous deductions and confirmation (or refusal) of theory" (Bertalanffy, 1972, p.30). Others have also contributed well-developed descriptive theories (e.g., Wymore, 1967; Cornacchio, 1972; Mesarović & Takahara, 1975; Lin, 1987; Lin, 1999; Bar-Yam, 2003). In education, GST has been used by researchers to discuss educational systems design and systemic change, but these approaches have not been grounded in scientific theory about educational systems (Banathy, 1991; Caine & Caine, 1997; Duffy, Rogerson & Blick, 2000; Senge, Cambron-McCabe, Lucas, Smith, Dutton & Kleiner, 2000). Rather these approaches largely describe processes through which organizations can change, not whether those changes are likely to result in desired outcomes.

The SIGGS theory model provided the first extensive formalization of a GST model for educational theorizing (Maccia & Maccia, 1966; Steiner, 1988). Through the synthesis of four theories: Set, Information, di-Graph, and General Systems, SIGGS provided a logical description of general system properties, which enabled the development of an educational theory of school systems by the logical process of retroduction from the 201 SIGGS hypotheses. Frick, Hood, Kirsch, Reigeluth, Walcott and Farris (1994) extended Maccia and Maccia's work by classifying the system properties into basic, structural, and dynamic properties. This classification recognized that some SIGGS properties were structural as they described the connectedness between system components (SIGGS Website, 1996a). Yet, others were dynamic and described how patterns of relationships between system components are altered due to changes within the system or between the system and its environment (SIGGS Website, 1996b). Thompson (2005) recognized that the structural properties essentially defined the system topology.

To provide a theory that is logically and mathematically sound, a system-descriptive axiom set is needed. Although SIGGS was fairly comprehensive, there was no attempt to analyze the 201 hypotheses for consistency nor to finalize an axiom set that would be the underlying axioms for a GST. Thompson has since been developing Axiomatic Theories of Intentional Systems (ATIS), which is a logico-mathematical theory model for analyzing and predicting behavior of systems that are goal-directed or intentional. Using the original SIGGS hypotheses, Thompson developed a nomenclature to define system properties, which improved the precision with which SIGGS properties could be used (Thompson, 2005). Thompson also identified an initial list of approximately 100 axioms (subject to change, as this work is on-going), and extended the 73 SIGGS general system properties to 136 in ATIS (APT&C Website, 2005). Development is on-going and theorems are now being derived from the ATIS axioms for validation.

*SimEd* is a software program designed to model educational systems. It is a model of an education system and is designed so that selected parameters can be evaluated to determine projected outcomes in view of these parameters. Any behavior-predictive software must be founded on a logical base of some kind. The axioms of ATIS are being used as the rule-base for *SimEd* in the development of educational systems theory.

## Using General System Properties to Describe an Educational System

Following are a few examples of how general system properties formulated in ATIS can be applied to educational systems. For greater detail, the reader is referred to extensive reports by Thompson (APT&C Website, 2005): http://www.indiana.edu/~aptfrick/reports/ .

### Basic Properties

Basic properties define the initial attributes required to identify and analyze a system. In ATIS, there are only three Basic properties—complexness, general system state, and size. For example, a system consists of at least two components that are connected by an affect relation. Understood in the context of an education system, one example would be teachers and students, who are components that are connected together by a 'guidance of learning' affect relationship. These affect relations determine the complexness of the system. The formal definition and logico-mathematical typology of 'complexness' is:

**Complexness,** $\mathcal{X}(\mathbb{S})$, $=_{df}$ the connectedness of an affect relation.

$$\mathcal{X}(\mathbb{S}) =_{df} (\mathcal{A}_m \in \mathcal{A}) \mid (x,y) \in \mathcal{A}_m \supset x \in {}_{C}\mathcal{C}$$

Complexness is measured by the number of connections.

### Structural Properties

Strongness' is an example of a structural property that describes relationships between system components. 'Strongness' is defined formally:

**Strong system (strongness),** ${}_{S}\mathfrak{S}$, $=_{df}$ a system with affect relation sets characterized by strongly connected components.

$$ {}_{S}\mathfrak{S} =_{df} \mathfrak{S} \mid \exists \mathcal{A}_i({}_{S}\mathcal{C}) $$

'Strongly connected components' means that all components in the affect relation set are connected to each other, but at least one of the connections is unilateral (one or more is not bi-directional; otherwise the components would be completely connected).

Assume that we are examining the affect relation, 'guidance of learning', in a classroom. If classroom instruction is solely from the teacher (e.g., demonstrating, explaining, questioning, prompting, and evaluating student responses), then such 'guidance of learning' is unilateral connectedness from the teacher to students. Strongness can be increased if there were more connections between system components. For example, when students work in project groups, 'guidance of learning' connections can be created among students as they share what they know with each other. Such affect relations become 'completely connected' when all of them have bi-directional connections with each other. 'Completely connected' components are defined formally:

**Completely connected components set,** ${}_{CC}\mathcal{C}$, $=_{df}$ a set of system components that are pair-wise path-connected in both directions.

$$ {}_{CC}\mathcal{C} =_{df} \mathfrak{X} = \{x \mid x \in \mathfrak{R} \subset \mathfrak{S}_0 \wedge \exists y \in \mathfrak{R}[x \neq y \wedge (x,y) \in {}_{cc}E]\} $$

**Dynamic Properties**

'Adaptableness' is an example of a dynamic property that describes how the relationship between system components changes over time. It is defined formally:

**Adaptable system (adaptableness),** ${}_{A}\mathfrak{S}$, $=_{df}$ a system compatibility change within certain limits to maintain stability under system environmental change.

$$ {}_{A}\mathfrak{S} =_{df} \Delta\mathfrak{S}'_{t(1),t(2)} \Vdash \Delta\,\mathscr{C}_{t(1),t(2)} < \alpha \Vdash {}_{SB}\mathfrak{S}_{t(1),t(2)} $$

For example, a school system has high adaptability if its graduation rates do not vary significantly when the standards for passing state examinations are raised.

'Filtration' is another example of a dynamic property. It describes the criteria a system uses to determine which toput qualifies as input to the system. The criteria for selecting its applicants act as a filter for entry to the school (e.g. students who are less than 5 years old are typically not allowed to enter K-12 schools). 'Filtration' is defined formally:

**Filtration,** $\mathscr{F}(\mathfrak{S})$, $=_{df}$ the set of *toput system-control qualifiers* that control *feedin* of *toput.*

$$ \mathscr{F}(\mathfrak{S}) =_{df} \{P(x) \mid P(x) \in {}_{T_{\mathcal{P}}}\mathscr{L}_C \wedge A^{\mathcal{F}iltration}\sigma_x\ (\sigma_x\colon T_{\mathcal{P}} \times {}_{T_{\mathcal{P}}}\mathscr{L}_C \rightarrow (T_{\mathcal{P}}, I_{\mathcal{P}}))\} $$

### Simulating Change in Education: An Application of Logic-based Simulation in *SimEd*

**Logic-Based vs. Scenario-Based Simulation**

Scenario-Based programs are defined as programs that provide "scripts" to determine outcomes. The scripts can be narrative or quantitative. Narrative scripts characterize the qualitative parameters of a system; that is, the social, philosophical, and individual descriptions and the uncertainty of future outcomes. Quantitative scripts define the scientific facts, known or credible data, and quantitative models that are used to determine future outcomes. However, regardless of the type of script, their content is closed; that is, there are a limited number of possible outcomes, and the scripts predetermine the outcomes.

Friedman (1999) recognizes this closed characteristic of Scenario-Based Models in his report on SimCity, "The Semiotics of SimCity," when he states:

Of course, however much "freedom" computer game designers grant players, any simulation will be rooted in a set of baseline assumptions. SimCity has been criticized from both the left and right for its economic model. It assumes that low taxes will encourage growth while high taxes will hasten recessions. It discourages nuclear power, while rewarding investment in mass transit. And most fundamentally, it rests on the empiricist, technophilic fantasy that the complex dynamics of city development can be abstracted, quantified, simulated, and micromanaged.

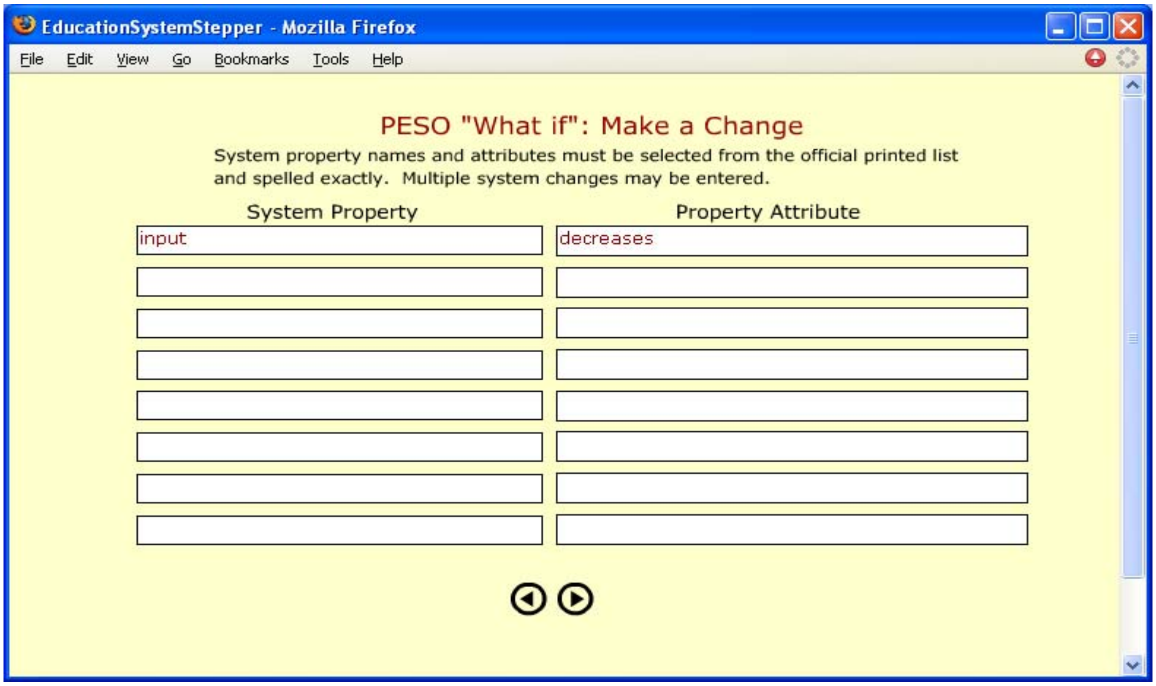
On the other hand, Logic-Based Models are not dependent on analyses of predetermined values, but on the logic of a theory that has been shown to be valid for the targeted empirical system; for example, an education system. The theory describes the empirical system in terms of its affect relations, properties, and axioms. The theory is then used to project outcomes founded on the theory with respect to input parameters. The instantiated axioms would generate a set of outcomes, which become input parameters that instantiate yet more axioms. Unlike Scenario-Based Models that are closed due to the limited number of scripts, Logic-Based Models potentially have an infinite number of outcomes. This is the model that *SimEd* is based upon.

**Example of *SimEd PESO* Predictions**

Suppose a school called Smithtown is labeled as failing by NCLB criteria, and consequently student enrollments begin to drop (input decreases), as parents send their children to other schools. What would happen as a result of falling enrollments? How might *SimEd* help administrators of Smithtown school predict and plan their required change of strategies?

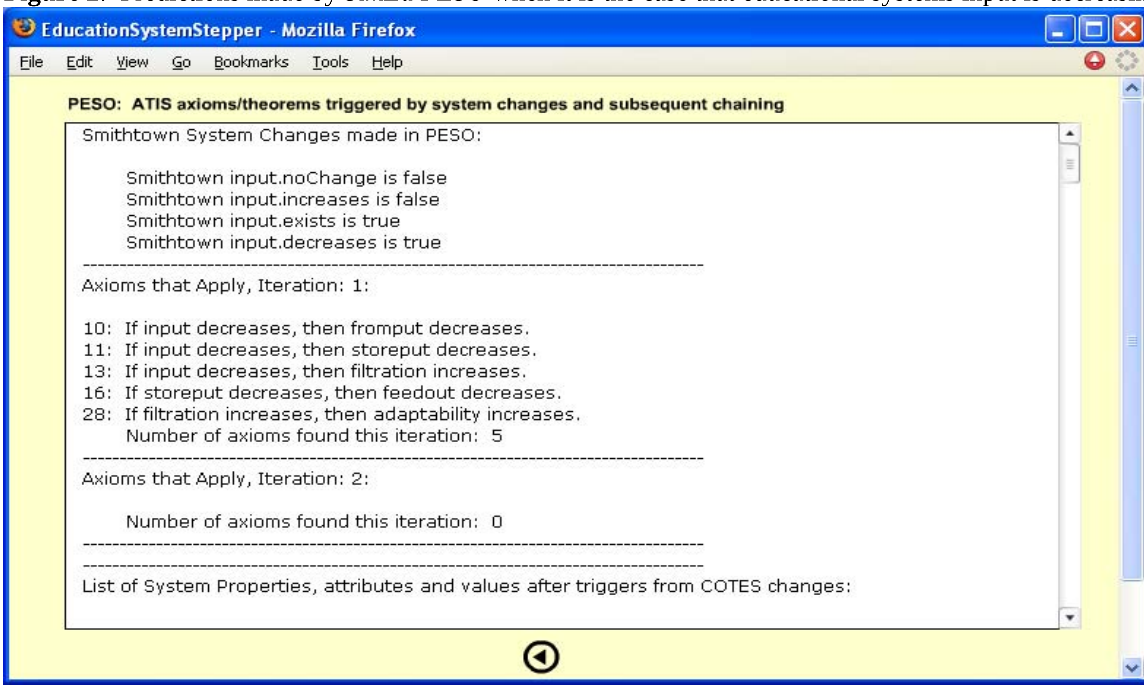
Using system properties defined by ATIS, if the student enrollments in the Smithtown School System are decreasing, this means that the educational systems property, input, is decreasing. One enters the current system conditions into the *SimEd PESO* prototype as illustrated in Figure 1. *PESO* refers to Predicting Education System Outcomes. *PESO* is one of the *SimEd Technologies*.

**Figure 1**: If input is decreasing in the educational system, the options set from the Educational System Theory are applied when this condition is true.




Next, *SimEd PESO* applies the relevant axioms and theorems from ATIS to make predictions, as illustrated in Figure 2.

**Figure 2**: Predictions made by *SimEd PESO* when it is the case that educational systems input is decreasing.




It can be seen from Figure 2 that the following axioms have been triggered:

10: If input decreases, then fromput decreases.
11: If input decreases, then storeput decreases.
13: If input decreases, then filtration increases.
16: If storeput decreases, then feedout decreases.
28: If filtration increases, then adaptability increases.

### How *SimEd PESO* Makes Logic-based Predictions

Even though there are approximately 100 axioms in ATIS at the current moment (APT&C Website, 2005), only 5 axioms apply under this condition (input decreases). Axioms 10, 11 and 13 predict the outcomes of decreasing input. However, Axiom 11 predicts a decrease in storeput, which triggers Axiom 16. Similarly, Axiom 13 triggers Axiom 38. This kind of chaining illustrates how the inference engine that is built into *SimEd PESO* works. *SimEd PESO* actualizes the logical implication of transitivity – e.g., if A implies B, and if B implies C, then A implies C.

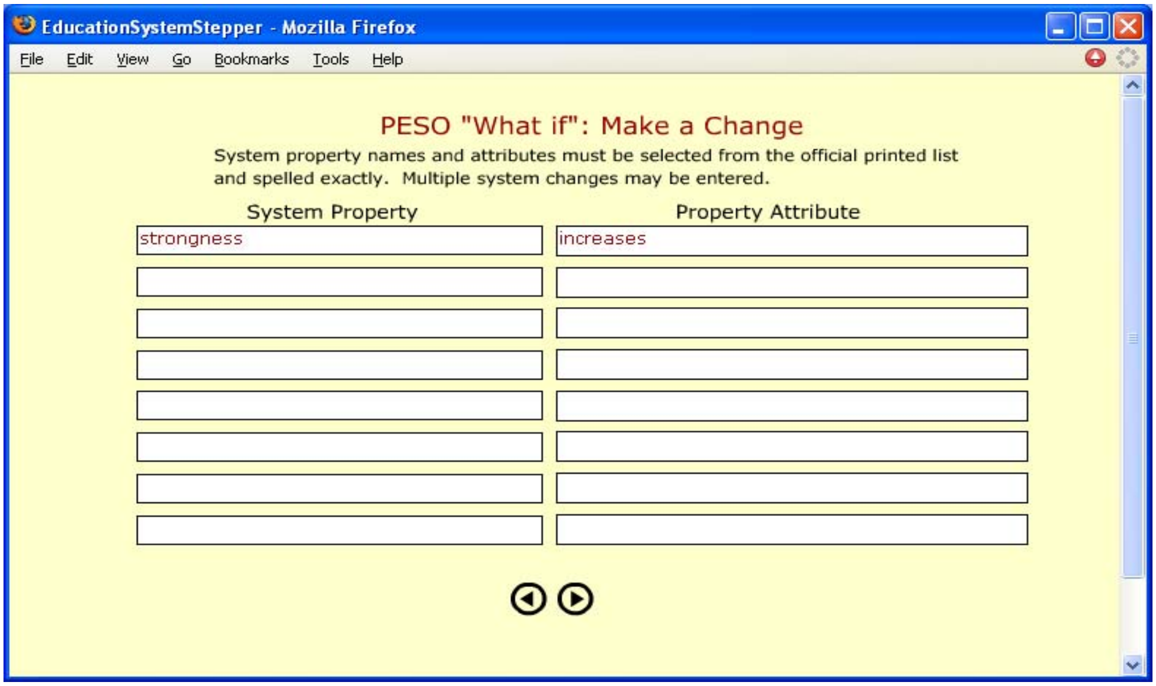
### Interpreting the Predictions

It can be seen that when enrollments decrease in Smithtown school, there will be fewer students attending classes (storeput decreases) and fewer students who will fulfill exit requirements (e.g., qualify for graduation). Thus, fromput decreases also. When there are fewer students attending classes (storeput decreases), there will be fewer students who eventually leave the system as feedout (e.g., through graduation or as dropouts). Another prediction is that filtration, or criteria for entry into Smithtown, increases. Inadvertently, the NCLB rating has acted as a filter by deterring parents from sending children to Smithtown. While the axioms discussed may seem logically obvious, Axiom 28 also predicts that Smithtown would change to maintain system stability. If filtration increases, adaptability is also predicted to increase. For example, Smithtown school may try to change instructional practices so that student performance will be improved, so that the school can be removed from the NCLB “failing” list. It could also adapt by firing incompetent teachers, and hiring competent ones – though this kind of adaptation would be typically resisted by teacher’s unions and tenure stipulations. It could adapt by purchasing and using computer software to tutor students who are not meeting expected annual yearly progress.

**Using *SimEd* to Stimulate Change**

One way that Smithtown school could better its enrollment rate is to improve student achievement. Suppose Smithtown wants to improve its learning guidance by changing its predominantly teacher-guided system to use more instructional technology and bringing in parent or senior citizen volunteers as teacher aides. Essentially, Smithtown is attempting to increase system strongness with respect to instructional affect relations (i.e., increase the number of 'guidance of learning' connections to students).
Suppose that an education system wants to increase the system property 'strongness'. What does *SimEd PESO* predict?

**Figure 3**: Educational system property, strongness, is increasing. What will *SimEd PESO* predict?



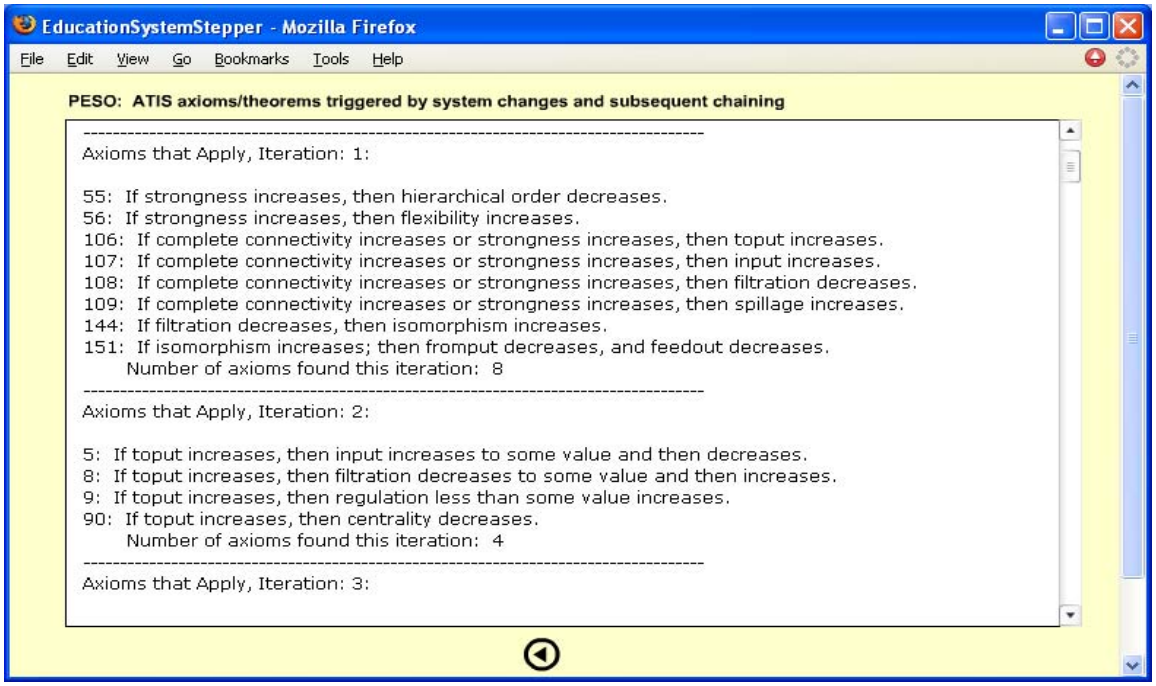

It can be seen in Figure 4 below that increasing system strongness has an impact on the hierarchical order and flexibility of instructional relationships in classrooms. It will also affect other aspects of the system such as the enrollment (input) and criteria for entering the system (filtration). Correspondingly, these in turn impact other aspects of the system such as isomorphism (how the system replicates the same strategy to other parts of the system) and regulation (which fromput qualifies to become output).

These are but two examples of what the *SimEd PESO* software is currently capable of doing. Through the *SimEd PESO* interface, users will be able to predict behavior of complex systems via Axiomatic Theories of Intentional Systems (ATIS) without needing to be experts in mathematics or logic.

***SimEd Technologies* Will also Include *APT&C* Software**

Education system administrators and researchers will also need to be able to measure system properties such as strongness, flexibility, filtration, centrality, etc. We have recently obtained funding for developing software to measure system dynamics and structure: Analysis of Patterns in Time and Configuration. *APT&C* is a different kind of measure paradigm that bridges traditional quantitative and qualitative research methods. *APT&C* builds on work done by Frick (1990) on *APT* and by Thompson (2005). Further information on *APT&C* and additional references are found in: http://education.indiana.edu/~frick/proposals/apt&c.pdf.

**Figure 4**: *SimEd PESO* makes a number of predictions when system strongness increases. The cascade of inferences is indicated by successive iterations of the axioms and theorems.




**Conclusion**

*SimEd Technologies* are theories, methodologies and software tools to help people understand complexity in educational systems. As the validity of the Education Systems Theory is established, educators can use *SimEd Technologies* to better understand how education systems can be improved. A valid educational systems theory will show educators all the consequences – even the unintended consequences – of changing one part of the complex educational systems they direct. These consequences could then be pre-empted and managed before the impact of changes is realized.

**References**

APT&C Website (2005). Analysis of Patterns in Time and Configuration. Retrieved 15 September, 2005, from http://www.indiana.edu/~aptfrick/ .

Banathy, B. (1991). *Systems design of education*. Engelwood Cliffs, NJ: Educational Technology Publications.

Bar-Yam, Y. (2003). *Dynamics of complex systems*. Boulder, CO: Westview Press.

Bertalanffy, L. von, (1968). *General system theory: Foundations, Development, Applications*. New York: George Braziller.

Bertalanffy, L. von, (1972). The History and Status of General Systems Theory. In G.J. Klir (Ed.): *Trends in general systems theory*. New York: Wiley-Interscience.

Caine, R. & Caine, G. (1997). *Education on the edge of possibility*. Alexandria, VA: Association for Curriculum Supervision and Development.

Cornacchio, J. V. (1972). Topological concepts in the mathematical theory of general systems. In G. J. Klir (Ed.), *Trends in general systems theory*. New York: Wiley-Interscience, 303-339.

Duffy, F., Rogerson, L. & Blick, C. (2000). *Redesigning America's schools: A systems approach to improvement.* Norwood, MA: Christopher-Gordon Publishers.

Friedman, T. (1999). The Semiotics of SimCity. *First Monday*, *4*(4). Retrieved September 15, 2005, from http://www.firstmonday.dk/issues/issue4_4/friedman/ .

Frick, T. (1990). Analysis of Patterns in Time (APT): A Method of Recording and Quantifying Temporal Relations in Education. *American Educational Research Journal*, *27*(1), 180-204.

Frick, T. (1991). *Restructuring education through technology*. Bloomington, IN: Phi Delta Kappa Education Foundation.
Frick, T. W., Hood, P. Kirsch K., Reigeluth C., Walcott A., and Farris H. (1994), *Simulosophy Group Report: Sixth International Conference on the Design of Social Systems*. Retrieved September 15, 2005, from http://www.indiana.edu/~tedfrick/simulosophy.pdf .
Jenlink, P., Reigeluth, C., Carr, A. & Nelson, L. (1996 – present, in process). *Facilitating systemic change in school districts: A guidebook.* Unpublished manuscript.
Lin, Y. (1987). A model of general systems. *Mathematical modeling*, *9*(2), 95-104.
Lin, Y. (1999). *General systems theory: A mathematical approach*. NY: Kluwer Academic/Plenum.
Maccia, E.S. & Maccia, G.S. (1966). *Development of educational theory derived from three theory models.* Washington, DC: U.S. Office of Education, Project No. 5-0638.
Mesarović, M. D. & Takahara, Y. (1975). General systems theory: Mathematical foundations. In R. Bellman (Ed.), *Mathematics in science and engineering*, Vol. 113. NY: Academic Press.
National Commission on Excellence in Education (1983). *A nation at risk.* Washington, DC: U.S. Governmental Printing Office.
Reigeluth, C. (1992). The imperative for systemic change. *Educational Technology*, *32*(11), 9-12.
Senge, P., Cambron-McCabe, N., Lucas, T., Smith, B. Dutton, J. & Kleiner, A. (2000). *Schools that learn*. New York: Doubleday/Currency.
SIGGS Website (1996a). *SIGGS Structural Properties*. Retrieved 15 September, 2005, from http://www.indiana.edu/~tedfrick/siggs3.html .
SIGGS Website (1996b). *SIGGS Dynamic Properties (temporal change)*. Retrieved 15 September, 2005, from http://www.indiana.edu/~tedfrick/siggs4.html .
Steiner, E. (1988). *Methodology of theory building.* Sydney: Educology Research Associates.
Thompson, K. R. (2005). "General System" defined for predictive technologies of A-GSBT (Axiomatic-General Systems Behavioral Theory). Manuscript accepted for publication, *Scientific Inquiry Journal*.
Wymore, A. W., (1967), *A Mathematical Theory of Systems Engineering: The Elements.* New York: Wiley.

# Social Interactions Experienced in the Massively Multiplayer Online Game Environment: Implications in the Design of Online Learning Courses

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**Abstract**

*The purpose of this research is to clarify the details of social interactions and experiences players encounter in the non-combat Massively Multiplayer Online Game (MMOG) environment. The research focuses on creating fundamental data for discussion useful for implementation for online learning courses. An ethnographic study approach is used for the research. Several possible themes which are relevant to the social interaction in the environment are found. Applicability of those themes to the educational settings is discussed.*

## Introduction

Video gaming, today, is becoming one of the major forms of entertainment, and as the industry has kept growing so has its market size. Generations born after 1970 are called "the game generation." Videogames are naturally a major form of entertainment for the game generations (Prensky, 2003). Online games provide players with opportunities to interact with others who are physically disconnected. Among the genres of the online game, Massively Multiplayer Online Game (MMOG) has become one of the most popular genres. The games in the genre have acquired millions of players (IGDA, 2004).

As using digital games for instruction has directed notable interest toward education, and extensive research has been conducted in this area (Mitchell & Savill-Smith, 2004). One aspect of games that educators and instructional designers have focused on is enhancing the social interaction in online learning environments (Muirhead, 2001). MMOG is also becoming a field of educational research. MMOG, considered a learning community (Steinkuehler, 2004), prompted college instructors to use MMOGs as a virtual classroom (Terdiman, 2004).

What often happens when games are designed and used for educational purposes is that they lose their aspects of fun, and the game does not engage student participation as one would expect. For this reason, principles and methodologies especially for utilizing games to maintain their engagement aspect in the learning environment need to be further researched and established.

The primary focus of this research is to investigate social interaction in the MMOG environment. In the MMOG environment, game players engage in peer mentoring and mutual learning, and the game environment becomes an online learning community (Yee, 2002b). This type of environment is what educators try to create in educational games.

## Literature Review

### Social interaction in online community

Social interaction is defined as "the acts, actions, or practices of two or more people mutually oriented towards each other's selves, that is, any behavior that tries to affect or take account of each other's subjective experiences or intentions"(Rummel, 1976). Online community is a research topic investigated by researchers in various fields (Tu & Corry, 2001). It is also called a "community in cyberspace" (Mccarty, 1999), and a "virtual community" (Erickson, 1997). Wagner (1997) outlined specific instructional outcomes which enhance learners' experience achievable through interaction in distance education settings and emphasized that social interaction in the distance education environment is important.

### Massively Multiplayer Online Game (MMOG) research

Past research on MMOG investigated the following issues: (1) understanding the ways people are, or are not, attracted to the game, and game addiction (Yee, 2002a; Choi & Kim, 2004; Foo & Koivisto, 2004); (2) clarifying how social interaction plays a role to engage people (Steinkuehler, 2004; Yee, 2002b); (3) defining the experience which players have in the MMOG environment (Griffiths et al, 2003); and (4) economic activities in a virtual world (Castronova, 2002).

The research shows that social interaction among the players takes on an important role in creating an online community in the game environment. However, most of the past research has been conducted on combat type MMOGs such as "Ever Quest" and "Ultima Online," and not on non-combat MMOGs. The combat type games are a type of “Dungeons and Dragons” game, which contains clear missions in the game system such as fighting with monsters and raising the strength level of the character. Even though the game players construct online communities in such environments, the game system and game contexts are not analogous to the learning communities in educational settings.

Detailed research, focused on social interaction in the non-combat environment is necessary to clarify why and how social interaction works for online game players in terms of engagement and motivation. The research has to be designed to provide a clear understanding of what engages players and what does not in the game environment. Detailed data on player behaviors and thoughts need to be collected, as well.

## Research purpose

The purpose of the research is to describe the social interactions and experiences among game players in the non-combat Massively Multiplayer Online Game (MMOG) environment.

The research is aimed at collecting data to answer the following questions:

(1) What are the elements creating social interactions which enhance players’ motivations to play the game?

(2) What are the players’ experiences which promote their engagement in the game play?

This research anticipates producing fundamental data to understand what kinds of social interaction occur in the MMOG environment. The research is also expected to establish a framework which can be applied to other MMOG research and other online community research, which investigates experiences of people in the environment.

### The field: MMOG “A Tale in the Desert”

The research is done on the game environment of “A Tale in the Desert” (ATITD), a non-combat MMOG which simulates ancient Egypt world, provides the players with a cooperative environment in which players need to collaborate with others to accomplish their missions (Figure 1). “The objective of ‘A Tale in the Desert’ is to build the ideal civilization by perfecting the ‘Seven Disciplines of Man’. The outcome of the game depends solely on the players. The storyline will revolve around what the players do. How they go about building their own cities, how they choose their own leaders, and how they face the stranger's challenges. If they can organize themselves and negotiate for what they need, Egypt will flourish (eGenesis, 2003).”


Figure 1. The environment of “A Tale in the Desert”

## Methods

As this research intends to collect detailed data and create “thick description” (Geertz, 1973) of culture in the field, ethnography (Rossman & Rallis, 2003) is chosen as a research approach. Coffey and Atkinson’s qualitative data analysis (1996) is chosen as a data analysis guideline. Because authentic ethnography requires long-term immersion which does not fit to the time span of the project, the research approach is considered mini-ethnographies.

Observations on game players' behavior, formal and informal interviews with game players, and document analysis of reflective journals, written by the game players are conducted. Observations occurred at the multiple locations in the game environment. Face-to-face and in-game chat interviews take place with game players. Document materials originate with the official game website and fan community websites.

**Research procedures**

Data collection occurred at the beginning of research. Documents related to the game were collected mainly originated with the ATITD wiki website (http://wiki.atitd.net/tale2), and ATITD.net (http://www.atitd.net/home/). Detailed information regarding game systems, in-game events, and game player interaction were compiled. Observations in the game environment were conducted to identify broad ideas on the behaviors of the game players. Several in-game events were observed. Interviews sourced from online chat and in-game chat functions in the game. These interviews consisted of seven formal interviews (six face-to-face interviews, one online-chat interview). Interviewees recruited from different identity groups allowed data collection from multiple aspects. An experienced MMOG player who has played ATITD for a long time, a novice game player who played ATITD, experienced MMOG game players who played ATITD for the first time, and a mother whose son is an experienced MMOG player, were the interview subjects.

The analysis phase included reconstruction of collected data. The expectation was that analysis will also reveal indications of interaction patterns, their meanings, power relations, roles, and interactive sequences. Based on the reconstructed data, a set of descriptions and evidences to addressing the research purpose and responding to questions emerged.

## Discussion and Results

**Game systems - the engine for social interaction**

There are some cultural forms found through the data analysis. The game systems and those cultural forms are closely related. Open-ended environment, cooperative tasks, and user-participated operation create the cooperative, autonomous player community.

(1) Open-ended environment

There are certain requirements to accomplish tasks, basically the game players are able to choose to pursue any tasks as they like. They run across the land of Egypt, visit seven different types of schools and universities (Schools/Universities of Leadership, Human Body, Worship, Art and Music, Architect, Conflict, and Thought) and learn skills (e.g. planting, cooking, mining, and construction) collect resources (e.g. woods, sands, irons, and slates) they need, and produce products (e.g. bricks, carrots, linens, and beers) which are necessary to accomplish the tasks.

(2) Cooperative tasks

The game players are required to accomplish the tests assigned by schools and universities. Some of the tests can be done individually, however, most of the tests require (or encourage) cooperation with other players. The players also have to donate resources to the universities to release the higher-level skills. The resources required for releasing skills are large and difficult to gather alone. It is also necessary to cooperate with other players to release the skills.

(3) User-participated operation

One of the unique features of ATITD is that the game system depends highly on user participation. The game websites (e.g. ATITD wiki and ATITD.net) are administrated and updated by player community. Tests in the game are also designed to encourage player participation to create social interaction by themselves. To pass the test of the host, the players have to host in-game events. The events are such as a gemcutting contest, a fireworks contest, a cooking contest, and so on.

ATITD also has a unique legal system in which the players prepare and pass around a legal petition to create a new game rule. Other players sign the petition if they agree to the new rule. Once the law is approved, the request is sent to the game designers. For example, "Driftwood Recycling Act" is the law to require the players on the novice island to remove the constructions they created, and "Full ban of Machiavelli" is the law to exile a misbehaving player. These laws petitioned by the players improve the quality of community life. Game publisher usually handle these sorts of requests as customer requests, however, ATITD includes the request process as a part of its game system.

In-game events take place to increase entertainment in the MMOG world. Though the game publisher usually produces the events in other MMOGs, in this game, players are also able to host the events. In-game events are opportunities to meet with other players. Just like in the real world, people enjoy conversation and play with the skills they learned. "…Others plan it in advance and invite a lot of people. then [sic] have drinks and acro and games. :)" (Data from online-chat log, 04/17/2005)

**Guilds – the place of mentorship**

A guild is a player group to share buildings, resources and manpower. It also works as a base for the players. The guild has a rank system and the higher-ranked players manage the guild. In the guild elder players support novice players through mentorship, or apprenticeship style instruction. The following dialogue is from online chat of the guild channel. A novice player learned how to move to other areas using a chariot stop from a guild elder.

A: How I can travel to other area?

B: ok, there are chariot stops, which are also shown on your map. They go to different regions. You can find what goes where on wiki

B: eventually you can get anywhere :) [smiley face]

B: the chariot stop is up the road from Thoth, north…from the chariot stop you would go to Nile Delta, then Sinai, then RSO. Travel at the chariot stop can be free if you want to wait, or if you are in a hurry, you can use travel time, it will tell you when you clock [click] on it.

A: Cool, now I can see pyro

B: :) (Data from the online-chat log, 03/27/2005)

**"Acro?" – the designed social interaction patterns**

As the game designers of ATITD intended, social interaction opportunities are designed and embedded in the game play. The players experience various types of social interaction. One of the unique phenomena observed is that the players start communicating with other players by asking "acro?" It means "Would you like to play acrobatics with me?" Acrobatics is one of the tests for the Human Body in the game. The players have to learn 28 moves to pass the test. To learn the moves, the players stand close to each other and perform the moves. The players need to communicate with others to know if they know the other moves.

KK: I have a petition that needs sigs, if anyone's within reach? [petition has to be signed by other players to be approved]

P: KK, I will check it out after the competition

KK: Didn't you take a copy, P?

(Data from the online-chat log, 04/09/2005)

**Barrier created by the social interaction**

On the other hand, existence of other player may create a barrier for the new players. Below is dialog with a novice ATITD player who has had no experience of MMOG play. She reflected why she did not feel engaged in the game.

Q: …So you are saying you have the same personality in the real and in the game.

A: Absolutely. I tell you what, not in the game, in the real world, if I am in the event, there is one or two persons I know, then I am fine. But when there are no people I know, then I become uncomfortable, and I will find a reason to leave.

Q: Yeah, I see... In the tale in the desert, did you talk to the mentor?

A: Yeah, my relationship with mentor was uncomfortable because I don't know who the mentor was. If the mentor was you, or other members of the class, I would have been fine. But when I was not knowing who the mentor was, I was not comfortable. (Data from interview with GS 04/11/2005)

Novice players tend to be overwhelmed by the complex MMOG environment. The interviewee above was also not familiar with the anonymity of the environment. Some informants stated that they prefer to play solo if their friends in the real world do not play the game. The personality of the player seems to affect his/her attitude to other players in the game.

**Conclusion – implications for online course design**

The social interactions in ATITD are carefully designed and embedded in the game play. Interactions take place in various ways. The significant differences between the player community in ATITD and learning community in online courses are that the role of provider, and the relationship of provider and receiver. The learning community in online courses is usually instructor-led. Automated course are unlikely to create interaction among learners. Provider (instructional designer and instructor) and receiver (learners) are clearly separated. Mutual learning among the learners passively occurs in partial ways. Continuous facilitation by the instructor is necessary to sustain the learning activities in the course.

In ATITD, on the other hand, the game designer is the service provider and designs and implements the game system to realize the planned activity (Figure 2). Once the activity is implemented, the players operate the activity and the advanced players voluntarily support novice players to learn and participate in the process.

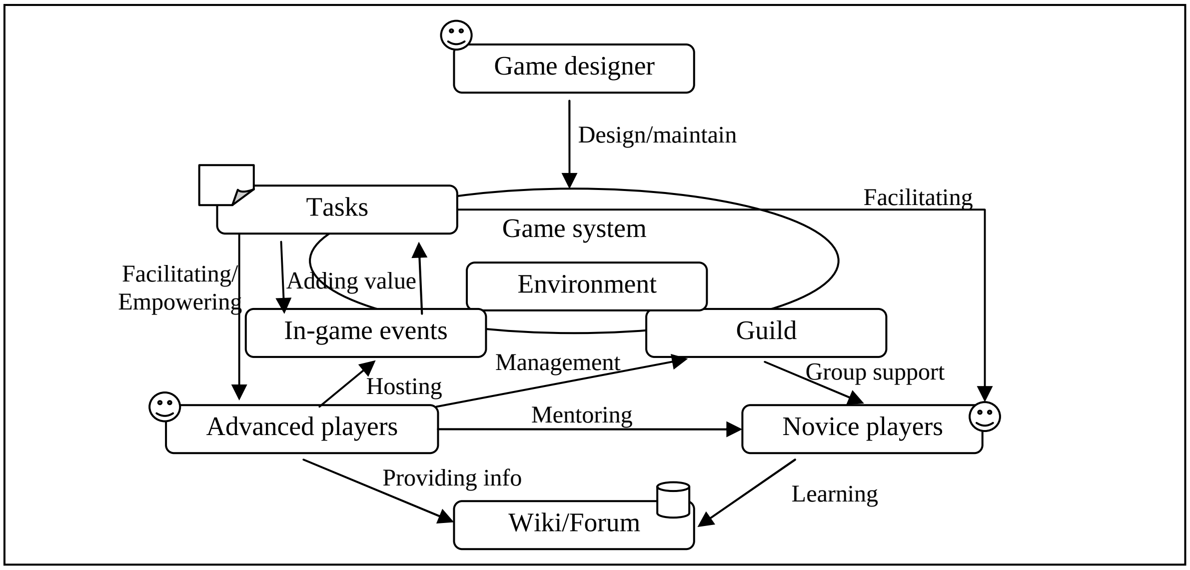


Figure 2. Relationship in the game world

In-game events and festivals are planned and hosted by advanced player who pursue the higher-level task. The community works autonomously, and the players learn mutually without direct help or intervention of the providers. The main providers' roles are an initial design and implementation, and maintenance. The design concept and design constructs are different between ATITD and online courses. Social interaction opportunities are interwoven in ATITD, whereas social interaction is not necessarily a concern of design in the online courses. Perhaps taking these differences into account in the online course design could improve them.

Playing a new MMOG is analogous to starting a new life in a foreign country. Significantly a researcher who studies MMOG has to become acclimated not only the language, but also the culture and rules of the "world". Despite the hardships, meet the people in ATITD world was a wonderful experience. The elders of the guild were generous and cooperative. People in the gemcutting contest welcomed and encouraged the novice player. Everyone encountered during the research positively supported each other to build a better society. Compared with other popular MMOGs, ATITD is just like a small village with just about 1500 villagers; however, with a unique and valuable culture in the village. As past ethnographers who studied uncivilized tribes become enchanted with the field, the field of ATITD provided the researcher with engaging and invaluable experiences. Amazingly the game arose from a small team of game developers, but the encouraging news for instructional designers is that a small team could create such an online learning community which is filled with social interaction and learning opportunities.

**References**


Castronova, E. (2002). On virtual economies. CESIFO Working Paper. 752 (9). Industorial Organization. Retrieved March 4, 2005 from: http://ssrn.com/abstract_id=338500.

Choi, D. & Kim, J. (2004) Why people continue to play online games: In search of critical design factors to increase customer loyalty to online contents. *Cyberpsychology & Behavior*, 7(1).

Coffey, A., & Atkinson, P. (1996). Making sense of qualitative data: complementary research strategies. Thousand Oaks, CA: Sage.

EGenesis (2003). A Tale in the desert game manual. Retrieved March 2, 2005 from: http://www.atitd.com/manual.pdf

Erickson, T. (1997). Social interaction on the net: Virtual community as participatory genre. *Proceedings of the Thirtieth Hawaii International Conference on System Sciences*. January 6-10, 1997, Maui, Hawaii.

Foo, C., & Koivisto, E. M. (2004). Grief player motivations. *Paper presented at the Other Players conference,* Center for Computer Games Research, IT University of Copenhagen, Denmark.
Geertz, C. (1973). *The interpretation of cultures*. New York: Basic Books.
Griffiths, M. D., Davies, M. O., and Chappell, D. (2003). Breaking the stereotype: The case of online gaming, *Cyberpsychology & Behavior 6*(1), p81-91.
International Game Developers Association (2004) *2004 Persistent Worlds Whitepaper*.
Mitchell, A., Savill-Smith, C. (2004) *The Use of Computer and Video Games for Learning*, Learning and Skills Development Agency, Retrieved March 4, 2005 from: http://www.lsda.org.uk/files/PDF/1529.pdf.
Muirhead, B. (2001). Enhancing social interaction in computer-mediated distance education. *USDLA Journal*, 15(4). Retrieved January 4, 2005, from: http://www.usdla.org/html/journal/APR01_Issue/article02.html.
Rossman, G. B. and Rallis, S. F. (2003). *Learning in the field* (2nd Ed). Thousand Oaks, CA: Sage Publications.
Rummel, R.J. (1976). Social behavior and interaction. In Rummel, R.J., *Conflict and War vol.2*. Beverly Hills, CA: Sage Publications. Retrieved March 4, 2005 from: http://www.hawaii.edu/powerkills/TCH.CHAP9.HTM.
Yee, N., (2002a). *Befriending ogres and wood elves – Understanding relationship formation in MMORPGs*. Retrieved March 2, 2005 from: http://www.nickyee.com/ hub/relationships/home.html.
Yee, N., (2002b) *Ariadne – Understanding MMORPG addiction*. Retrieved March 2, 2005 from: http://www.nickyee.com/hub/addiction/home.html.
Terdiman, D. (2004). Campus Life Comes to Second Life, *Wired News.* Retrieved March 15, 2005 from: http://www.wired.com/news/games/0,2101,65052,00.html.
Mccarty, J. E. (1999). Cyberjunctions: Building learning communities in cyberspace. *The Journal of Experiential Education*, *22*(2), 74.
Tu, C.-H., & Corry, M. (2001). A paradigm shift for online community research. *Distance Education*, *22*(2), 245.
Wagner, E. D. (1997). Interactivity: From agents to outcomes. In T. E. Cyrs (Ed.), *Teaching and learning at a distance: What it takes to effectively design, deliver, and evaluate programs*. San Francisco: Jossey-Bass Publishers.

# Practices of Computer Use in Elementary Education: Perceived and Missed Opportunities

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## Introduction

This paper reports on the findings of a large qualitative dissertation study of eight Arizona elementary classrooms in seven public schools. The study revealed an uncritical use of Accelerated Reader (AR). AR software use was largely claimed as exceptional "technology integration" by educators who believed that AR enhanced students' standardized test scores. Such reliance on technology to manage, assess, and track students allowed for production and documentation of students' progress with "computerized reports", a hallmark of efficiency, modernity, and preparation for life in an industrialized society.

## Conceptual Framework

The process of using technology to enhance learning is by no means a mere technical matter. The computer, like the chalkboard and the textbook, functions in a social environment that is mediated by humans. Educational resources that make use of emerging technologies have not become the norm in US public schools. The issues of how to educate teachers in the use of technology for the enhancement of learning and how the structures of schooling intersect with the ideas of technology integration are complex. Even as the potential to fundamentally reform education with the help of emerging technologies exist (National Research Council, 2000), established institutional forms of schooling have been remarkably stable and resistant to change (Cuban, 1993; Cuban, 2001; Cuban, Kirkpatrick, & Peck, 2001).

Many scholars contend that the attempt to reform education practices with the introduction of technology is to democratize access to knowledge and to give students the power of owning their learning. Popkewitz, Tabachnick, and Wehlage (1982) found that reform programs have unforeseen consequences and hold hidden values that work against the ethical and political intentions of the reform planners. They establish that the institutional values of schools:

> *. . . are justified and supported by professionals in the schools and school districts, who view them as responsive to the values of the surrounding communities. Teachers' perceptions of community social and cultural backgrounds give credence to technical definitions of education. In addition, what parents expect of the schools supports the emphasis on skill development and social control. (p. 79)*

They make a case for how the activities of schools historically condition people's ways of giving form to their social world. The intent to reform schools with technology may have unanticipated outcomes that come into play in the reform implementation as observed in the practice of technology in this study.

Although one of the intents of school reform with technology was to give students the power of owning their own learning, the observed integration of technology in this study primarily took the form of skill development—keyboarding and the improvement of teacher and student efficiency—computer use to manage students' reading and mathematics education. Such uses of technology are far removed from the idea of knowledge construction as a process of continuous research and design in which students and teachers share the difficulties and results. The failure of the school technology reform effort cannot be laid upon teachers. In this study, we found that the organizational structure of the district, the school, and the classroom have shaped teachers' primary practices.

## Purpose of Study

We wanted to study classrooms that were typical, i.e., contained one to five computers which seems to be the norm in US public schools (Becker, 2000). In addition we wanted to find a school district known for its investment in instructional technology support. The school district we selected was reputed to be the best in the state of Arizona for its instructional technology support program and had replaced all older Macintosh computers in its 25 primary schools with new ones at the time of this study (2001-03).

We hoped that a study of locally identified effective computer technology use practices where educators function under typical conditions—one to five computers in the classroom and periodically scheduled access to the school computer lab may reveal particular attempts at technology integration. The primary objective was to study teachers' computer technology use within the particular context of their classrooms and schools. The secondary objective was to situate these practices in the context of the research community's expectations for educational technology and recommended exemplars of technology use in education.

## Data Sources and Methods

The research questions guided the study, resulting in a qualitative research design using the interpretive approach outlined by Erickson (1986). The inherent complexity of classroom life, multiple perspectives and the pluralism of educators' practices of computer technology uses within the context of their schools were sought. At the same time, balance and variety were important; no less than five and no more than ten elementary classroom teachers with wide-ranging teaching experiences within a large school district were preferred for participation in the study.

Stake (1995) said that a case is an integrated system with people and interactions, and when it comes to selecting cases the first criterion should be to maximize what can be learned. The choice of a case should lead to important understandings and warranted assertions. The essential question was what group of schools will help us understand primary teachers' technology use practices within the context of the selected school district? For collective case studies, site selection based on opportunity to learn is of primary importance (Stake, 1995, p. 6). The qualitative research attempt is a process of deliberate inquiry in a specific setting (Bogdan & Biklen, 1998); therefore the contexts in which the participants are to be studied have to be associated with the study's objectives.

Long-term data collection occurred during the 2001-02 and 2002-03 school years in eight classrooms in seven schools of a large district with 25 elementary (K-6) schools and over 25,000 students. Participants were nominated by school administrators as successful in their educational use of computers. Eight teachers participated. The goal was to access the quality of teachers' and students' interactions with computer technology. Long-term observations in classrooms and computer laboratory settings, interviews with principals, teachers, and technology specialists, and document collection were conducted. Teachers completed a technology checklist and a survey of their teaching philosophy and computer use practices. Students completed a survey of their access to and use of computer technology at home. Detailed descriptions of observed and perceived uses of computer technology, with interpretive commentary were described through individual case studies.

### Site Selection

Researchers make decisions throughout their studies starting with the very important and yet basic questions of "what should I study?" and "where should I study?" Factors related to the school environment may promote educators' use of computer technology to enhance learning (Becker, 1994; Hadley & Sheingold, 1993). For that reason, it was essential to identify a school district that had created a supportive environment for educators' use of computer technology. Awan Public Schools, a large suburban Arizona district that had made an effort to support the use of computer technology in education was identified. In 2001-02, Awan Public Schools was the only school district in Maricopa County that had a technology personnel support program to assist classroom educators and students with the instructional use of computers in school computer labs. Each technology specialist, who was also a certified teacher, served two school campuses and spent approximately 9-10 days per month at each campus of which 35 hours was to be spent on direct instruction in the lab and in supporting classroom teacher's use of technology. This program was unique and represented the administration's effort to support the use of computer technology in education in more than a symbolic way.

### School Site Settings

The seven primary (K-6) school sites in the study functioned under somewhat similar support structures organized by the Awan school district's administration. Each school had one school administrator—the principal, and was supported by district staff with regard to technology support and maintenance. A central computer laboratory with 30 Macintosh workstations, a teacher workstation, a video projector, and one or more laser printers; and one Internet accessible computer in each classroom was the standard technology model at all the schools. To a large extent, schools in the study served middle and upper-middle class families; the student population was not very diverse.

**Participant Selection**

Once the school district was identified and permission was obtained, the Assistant Superintendent for Curriculum and Instruction introduced the researchers to all the primary school administrators via email. The researchers contacted the school principals by phone and email, and asked them to nominate 5th grade classroom teachers whom they identified as successful users of computer technology in education. As the nominations were received, researchers spoke with the nominees and scheduled to meet with them. In two separate instances, the school administrators nominated a fourth grade and a fifth/sixth grade teacher for participation in the study, citing that these classroom teachers were the most successful users of computer technology at their school sites.

Five female and three male classroom teachers participated in the study; their teaching experience ranged from 3 to 24 years (Table 1). Reasons citied by school administrators for recommending these teachers' for participation in the study included their willingness to use computers, use of software programs to manage students' reading and mathematics education, and use of computers by students to create demonstrations of learning (e.g., *HyperStudio*).

Table 1 Comparison of Teacher Experience, Demographics, and Technology Resources, Participant Classrooms, 2002-03

| Descriptor | Pule | Bain | | Hoyt | Rian | Sloan | Ely | Oden |
|---|---|---|---|---|---|---|---|---|
| Classroom Teacher | Mr. M | Mr. C | Mr. S | Mrs. H | Mrs. C | Mrs. T | Mrs. L | Mrs. G |
| Years of Teaching Experience | 24 | 4 | 3 | 6 | 12 | 21 | 7 | 3 |
| Highest Degree Attained | MA | MA | MA | BA | MA | MA | BA | MA |
| Additional University Credits | 72 | 30 | 30 | 15 | 60 | 50 | 15 | 33 |
| Grade Taught | 4 | 5/6 | 5 | 5 | 5 | 5 | 5 | 5 |
| Class Size | 28 | 21 | 28 | 25 | 28 | 29 | 28 | 25 |
| Number of Limited English Proficient Students | 0 | 17 | 5 | 4 | 4 | 1 | 0 | 0 |
| Number of Internet Accessible Computers | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 1 |
| Total Instructional Use Computers | 14 | 6 | 1 | 2 | 2 | 2 | 2 | 1 |

## Data Analysis

Making sense of the data began early on during field-work. As a human interpreter of the observed phenomenon, thoughts about happenings in short handwritten notes were documented, ideas about observations were scribbled on the margins of the field notes or spoken into the tape-recorder as the researcher prepared to leave a school site after an observation occasion. These notes became a part of the sense-making process and formed an integral part of the data corpus. These early notes represented the first interpretations of the observed events.

Erickson (1986) used a mode of analysis that can be described as analytic induction. Using this mode of interpretive research, the research data record was read as a whole several times and assertions were generated. These preliminary assertions were propositions or conclusions based on the data as a whole that the authors believed to be true. Attempting to understand the classroom use of technology, preliminary assertions were created. Then the assertions were warranted by looking through the data, seeking to verify or support and also seeking to disconfirm the assertions. In order to warrant the assertions, the data corpus as a whole was searched for all instances of computer use. All cases of computer use that supported the particular assertion to be warranted were identified. Any discrepant cases found in the instances of computer use that differed from that of the preliminary assertion were searched, identified, and examined for plausibility and consistency of regular practice of computers in education.

**School Goals and Technology**

From school mission statements and stated academic goals (Arizona Department of Education, School Report Cards, 2002, 2003, http://www.ade.state.az.us/srcs/, Accessed May 20, 2003), it was evident that student achievement and a focus on reading, writing, and mathematics were high on the list of school objectives. The school report cards which contain information reported by school administrators, typically reported four academic goals. Based on the order in which the academic goals were presented, researchers assigned them a priority rating of 1 (highest) through 4 (lowest) as shown in Table 2. The relationship of the stated academic goals to technology uses and the expectations for student learning can be inferred from these data. Specific mention of the student achievement was mentioned as follows: (a) SAT 9—Stanford 9 Achievement test; (b) AIMS—Arizona Instrument to Measure Standards, the state mandated test administered in reading, writing, and mathematics in grades 3, 5, 8, and high school; and (c) Six Trait Writing-the NorthWest Regional Educational Laboratory writing assessment model that included the following characteristics of writing: ideas, organization, voice, word choice, sentence fluency, and conventions. All schools in this study had formally prioritized improving student achievement as measured by standardized tests. We found that these goals were reflected in the observed technology practices.

Table 2 Comparison of Academic Goals and Relationship to Technology, Elementary Schools in Study, 2002-03

| Academic Goals | Pule | Bain | Hoyt | Rian | Sloan | Ely | Oden |
|---|---|---|---|---|---|---|---|
| Staff development in classroom technology uses | 1 | — | — | — | — | — | — |
| Incorporate / maintain the following programs in the curriculum | | | | | | | |
| Accelerated Reader (Reading) | 2 | — | 1 | — | — | 3 | — |
| Accelerated Math (Supplement Instruction) | — | — | — | — | — | 2 | — |
| Increase student achievement (SAT 9, AIMS) | 3 | — | 2 | 1 | 2 | 4 | 4 |
| Staff development in Six Trait Writing (AIMS) | — | 4 | — | — | 4 | 1 | — |
| Implement the following into student learning activities | | | | | | | |
| Critical thinking/questioning strategies | — | 1 | 3 | — | — | — | — |
| Cooperative group work | — | 1 | — | — | — | — | — |
| Make learning stimulating and challenging | — | 3 | — | — | — | — | — |
| Apply math to real-world experiences | — | — | — | — | — | — | 2 |

*Note.* The symbol — is used to denote that the participant school did not prioritize the corresponding academic goal. The number 1, 2, 3, or 4, represents the priority of the academic goal, 1 representing the highest and 4 the lowest priority.

**School Computer Lab Model**

Schools in Awan had adopted the school computer lab model for technology integration. This model allowed for maximization of student computer use in a central location; however, it did not provide access to computers in the one location where students spent most of their school day—the classroom. The typical classroom in participant schools had 1 or 2 Macintosh computers which did not make for a technology-rich classroom. Table 1 shows the number of student accessible computers in participating classrooms. The exceptions to school district, state, and national trends were Mr. M's fourth grade classroom at Pule Elementary and Mr. C's fifth-sixth grade dual language classroom at Bain Elementary. These exceptions are attributed to the classroom teachers' personal efforts to find additional computers for classroom use and not to school district policy.

**Prevalent Software Programs**

The implementation of the Renaissance Learning programs (http://www.renlearn.com, Accessed May 20, 2003) and other software used in the computer lab or participant classrooms is shown in Table 3. Implementation or maintenance of the Accelerated Reader (AR) and Accelerated Math (AM) programs which had computer software-based reading comprehension and math ability assessments was mentioned as a priority academic goal by three of the seven schools. Where these programs were available, they were usually used in the classroom setting. There, students took turns to take the relevant AR reading comprehension quiz after reading a book or scanned their answer sheets for the AM practice and tests of math skills. From the field-work at the seven school sites, it was noted that Oden Elementary was the only site that had neither implemented nor initiated the integration of the AR or AM programs into its school curriculum.

Software programs such as *Kid Pix*, *HyperStudio*, and *Apple/ClarisWorks*—which contained word processing, spreadsheet, and database programs were typically used during the scheduled sessions in the computer lab. In some participant classrooms, if students had not completed their research at home or did not have access to a computer at home and needed extra time beyond the regularly scheduled session (once every 6 days for one class period) in the computer lab, students were occasionally allowed to use the Internet for researching information to include in their social studies reports (e.g., the fifth grade report on selected US Presidents).

*Computer-Based Programs and Student Achievement*

Interest in improving student achievement as measured by standardized tests was expressed by all school principals in the study. During formal interviews, most of the principals expressed their belief that use of certain software programs such as the Renaissance software programs (e.g., Accelerated Reader, Accelerated Math, and Math Facts in a Flash) helped increase student achievement. They believed that the use of the Accelerated Reader (AR) program helped increase student interest in reading. They also expressed their faith that the AR program provided the all important reading practice that helped improve comprehension and reading ability, thereby helping to raise student achievement scores. In the schools where the AR program was implemented, students' were assessed at the start of the school year using the STAR-Reading computer-based test to identify their reading ability and at the end of each quarter. Based on this evaluation, students read books at their "zone". For each book read, individual students took a computerized comprehension quiz (comprised of 5 to 10 multiple choice questions), and received scores and points as they completed the quizzes successfully. The AR software program kept track of the books read, and the scores and points received for each student during the school year. In the schools where AR was "implemented" (see Table 3), the principals set school goals for the number of AR points to be achieved by students. The principals regularly monitored each classroom's progress in reading as reported by weekly or monthly status reports generated by the AR software.

Table 3 Comparison of Prevalent Software Programs, Elementary Schools in Study, 2002-03

| Software Program | Pule | Bain | Hoyt | Rian | Sloan | Ely | Oden |
|---|---|---|---|---|---|---|---|
| *Accelerated Reader* | Implemented[a] | Used[b] | Implemented | Implemented | Implemented | Implemented | — |
| *Accelerated Math* | — | — | Implemented | — | Implemented | Implemented | — |
| *Math Facts in a Flash* | — | — | Introduced[c] | Introduced | — | — | — |
| *Kid Pix* | Used | — | — | — | Used | — | — |
| *HyperStudio* | Used | Used | Used | — | — | — | Used |
| *Claris/Apple Works* | Used | Used | Used | Used | Used | Used | Used |

*Note.* The symbol — denotes a participant school where the corresponding program was not implemented, used, or introduced.
[a]Implemented = The school had two or more years of experience in using the Renaissance programs of Accelerated Reader or Accelerated Math; the programs were used regularly and the school principal paid attention to student progress in reading via periodic reports.
[b]Used = The school used the software program routinely, but did not give special attention or credence to the programs; they were used generally in the school computer lab and seldom in classroom conditions.
[c]Introduced = The school had recently piloted the program with the intention of integrating the program into the Math education curriculum on a school-wide basis.

Among the seven school sites, six schools—Pule, Bain, Hoyt, Rian, Sloan, and Ely Elementary —had integrated the Accelerated Reader (AR) program into their curriculum to varying degrees. In some school sites, especially the ones where AR was "implemented" vs. "used" (see Table 3) the importance assigned to AR was obvious. As soon as one walked into the school, near the office one could find a large display that indicated the school's monthly or quarterly progress in AR points to reach the school goal. In 2002-03, many schools in the Awan School District that had successfully integrated the Accelerated Reader program in previous years began the integration of the Accelerated Math software program or another math practice and test program called Math Facts in a Flash, also a Renaissance software product.

Hoyt, Sloan, and Ely Elementary schools had one year or more experience in integrating the Accelerated Math (AM) program into the school's curriculum. At the start of the school year, students were tested using the computer-based STAR-Math assessment which allowed them to be placed into grade level ability such as 4.6 ($4^{th}$ grade, $6^{th}$ month). Based on student performance in the STAR-Math test, the AM software program generated customized practice and test assignments. Students printed these software generated practice assignments and tests, marked their answers on bubble sheets, and self scanned the bubble sheets to a computer in the classroom using a customized scanner. Student performance on assignments and tests were tracked by the software. Teachers had the ability to set goals for individual students in the software if they noticed students struggling or excelling in specific skill areas. Every quarter, students were tested on the STAR-Math test to determine their grade level gains.

**State Legislation on School Accountability**

In 2002, the Arizona Department of Education developed the “Arizona Learns” formula based on student performance on the Stanford 9 (SAT 9) and the Arizona Instrument to Measure Standards (AIMS) in response to state “school accountability” legislation (http://www.azleg.state.az.us/ars/15/00241.htm, Accessed January 20, 2003). The legislation was introduced during Fall 2001 (when data collection for this study started) and was passed in Spring 2002. In October 2002, the formula assigned one of four possible profiles—*Excelling*, *Improving*, *Maintaining Adequate Performance*, or *Underperforming*—to every Arizona public school. All of the schools that participated in the study received the second best profile—Improving, only two schools in the entire state received the best profile of Excelling. Nevertheless, under such state school accountability conditions, it was no surprise that school administrators’ expressed their interest in using supplemental computer-based programs to improve student achievement as measured by the national level Stanford 9 and the state mandated AIMS.

**Reading Renaissance Program as Primary Use of Computers in the Classroom**

A common theme among the participants’ use of computer technology in the classroom was the use of the Reading Renaissance Accelerated Reader (AR) program. The AR program provided a software management tool to test students’ reading comprehension via computer-based quizzes. At the start of the school year, students were tested using the STAR Reading program—a computer-based software program to identify their reading ability and reading zone known as Zone of Proximal Development (ZPD). Any book in the school library for which the school owned quizzes was known as an AR book. On completion of reading an AR book in their recommended ZPD range, students took a related quiz within 24 hours. They earned AR points based on the number of correct answers in the quiz of 5 to 10 multiple choice questions. Students spent 15 to 20 minutes each week taking quizzes on the computer and read AR books for 60 minutes each day. Teachers and administrators monitored students’ reading progress by reviewing diagnostic reports generated by the AR software. Teachers intervened when necessary (either when students were struggling or needed to be pushed further) by suggesting that students read at a different reading level. School goals were set for the number of AR points to be achieved, school progress in reading as measured by AR points were constructed and displayed near the school front office. Earning AR points became the primary goal at a number of school sites.

**Staff Development with regard to Computer Technology**

It is important to note that the district offered staff development classes coordinated by the district’s Reading Renaissance coordinator, some of which were labeled “Computer Classes”. Participants in these classes could receive credit towards salary increments. The “Computer Classes” focused on helping teachers understand how the STAR Reading Assessment program worked, how to manage the Accelerated Reader software, how to access the various reports in the software, and how to use the Book Guide components of the software. The other classes focused on goal setting for AR use in one’s classroom; assessing the status of the students’ in one’s classroom and maintenance of student reading logs; diagnosis and intervention to assist students; how to match books to students; adjusting reading levels; model mini-lessons for classroom use; and understanding the requirements to seek “Model” and “Master” Reading Renaissance certification. These classes were offered in a central location or at Hoyt Elementary which had served as the initial pilot site for AR.

Classroom educators who received Reading Renaissance certification proudly displayed their achievements on their classroom door. When all classroom educators received a certain level of certification, the school would also receive the related Model or Master Renaissance (http://www.renlearn.com/rencertification/default.htm, Accessed March 20, 2003) school label. Ely Elementary was reported as the first school in Arizona to earn the Master Renaissance school status. In 2001-02, Hoyt, Rian, and Sloan Elementary schools all reported achieving Model or Master Renaissance school status. This achievement was reported to the Arizona Department of Education by the school principals in the annual school report card as one of the three or four school level accomplishments for the year. Pule Elementary reported the fact that all classroom teachers at the school had received training in the Reading Renaissance program in 2002-03 as an accomplishment. These highlight the importance placed by administrators and teachers on the school-wide implementation of the Reading Renaissance program.

**Use of Computer Lab Sessions**

Students typically used the school computer lab merely for a total of 15 hours or 1% of 1,035 instructional hours in a school year. Access to school use of computers for the typical student was insignificant in relation to the amount of instruction time at school. Whereas, a large number (87%) of the students in participant classrooms said that they had access to a home computer. Use of the scheduled computer lab sessions were dedicated to cultivation of technical skills (e.g., keyboarding and learning the use of word processing, spreadsheet software, Internet). The district's technology integration model focused on "vocational life skills" as evidenced by the enacted key-boarding curriculum and the technology education curriculum. The mission for integration of computers into the district was of the view, "unless we have technology in our schools, kids won't be able to get jobs in an increasingly computerized world."

Computer lab instruction was supported by part time (50%) district assigned computer resource technology specialists who were also certified teachers. These specialists typically served two different campuses, part-time on each campus. Their role was to support instruction in the computer lab by designing and introducing lessons. The classroom teacher was expected to complete the project started by the specialist. However, teachers used the computer lab sessions as specials and did not stay in the lab during instruction. Teachers were not evaluated on their use of computers in education and did not feel responsible for instruction in the lab. The district's project-based technology integration plans functioned in isolation from classroom instruction. Additionally these lab sessions did not challenge students' prior experience with computers at home.

In 2001-03, the average per pupil expenditure for participant schools was $3,323 and comparable to the state average of $3,012. The schools were well funded by state standards and the district primarily served children from largely middle class families. These families typically had middle class aspirations for their children and expected school to provide their children a "good" education. However, access to computer technology for students in school was very limited. Chiefly, students' ability to think for themselves, think critically, and appropriate computer technologies as learning tools were not facilitated and exploited by school.

## Findings

An interpretive comparison (Erickson, 1986) of the patterns in the set of eight case studies led to the following assertions:

1. Classroom use of computers was defined by the use of the Accelerated Reader program and its uncritical acceptance as a software tool to manage students' reading practices.

2. School use of computer technology was similar, ordinary, and monotonous.

3. Access to school use of computers for the typical student was insignificant in relation to the amount of instruction time at school.

4. Use of computer technology in education was symbolic and did not represent curricular integration with technology.

The findings suggest that schools need to establish clear academic goals, determine how the use of computer technology will help achieve these school goals, and employ new models of professional development that go beyond the training paradigm.

The technology infusion model initially adopted by the district in 1994 was organized by a committee composed of administrators, teachers, and parents. The committee conducted parent and teacher surveys to seek input on the district's "needs relative to technology in the classroom." Yet, in a rapidly growing district such as Awan Public Schools, seven years later, in 2001, the original model along with the technology education standards and technology skills performance goals for learners seemed out of place. The 1993-1994 technology committee that developed plans for technology infusion into Awan's public schools stated its mission as, "to maximize the resources available to educate students for life-long learning of vocational and life skills through the utilization of modern technology." This mission as implemented by the district's administration and staff gave the impression of modernity whereas the observed use of computers in education was rather pedestrian.

The school district had grown rapidly. In a span of five years, from 1997-98 to 2001-02, enrollment had increased by 45%. At the same time hardware and software technology had advanced considerably and ideas about the place of computers in education were still unresolved. The initial model focused on the cultivation of "vocational life skills" as evidenced by the key-boarding curriculum and the technology education curriculum. The mission for the Awan Public Schools, with regard to computers, seemed to be simple: Unless we have technology in our schools, our kids won't be able to get jobs in an increasingly computerized world. Consequently, the focus on preparing students for vocational and life-skills justified the investment in school computer technology.

In 2002-03 was this goal still valid for a population that was increasingly upwardly mobile with 44% of Awan's labor force in professional occupations? Or for that matter, is a curriculum of the kind adopted and implemented by Awan Public Schools—a curriculum that aims to "teach" students about commonplace software technology–appropriate for student populations of any socio-economic level? In 2000, Larry Cuban, a critic of techno-enthusiasts, said:

> We worry about teaching keyboarding today but it won't be needed when voice activation becomes common in a few years. The dogma will only be replaced when people realize how quickly it is all

> changing. Kids don't need years of computer exposure to succeed. People with no computer background generally catch on in a few weeks-a few months tops. (Salpeter, 2000)

Then what is computer's place as a "modern technology" or "new technology" in public education? The population served by Awan Public Schools was largely middle class and upwardly mobile as noted by students' reports of parents' occupations and confirmed by data from the 2000 census. In July 2003, the town of Awan was designated as the fastest growing city of 242 cities with populations of 100,000 or more in the nation. Between April 1, 2000, and July 1, 2002, Awan's population had grown by nearly 23%. According to the 2000 census, the racial diversity in the town of Awan was as follows: 80% White, 12% Hispanic or Latino, 4% Asian American, 3% African American, and 1% Native American. Further, according to the 2000 census, Awan had close to 35,000 households. Only 8% of these were female led households with children but no adult male present, whereas, 82% of the households were families with children. In 2000, 44% of the town's labor force was employed in management or related professional occupations, 31% in sales and office occupations, 10% in service occupations, 6% in construction, extraction, and maintenance occupations, and 8% in production, transportation, and materials moving occupations. The district primarily served children from largely middle class families. These families typically had middle class aspirations for their children and expected school to provide their children a "good" education.

Cuban (2001, p. 156-159) argued that the acquisition of computers by public schools is symbolic of high status and modernity:

> By the late 1990s, the computer—like past mechanical marvels such as the steam engine, the railroad locomotive, and the airplane—had become, among other things, a high-status symbol of power and modernity...Woe to the school leader unable to show patrons and visitors rooms full of machines. A "good" school has become, by definition, a technologically equipped one.

Awan Public Schools certainly fit the description of a "good" school. Each school showcased a computer lab and each classroom contained one or two Internet accessible computers. Nevertheless, the school and classroom computers were largely used to emphasize technical skills and technology education. The implementation of the Accelerated Reader and Math programs suggested teacher efficiency and productivity. In theory these programs freed up teachers' from manually creating, administering, and grading, individualized reading and math assessments. The Accelerated Math software program used Scantron—bubble sheet technology to assess student practice and assessments. The software program was chiefly used to print additional practice assignments for students to practice math skills as a supplement to classroom instruction. These instances of classroom use of computer technology were also geared to increasing student productivity by providing additional practice and immediate feedback.

The observed applications of computer technology, particularly the Accelerated Reader and Math programs were believed to raise student achievement, promote better teaching as their use provided the elementary grade teacher with more time to provide individualized instruction, and demonstrate school's use of technology to document students' academic progress in reading and mathematics. Yet, there was no research-based evidence that these programs were helpful in increasing student achievement. Many scholars have noted that American culture has long valued "modernity," as meaning that schools, like businesses, must appear efficient, productive, business-like, pioneering, and futuristic (Cuban, 2001; Spring, 1998).

## Conclusion

While giving a semblance of modernity, essentially, the observed use of classroom computers in eight Arizona upper elementary as defined by the Accelerated Reader program chiefly served the amplification purposes of technology. It represented the use of computers to improve teacher and student efficiency. The observed practices of technology integration did not represent curricular integration of technology; instead they served to draw attention to the isolation of classroom instruction from computer use. Computer technology use was largely symbolic of modernism and only a token representative of the notion of curricular technology integration.

The district's technology support structure was designed to be efficient from the viewpoint of maintaining the technology. But this structure prevented teachers from attempting innovation with the available computer technology. The mandatory procedures to install software programs that were not already available on the school computers were cumbersome and time consuming. In addition, the age-graded school with self-contained classrooms, and a district curriculum that required teachers to teach subjects in allotted time periods, forced teachers to "ration" their energy and time (Cuban, 1993). The structure of schooling in participant classrooms was largely designed for whole-group instruction. Explicit classroom rules prevented students from working in groups and sharing their learning with each other and their teacher. Teachers had to maintain classroom order, transmit knowledge, and determine whether students learned the subject matter. These tasks were to be done efficiently within the pre-specified instruction time of a school-day. Thus teachers engaged in instructional techniques that were compatible with the district's and the school's existing structures.

Very few teachers in the study were willing to explore a student-centered approach that would force them to let go of set class periods, allocated instruction time for subject matter, and classroom routines. Technology can play a significant role in supporting a student-centered approach to curriculum. Such an approach would associate knowledge construction as a strategy that enhances learning; helps personalize concepts; gain deeper understanding; expand thinking and problem-solving skills; and generate, develop, explore, model, and synthesize ideas. In direct contrast, the organizational structures of the district and the school encouraged regularities in instruction that were ordinary and monotonous. These structures did not promote innovation in the instructional use of technology. School reform with technology would require that teachers completely refurbish their fundamental methods of classroom operation and few teachers demonstrated the will to disturb the stability of a controlled and orderly classroom.

Integrating computer technology into instruction is complex. Merely providing an Internet accessible computer in every classroom and scheduling each class to use the school computer lab once every week does not meet the requirements of technology integration. Students in this study had limited access to computer technology in school. Expecting such limited access to technology to significantly change the process of learning would be unreasonable. Each of the teachers and administrators in the study noted the difficulty in having students use the only computer in the classroom and the problem of the availability of a computer lab session once every six school days. Despite reports of increasing access to computers in both school and home, the reality of the public school classroom may be that only limited access to computers is the norm.

Having one or two computers in the classroom does not constitute adequate access to technology and it does not lead to significant student use. Computer technologies cannot have a significant impact on student learning when teachers and students do not have the opportunity to access and use the technologies on a regular basis. All the same, the most noticeable and commonplace use of computers in participants' classrooms and schools were restricted to the use of computer-based reading comprehension quizzes. In addition, use of the Accelerated Reader program was representative of schools' need to use computer technology or any program that seemed to enhance student achievement as measured by standardized tests. It was indicative of the larger school accountability model under which schools operate today. Policy makers hold schools accountable through use of tests of student achievement that can be widely and uniformly administered across schools. Although there have been advances in measurement of student achievement using standardized tests, they are not compatible with our increasing understanding of learning and the development of expertise. A major research emphasis is necessary on measures of student achievement that reflect the characteristics of learning advocated by the National Research Council (2000). What researchers consider are exemplary uses of computer technology to enhance learning and what educational policy makers demand that schools measure regarding student achievement are mismatched. Given the prevalent school accountability disposition in the nation, schools cannot be expected to seriously engage with new technologies to enhance learning in desirable ways.

**References**


Becker, H. J. (1994). *Analysis and trends of school use of new information technologies* (Contractor Report). Washington, DC: Office of Technology Assessment.

Becker, H. J. (2000). Who's wired and who's not: Children's access to and use of computer technology. *The Future of Children: Children and Computer Technology, 10* (2), 44-75.

Bogdan, R. C., & Biklen, S. K. (1998). *Qualitative research for education: An introduction to theory and methods* (3rd ed.). Needham Heights, MA: Allyn & Bacon.

Cuban, L. (1993). *How teachers taught: Constancy and change in American classrooms 1880-1990* (2nd ed.). New York, NY: Teachers College Press.

Cuban, L. (1986). *Teachers and machines: The classroom use of technology since 1920.* New York, NY: Teachers College Press.

Cuban, L. (2001). *Oversold and underused: Computers in the classroom.* Cambrdige, MA: Harvard University Press.

Cuban, L., Kirkpatrick, H, & Peck, C. (2001, Winter). High access and low use of technologies in high school classrooms: Explaining an apparent paradox. *American Educational Research Journal, 38* (4), 813-834.

Erickson, F. (1986). Qualitative methods in research on teaching. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed. pp. 119-161). New York, NY: Macmillan.

Hadley, M., & Sheingold, K. (1993). Commonalities and distinctive patterns in teachers' integration of computers. *American Journal of Education, 101*, 261-315.

National Research Council. (2000). *How people learn: Brain, mind, experience, and school.* Committee on Developments in the Science of Learning, J. D. Bransford, A. L. Brown, and R. R. Cocking (Eds.), Committee on Learning Research and Educational Practice, M. S. Donovan, J. D. Bransford, and J. W. Pellegrino (Eds.), Commission on Behavioral and Social Sciences. Washington, D.C.: National Academy Press.

National Research Council. (2002). *Improving learning with information technology.* Steering Committee on Improving Learning with Information Technology, G. E. Pritchard (Ed.), Center for Education, Division of Behavioral and Social Sciences and Education. Washington, D.C.: National Academy Press.

Popkewitz, T. S., Tabachnick, B. R., & Wehlage, G. (1982). *The myth of educational reform: A study of school responses to a program of change.* Madison, WI: The University of Wisconsin Press.

Salpeter, J. (2000). Interview with Larry Cuban—Taking stock: What does the research say about technology's impact on education? *Technology and Learning Magazine,20* (11), Retrieved May 20, 2002, from http://www.techlearning.com/db_area/archives/TL/062000/archives/cuban.html

Spring, J. (1998). *American education* (8th ed.). Boston, MA: McGraw Hill.

Stake, R. E. (1995). *The art of case study research.* Thousand Oaks, CA: Sage Publications, Inc.

# Designing an Interdisciplinary Degree for Performance Improvement: A Case Study at the University of Georgia

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The University of Georgia

**Abstract**

*In August 2002, the University of Georgia's College of Education started the Instructional Psychology, Training and Technology (IPTT) bachelor's degree, an interdisciplinary degree that integrates Instructional Design and Technology, Educational Psychology, Adult Education, Occupational Studies, and Workforce Development. This degree was the first of its kind, because it provided these critical skills and competencies at the bachelor's level to adults already working in the field. The challenges and rewards in providing an interdisciplinary bachelor's degree to non-traditional students in an off-campus, metropolitan setting are discussed, as well as the reasons why the degree was abruptly discontinued in the midst of rapid growth and growing reputation. This degree could serve as a model program for institutions serving non-traditional students in a metropolitan environment.*

Increasingly, businesses have become a larger provider of educational services for adults than higher education. Government agencies, hospitals, community agencies, unions, and a host of other private sector, federal, state, local, and voluntary associations are providing educational services to their employees, customers, and suppliers. Rapid technological change, globalization, restructured workplaces, labor market shifts, and pressure for reduced costs and increased productivity have increased the demand for professionals capable of developing human capital through the application of several disciplines. People working in areas of developing employees, a workforce, or an organization, with the goal of producing competent, confident, and satisfied personnel; without formal or with limited education; become successful through a process of trail and error, coupled with the varied experiences received through attending conferences, seminars, or workshops. Moreover, formal education for skilled personnel in the areas of adult education, instructional design and technology, career development, change management, and the science of learning and motivation has largely been limited to the graduate level, and is generally limited to one or two programs or departments.

People working in the broad fields of training, instructional design, and human resource development often entered their craft through various avenues and developed their own career paths, or stumbled into their careers, without ever completing their bachelor's degree. For individuals who received their training on the job, standards have been created by professional organizations and accrediting bodies to ensure a minimum degree of competency; for example, the Association for Educational Communications and Technology (AECT), the International Society for Performance Improvement (ISPI), and the International Board of Standards for Training, Performance and Instruction (IBSTI).

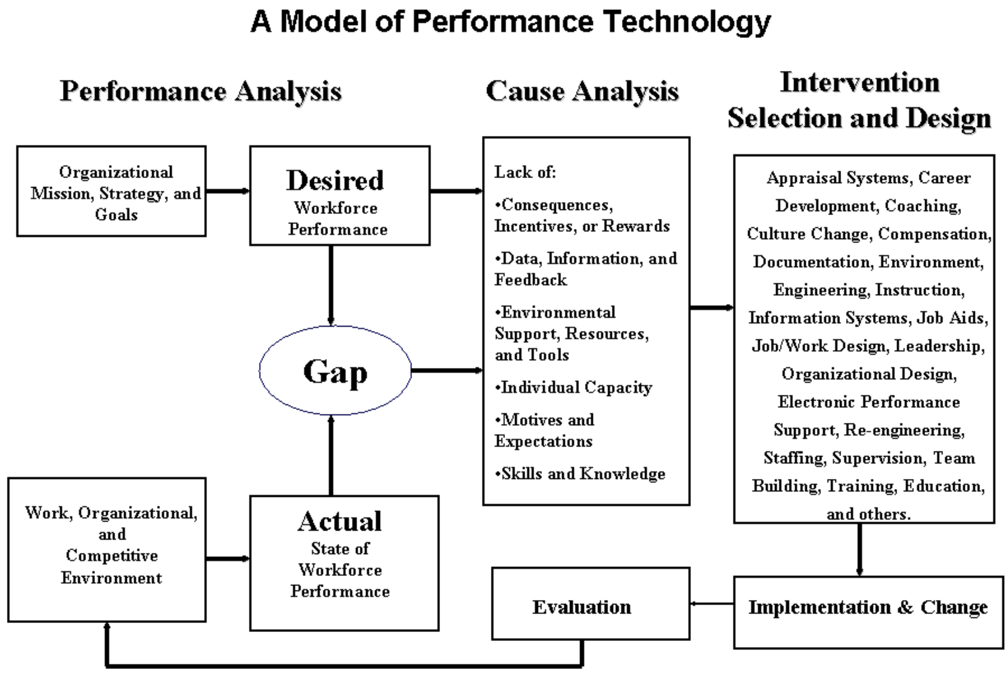
### UGA Expands its Reach into the Community

In 1999, leaders in Gwinnett County requested that the University of Georgia begin providing bachelor's degrees in Gwinnett County, a rapidly growing county in the metropolitan Atlanta area. The Board of Regents approved this request and UGA committed to providing three bachelor's degrees in 2002. UGA had already been serving the greater Atlanta area by providing evening Master's degrees in Gwinnett County for several years, with great success. In addition, Georgia Perimeter College had been providing Associates degrees at the same location. In fall, 2002, UGA began offering three separate bachelors degrees, (1) Instructional Psychology, Training, and Technology, (2) Business Administration, and (3) Biological Sciences. By 2004, UGA was offering seven bachelor's degrees in Gwinnett.

### Interdisciplinary Learning

In the field of human performance technology, there are many ways to affect change; all beginning with a thorough needs assessment and requiring a myriad of blended solutions, resulting in summative evaluation which can be equated with return on investment for companies seeking a productive and competitive workforce and monetary returns for their shareholders. The interventions for improving performance and managing change to ensure systemic benefits require a broader perspective and a greater range of disciplines from which to draw to accurately analyze and solve complex business problems, without harming those processes that are working well within and outside the organization. Interdisciplinary programs provide an opportunity for students with career goals that can best be met by drawing from the knowledge base, methods, and experiences of more than one discipline. Figure 1 depicts a model of human performance technology that requires an interdisciplinary perspective for analysis of needs and interventions.

Figure 1. One Model of Human Performance Technology (Adapted from ISPI's HPT Model, 2004)




Promoting learning and change in work processes beyond a single discipline is a primary goal toward a construction that integrates and synthesizes multiple perspectives. Schommer (1994) noted that interdisciplinary learning shifts the focus from memorizing facts in a single theme to the interpretation and application of knowledge across several contexts. This was a wake up call for institutions of higher education to develop programs of study that enhance students' critical abilities to solve complex business problems.

Michael & Balraj (2003) reported that few institutions have established procedures for developing, regulating, and evaluating interdisciplinary degree programs. A report by the Carnegie Foundation (1998) noted the lack of interdisciplinary bachelor's degrees at research universities and cited such barriers as traditionally defined departments and lack of sponsorship. Interdisciplinary programs require support by an administration that demonstrates commitment, including monitory support, and recognition of the faculty members willing to invest themselves and commit to the quality of interdisciplinary education (Einhellig & Marre 1999). These issues are obvious to Research 1 institutions where research and external funding are the primary focus.

Einhellig & Marre (1999) suggested that an interdisciplinary curriculum might emerge as a new and distinct field of studies. A noteworthy example is UGA's Human Resource – Organizational Development (HROD) Master's degree, also offered in Gwinnett County. The College of Education's Adult Education and Occupational Studies departments joined forces to develop this unique degree, which incorporates perspectives and faculty from both disciplines. IPTT's interdisciplinary curriculum would serve as an ideal model for institutions seeking to establish a distinct field of study to meet the needs of both students and organizations.

**Program Development**

In 2001, a market survey conducted by businesses in Gwinnett County revealed a need for an undergraduate degree that would provide graduates with the skills and competencies necessary to help its growing number of public and private organizations become more productive and successful. Gwinnett County is home to more than 930 manufacturing companies, over 981 high-tech companies, and 235 international companies (Gwinnett

Chamber of Commerce, 2002). Gwinnett County has almost doubled its population in each of the past three decades, and it is predicted that its population will be over 1,000,000 by 2020. Moreover, Gwinnett County is diverse. Students attending Gwinnett County's public schools represent language and cultural backgrounds from an estimated 115 countries, which range alphabetically from Afghanistan to Zimbabwe (Morgan, 2002).

The Interdisciplinary IPTT degree was developed by the University of Georgia's College of Education in response to a formal request by businesses in Gwinnett County, just north of Atlanta. The curriculum was designed to enhance the skills and knowledge of adults in the metropolitan Atlanta area who have work experience in the areas of training, organizational development, human resource development, and other areas of performance improvement or who were seeking a career change, and who never completed their bachelor's degree, and are often penalized by losing their jobs or being overlooked for promotion.

Based on a formal request from the community, there was no question that the first bachelor's degree offered by UGA's College of Education would require an interdisciplinary focus geared to meet the growing performance needs of working adults. Therefore, in 2002, four departments in UGA's College of Education created and began offering a unique, interdisciplinary undergraduate major as a collaborative effort. At the time, these four departments were Educational Psychology, Adult Education, Occupational Studies, and Instructional Technology. Since that time, the College of Education reorganized, which affected representation on the IPTT advisory committee, but did not affect the curriculum in any major way. The advisory committee, which previously consisted of department heads of the four departments, became the department heads of three departments, namely, Educational Psychology – Instructional Technology (EPIT), Occupational Studies, and Adult Education.

The author started the IPTT program at the Gwinnett Campus in 2002 and served as program director, recruiter, advisor, liaison between Gwinnett and the main campus, internship supervisor, and instructor of five major courses in the degree. She left the program in July 2005, after the decision was made to discontinue undergraduate degrees in Gwinnett.

## IPTT Program Goals

The interdisciplinary Instructional Psychology, Training, and Technology bachelor's degree completion program was designed to provide students with the skills, competencies, and experience to help organizations in the greater Atlanta area identify their performance needs and to provide measurable improvements through training and non-training interventions.

## Major Coursework

As most of the IPTT students were non-traditional and working in the greater Atlanta area, all courses meet in the evenings, once per week, with two courses scheduled back to back each evening. Some courses are offered on line, or through blended delivery. Table 1 provides a complete listing of major coursework.

Table 1. Instructional Psychology, Training and Technology Major Coursework

| Instructional Technology | Adult Education |
|---|---|
| Instructional Design<br>Design & Development Tools (web development)<br>Project Management<br>Learning Environment Design (web based learning environments) | Adult Learning in the Workplace<br>Adult Development in the Workplace<br>Organizational Learning in the Workplace<br>Diversity & Globalization of the Workplace |
| **Educational Psychology** | **Occupational Studies** |
| Cognitive Foundations for Education<br>Motivational Foundations for Education<br>Research Methods<br>Applied Educational Assessment | Needs Assessment for Workforce Development<br>Career Development in the Workplace<br>Situated Learning in the Workplace<br>Internship in Business or Industry |

## Demographics, Student Involvement, and Faculty

All IPTT majors have been working from five to twenty years and they range in age from 23 – 55, with an average age of 34. Since its inception, approximately 41 students have graduated and the remainder of the students will graduate by 2007.

In 2004, IPTT students formed the Human Performance Technology Student Association (HPTSA), a chartered UGA organization, and they met on a regular basis, networking and bring in speakers of interest to our students. Even our graduates continued to attend the monthly HPTSA meetings and fundraisers, and they still participate in events.

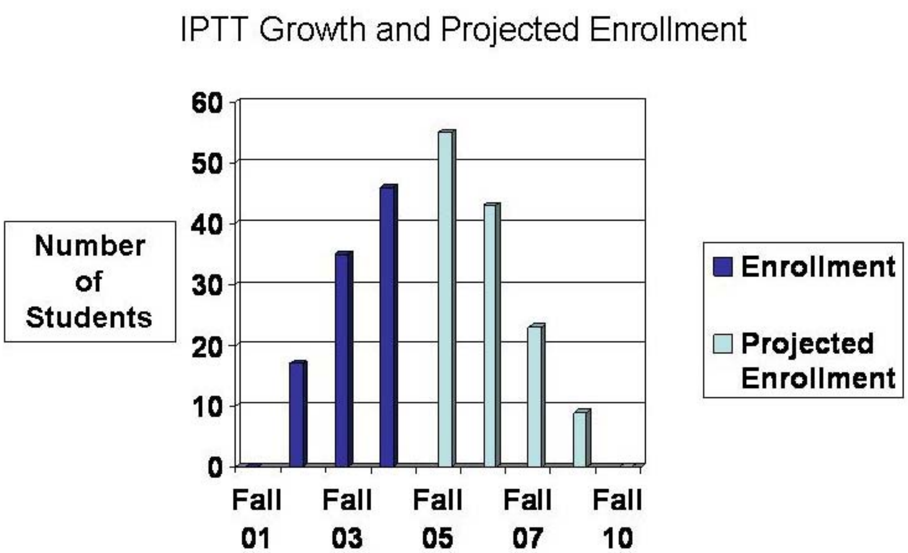
Most students have full time jobs, working in a variety of industries in the greater Atlanta area. They pursued internships in career centers, multimedia development companies, non-profit, and for profit industries. We also started an internship program with the Gwinnett Detention Center to help inmates with reentry skills to reduce the revolving door.

Our instructors are tenure track faculty from the four respective departments and programs, who typically travel from Athens once a week to teach their classes. They generally teach graduate students in Athens, which adds richness to the learning experience.

**Number of Majors Enrolled**

In our first semester, we started with 17 students, a major accomplishment for a newly designed and unknown degree. This was largely due to a marketing blitz on National Public Radio. Within a month, drastic budget cuts eliminated our ability to advertise, which adversely affected our growth. The degree maintained a steady growth since inception, largely through word of mouth, and we had 56 students enrolled at its peak. Figure 2 depicts growth and projected enrollment of majors in the IPTT degree, which will rapidly decline as the program is phased out.

Figure 2. IPTT Growth and Projected Enrollment




**Future of the Program**

In 2005, Gwinnett County made the decision to start its own four-year college, and the board of regents agreed through a unanimous vote. The Georgia General Assembly approved the new college. As a result, University of Georgia Undergraduate Programs are no longer admitting new students, as the new college will be housed in the same facility that UGA and Georgia Perimeter College currently share. Both UGA and Georgia Perimeter College will cease teaching undergraduate courses in Gwinnett County in 2008. Because the Instructional Psychology, Training, and Technology degree was created for a metropolitan campus, there will be no comparable undergraduate degrees offered in Athens, UGA's main campus.

**Summary**

UGA's interdisciplinary IPTT bachelor's degree was created in response to a formal request by business owners in Gwinnett County. The degree was designed for non-traditional working students and it only existed in Gwinnett. Clearly, this unexpected decision by Gwinnett County and the Board of Regents will adversely affect the futures of the students, staff, and faculty who were involved in growing and promoting this unique UGA bachelor's degree in Gwinnett. However, the model would work well in an institution serving non-traditional students in a metropolitan area.

**References**

Carnegie Foundation. (1998). Reinventing undergraduate education: A blueprint for America's research universities. *The Boyer Commission on Educating Undergraduates in the Research University*. Princeton, NJ

Einhellig, F.A. & Marre, K. (1999). Interdisciplinary programs: Challenges and values. *Council of Graduate Schools (CGS) Communicator, Vol. XXXII.*

Gustafson, K.L. (2000). Undergraduate degree programs in instructional design and technology: Do They Make Sense? *Paper presented at the Instructional Technology Forum, The University of Georgia.*

Ivanitskaya, L., Clark, D., Montgomery, G., & Primeau, R. (2002). Interdisciplinary learning: process and outcomes. *Innovative Higher Education, 27(2)*, 95-112.

Michael, S. & Balraj, L. (2003) Higher education institutional collaborations: An analysis of models of joint degree programs. *Journal of Higher Education Policy and Management, 25(2)*, 131-145.

Morgan, D. (January 2003). 21st century baccalaureate programs for Gwinnett University Center, *A report to the director and management team of the Gwinnett University Center*.

Rowntree, D. (1982). A *dictionary of education*. Barnes & Noble Books, Totowa, NJ.

Schommer, M. (1994). Synthesizing epistemological belief research: tentative understandings and provocative confusions. *Educational Psychology Review, 6*, 293-319.

# Designing and Teaching Practice of Online English Writing Course

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**Abstract**

*Designing online courses should be aimed at broadening students' knowledge, improving their makings, and developing their comprehensive abilities. It should be guaranteed to achieve the effectiveness by means of appropriate teaching strategies. This paper consists of four parts, explaining the fundamental requirements of English writing teaching in web settings, and discusses the designing of its teaching contents and strategies. Some beneficial suggestions are put forwarded, based on the authors' practical online teaching experiences.*

An overview of online teaching in the world enables us to see its realistic and potential advantages more clearly, and online courses have aroused people's increasing attention in China, including various online foreign language teaching courses. Although these courses have their own traits, they are by and large in the infant stage. With increasing perfection of web technology and people's recognition of online foreign language teaching, we believe that the prospect of foreign language teaching in online settings is promising. Based on this awareness, we combine design of the online English writing course and teaching practice into an integral research project so that this teaching mode goes on in a scientific, systematic and standardized status from the very beginning.

**Basic requirements on designing the online English writing course**

Is the online writing course a digitalized and networked copy of the conventional writing curriculum? Is it an online VOD of the classroom teaching? What should design of an online writing course include? And What strategy should be adopted in teaching the course? These are the questions that should be answered in designing a good online foreign language writing course.

Online teaching not only breaks through the conventional classroom teaching mode but breaks through the limitations of ineffective communication and idea exchange in conventional distance education [1]. Online teaching wants to establish a novel teaching mode, which is far from simply placing the teaching content on the web and letting the student read it passively; what it needs more includes:

1) Enabling the teacher and the student to communicate and exchange ideas freely so that the student feels that he or she is learning under the instruction of the teacher rather from the computer. In other words, teaching and learning is being conducted in a human-based manner.

2) Enabling the teacher to organize the student's learning activities, tempt the student to learn actively, and help the student solve difficulties in his or her studies.

3) A good function of evaluating and monitoring teaching feedback of the online course so that the teacher is able to know characteristics and learning progress of the learner as the principal part of the teaching activity and to offer individualized assistance and improve the outcome.

4) Enabling the core link in the conventional teaching mode to be well implemented on line with respect to lecturing, learning, taking examinations, giving assignments, discussing, evaluating and answering questions.

5) implementing quality education, transforming conventional knowledge teaching into ability teaching, where the online course should be able to support a variety of teaching modes, especially the question-based explorative and coordinative learning mode in the form of writing forums, internal E-mail and English chatting rooms as interactive teaching zones[2].

Course development and design are of crucial importance in online teaching settings including the English writing course, the purposes of which are to motivate initiative of the teacher and the student, broaden the curricular scope, and improve the teaching outcome and quality. At the same time, the designer should condense abundant related information into the online course so that interaction between the student and the teacher can be developed on a more informative and colorful level, and the student's interest in writing can be activated by taking advantage of interaction of the online course. The students should be encouraged to tap more materials and think more creatively.

## The art of designing teaching contents of the online English writing course

Essay writing is a complex psychological process on the part of the student, involving the use of comprehensive knowledge and abilities. Online writing is intended to optimize teaching and training in three aspects: emotion, knowledge and ability, so as to upgrade the student with respect to aspiration, quality, writing knowledge and ability. For this purpose, design of the teaching content is mainly concerned with topic making, topic discussion and practice, literature support and master page of teaching.

### Topic making

To ensure stability of the curriculum, the teacher is usually quite prudent in selecting sensitive topics and model writings. To make full use of Internet's dynamic interaction, online writing teaching is not restrained by such limitations; on the contrary, it usually selects topics of high timeliness and literary works of high sensation so far the language is standardized, such as a paragraph from a newspaper column, or a broadcast and TV program. Of course, it is necessary to deal well with the relationship between material selection and language ability training; the former should be subordinated to the latter. To make full use of the web advantage in language resources, we combine the "blueprint" with the "resource". For example, we not only provide the student with materials about various writing styles, but design more than ten writing forums on the best seller TUESDAYS WITH MORRIE (Mitch Albom) and related resources on web.

### Topic discussion and practice

To encourage the student to participate in the online teaching activity, we use diverse means of communication to promote the student's initiative. For example, we assign students in several teams; students in each teach can either exchange learning experience within the team, or with those in the other teams. This requires the teacher to prepare some topics in advance and make them known on the notice board a week or two weeks ahead. The student can voice his or her view in English freely, or raise some questions that he or she is unable to answer, which needs the teacher to give instructions or make a summary in the end. In addition, we regard the student's participation as important as the writing quality as a part of evaluation on the student's learning proficiency.

If the student is required to express his or her view on a problem or write a short article, the task can be accomplished independently by the student him- or herself, or by the team as a whole. The student is learning autonomously, while the teacher is supervising remotely. As writing is a matter of practice more than just learning some knowledge, we lay special stress on designing the practice part.

3) Literature support

To make full use of Internet's advantage of global information sharing, we super-connect the websites related to writing, including information related to the designed topics, online libraries and E-dictionaries for the sake of facilitating the learning process of the student.

4) Master page of teaching

The online mast page of teaching can not only fuse the teaching curriculum, references and various resources as an entity, but give each student a workable space to introduce his or her experience in writing. We advocate a coordinative and competitive online learning mode; the student can create an E-periodical to publish their exercise writing works and make comments on the writing course they are engaged in. The students may be asked to answer the following questions:

If you were the teacher, how would you design this course? What suggestions would you make to those who are scheduled to join the course? Is there any part that you expected to have in the course but actually is missing? Will you recommend this course to your friends? Why? Answers to these questions would help the teacher improve design of the course [2].

## Teaching strategy design of the online English writing course

Online English writing teaching depends on modern educational technology and web technology. On the other hand, by drawing on the experience in conventional writing teaching, it follows the process from oral description to literal writing, and from imitation to creation, leading the student in a heuristic and step-by-step way to turn what he or she sees or hears, from the easy to the difficult, from the simple to the complex, and from the superficial to the deep, into a series of thinking, and finally turn what is in mind into a written form. In this way, problems encountered by the student in English writing can be solved more effectively in a non-native-English environment.

**The form of teaching organization**

Unlike the conventional teaching form, the classroom in online teaching is only seen in the first class when the student is registered into the course and in the last class when the course ends. In the first class, the teacher makes a general introduction of the course, purpose of the course, teaching methodology, criteria for evaluation, and the function of the website and how to use it. In the last class, the student displays his or her achievements from the course while the teacher makes a comprehensive evaluation on each student. Obviously, online teaching is conducted in teams, especially in the form of individual on-machine maneuver. Online interaction in a sense hatches the concept of individualized learning. The web setting also provides a new mode for team learning by breaking through the concept of students being in close proximity to each other in the classroom; the student is allowed to choose any other student as a partner of the team to discuss the writing problem so that the student can have a true understanding about the meaning of "net neighbor". This will instill an significant impact on the student's way of thinking[4].

**Teaching methodology**

Teaching in web settings becomes more flexible. The teacher is able to display the teaching content by means of net broadcast, or provide the student with a virtual milieu for writing drill, or recommend cooperative learning between students by giving instructions to individual students and revisions.

i. Teacher's creation of writing situations by means of the web broadcast function

Ample evidence has demonstrated that the extent of success in teaching often depends on the initiative of mental activity of the learner in the teaching process. Interest is the impetus of learning on the part of the student. We can publish teaching materials and background information of popular topics by means of the web broadcast function to tempt the student's interest in writing, or create a situational atmosphere related to the teaching content where the student is able to experience a virtual but true living space.

ii. The student makes use of the virtual environment such as the writing forum that web provides to do writing drills

Through exchanging ideas with other students by means of the writing forum, the student's sense of creation is stimulated. In such a virtual environment, the student is freed from psychic stress from being questioned directly so that his or her thinking is activated to the maximum. He or she is not just receiving instructions passively but thinking actively and expressing ideas freely.

iii. The teacher gives writing instructions to individual students through internal E-mail.

We often deal with "divergence" passively in teaching a conventional writing course. As a matter of fact, divergence is an objective existence. The right and active way of solving this problem is to go into the internal psychic environment of individual students and help them develop the strong points and avoid the weak points by using appropriate curricula so as to perfect the knowledge structure of the student and develop his or her writing ability. Internal E-mail provides us with an ideal channel of going into the thinking process of the student in writing. The teacher is able to get timely information about how frequently the student is online, the writing material and score by means of internal E-mail.

iv. The student can make use of the writing databank by means of web technology.

Thinking training in conventional writing teaching mainly includes examining the topic, and selecting and organizing materials around the topic. This often leads to a tendency that all students are thinking in the same way. This is not beneficial to foster the student's interest in writing and develop new individualized styles of writing. Web technology has changed the conventional one-way teaching mode, whereas it provides the student with a space where he or she can think freely and autonomously [5].

v. Comment and revision making of typical writings by taking advantage of web monitoring and broadcast functions

Educational evaluation is a feedback and correction system between the teacher and the student. The efficiency of writing revision as a means of evaluation should be raised to such a level that the student can lose no time to find his or her gain and loss in the process of writing so that his or her ability of making revisions in writing is improved. We first deliver some typical sentences and paragraphs to the students by means of the web broadcast function, and then the teacher and the student work together to complete the task of correction in a warm and cheerful atmosphere, where the student airs their views freely. In the process of correcting the writings of other student, his or her writing ability is being raised imperceptibly. Urged by the sense of performance, the student is willing to show off his or her writing in front of other students and savor happiness of success; he or she will not feel embarrassed in public because of his or her illegible handwriting.

## Implementation of the online English writing course in practice

We set up the online English writing course in Grade 2001, 2002, 2003 and 2004 doctorial graduates in our school, and each course lasts 12 weeks in 40 teaching hours. Through the online course and the whole teaching process, the teacher savors a new teaching model, and the student is offered an opportunity to develop their capabilities and improve their writing skills. Also, the student learns good qualities from others and strengthens mutual ties between them in the interactive process. Most of them have had more confidence in their writing ability. Indeed, the online English writing course is beneficial to the teacher as well as to the student.

### Achievements in teaching practice

Undoubtedly, the most important achievement is that all students have made measurable progress in writing.

i. The number of articles is increasing dramatically and the number of words of an article is usually between 300-400.
ii. ii. The students can write a variety of articles including narratives, expository, descriptive and argumentative essays. Grammatical errors are reduced greatly, the language becomes more vivid, and the sentence structures are more complex.
iii. iii. The teaching content is more varied, and discussion and idea exchange go further into the center rather float on the surface.

### Summary of web course practice

Online courses should be fused into the whole network of the other existing courses. The purpose, the curricular content, teaching scope and depth should be defined more clearly and scientifically, which include:

i. Defining the teaching goal of every module on the web page;
ii. Defining the form of expression on the basis of the course content;
iii. Teacher's responsibility of marking the relationship between the web address and the course content, reminding the student of problems that should care for in visiting the address and indicating the goal to be achieved lest the student should wander aimlessly on the web.

The key to success is sufficient exchange of ideas. Whether the teaching content is appropriate is also reflected to some extent by the amount of teaching hours. Our experience shows that 5 hours a week is necessary for each student spending on the writing course, which include:

i. 1 hour for learning about the content of the course and reading references;
ii. 2-3 hours for online writing drills, including some online academic activities
iv. It is important for the managerial personnel to coordinate, supervise and manage the whole online teaching process. The managerial personnel should work together with the teacher to give the student a clear explanation about the course, examine whether the student has qualification of selecting the course, and find and solve problems that emerge in the teaching process.
v. Assignment design and correction are more important for online teaching. Assignment design should be based on the teaching purpose and workable on the web.
vi. The style and method of examination should be adjusted. The online examination no longer uses the conventional written form; rather it is conducted in the form of groups: each group presents the topic discussion orally first, and then makes it into a web page or publishes it on the website in the form of PPT

## Summary

In summary, a sound design is the key to success of online teaching. Undoubtedly, use of web technology is a revolution in foreign language writing teaching in that it breaks through the time and space limit of the conventional writing teaching. The web environment provides the student with a realm of displaying their personality traits and arouses the students' initiative in writing. The abundant literature resources and language tools on Internet make writing a pleasant and creative maneuver. A survey shows that 94% of the graduates engaged in the course agree that the online English writing course as a new teaching model is better than the conventional English writing course; and 100% of the students believe that spreading this kind of online language teaching courses has practical or far-reaching significance. Like any other teaching methods, online teaching is by no means perfect, and there are various problems that need to be studied and solved. Nevertheless, we believe that online language teaching is a sector that warrants more attention and efforts in future language teaching.

## References

Gary Motleram Effective virtual language learning what do we need to consider [Z] CALLAC, Guangzhou 2000.11

GY ZHANG et al. Establishment and study of a distance teaching website [J], China Distance Education, 2000,(Suppl) 70--72

XQ KANG, et al. English teaching reform in institutions of higher learning and use of CAI [J], Foreign language electronic teaching, 2002, 83 1 26--29

R FENG, et al. A systematic study on online cooperative teaching design [J], China Distance Education, 2000 163 8 25—27

PY GU, et al. Wandering the Internet English world [M], Shanghai Foreign Languages Education Press, 1999. 56--69

L LI. Teach process design [M], Neimenggu People’s Press, 2000. 381—394

# Project Management Simulation as a Vehicle for Establishing a Community of Practice across Undergraduate and Graduate Programs in a Blended Model

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**Abstract**

*Now, in its third phase, this project management simulation has added a third traditional graduate project management class to serve as liaison between traditional undergraduate and online graduate classes and serves as senior management and mentors to undergraduates. The online class serves as a client that generates RFP's for undergraduates. The findings from this simulation will be discussed, as well as recommendations for establishing collaboration between undergraduate and graduate students in a hybrid environment.*

## Introduction

Western Illinois University offers B.S. and M.S. degrees in Instructional Technology and Telecommunications (ITT). The need for this class arose from a perceived separation that existed between our undergraduate students, who were instructed in traditional or web-enhanced classes, and our graduate students, who completed most of their courses online, many of whom were at a distance. It was felt that the usual community of practice that existed between undergraduate and graduate students was weakened.

The undergraduate and graduate programs in ITT both offer an instructional project management course. The undergraduate version of the course focuses more on working as part of an instructional design team. The graduate course focuses more on developing management skills for instructional designers.

These two courses seemed like an ideal vehicle for developing collaboration between the undergraduate and graduate communities. In Spring, 2003, the first case study was conducted using one team of graduate students in the graduate class and the entire undergraduate project management class. Since that time, the model has been expanded in three later case studies, including one that paired undergraduate and graduate students taking an introductory course in instructional technology. In Spring 2004, the model was expanded to include an entire traditional undergraduate class on instructional project management and an online graduate class on the same topic (Hemphill and Spencer, 2004). From the results of this study, it was felt that there needed to be more direct face-to-face (F2F) interaction between undergraduates and graduate students, so a third graduate section was added that met F2F in a traditional classroom setting, but also had online access to the undergraduates, themselves, and the graduates in the online section.

It was felt that such a model would allow a direct mentoring experience for F2F graduate students, while providing interaction in the process for online students. It also gave the undergraduates experience with dealing with clients (online graduate students) and senior management (F2F graduate students). The primary goal was to develop a community of practice that extended beyond physical boundaries and to explore a cognitive apprenticeship model for both undergraduate and graduate students.

## Background

### Theoretical and research underpinnings

Instructional project management is a complex discipline requiring a broad range of skills. It combines project management skills, as defined by the Project Management Institute (1997), and the instructional design process. Today's workplace is increasingly requiring instructional project management skills of instructional designers. Evolving technology is causing the elements requiring management to be even more complex and interactive. Communication challenges become more demanding as management occurs over distances rather than at one location (Litchfield & Keller, 2002). Effective communication is at the heart of skillful instructional project management. Devising methods to teach these important skills effectively can be a challenge. It is essential for later transfer to job performance that the job context be integrated into learning (Clark & Mayer, 2003). For this reason, the authors chose to provide their students with the same experiences that they would encounter in the working world, supplemented with group interaction and coaching. This included exposure and appropriate practice at the various levels of interaction and role modeling involved in instructional project management.

The cognitive apprenticeship model (Collins, Brown, & Newman, 1989) has been used in online mentoring models (Dorneich & Jones, 1997). It has been found to be an effective model for preparing students for entering the professional workplace. Graduate students have been used for the mentoring of undergraduate students (Russell & Daugherty, 2001; Koals, 2000).

Nevertheless, developing a community of practice can be somewhat difficult to develop and maintain in online classes and even traditional classes (Dorneich & Jones, 1997). Another challenge is trying to develop a cognitive apprenticeship program across graduate and undergraduate students (Russell & Daugherty, 2001; Koals, 2001). The solution involves finding a common project or projects with appropriate levels of mastery for the students (Clark & Mayer, 2003). The project roles must be authentic, yet attainable for students' level of proficiency and understanding of the field and real-world experiences.

**Need**

Online students sometimes feel disconnected from the learning community on campus. They do connect with each other through discussion groups and collaborative projects, but do not always feel connected to, or even know, the undergraduates in the same program.

The graduate students need experience managing others since they will normally be entering the work force at management or supervisory levels. Conversely, the undergraduate students will be entering more production level positions. They need to learn to work with others and understand how on-the-job mentoring can be an effective way to learn.

Today, more actual projects use virtual project management approaches that utilize telecommunication tools to allow project team members to work at a distance in a shared, virtual work space. Both undergraduate and graduate students need experience working collaboratively in such an environment.

The previous studies with ITT courses had limited involvement of graduate students with the undergraduate students. It was felt by having a F2F group of graduate mentors, this would serve to develop a better cognitive apprenticeship model and serve as a liaison between the undergraduates and online graduate students.

Also, there was a need for a common goal for all groups. This was initiated by the RFP first developed by the graduate online class and then implemented by the undergraduate class. This allowed all members to see the development of the project from conception to completion.

## Method

**Context**

The study occurred in the spring of 2005 at Western Illinois University. All three courses were offered through the Instructional Technology and Telecommunications Department. The undergraduate course (ITT 330) was offered three days a week, as was the F2F graduate course (ITT 565). A second section of ITT 565 was offered online. All three courses used support through the Blackboard CMS.

ITT 330: Instructional Project Management is a core course in the undergraduate program for a B.S. in the Department of Instructional Technology and Telecommunications. The course is usually taken during the junior or senior year at WIU and is offered in the spring semester. Students coming into the course are expected to have taken ITT 310: Principles of Instructional Design prior to taking this course. This semester, the course consisted of twenty four students.

ITT 330 concentrates on techniques used by training and education specialists, instructional designers, and managers to plan a budget, schedule a project, and lead a project team through to successful completion. In-class discussions and take-home reading assignments are integrated with hands-on experiences that lead to the development and production of instructional materials for education, business, and industry. The course is also designed to help ITT students begin their individual portfolios needed for graduation.

The goals of the course center around leading a group effort on all or part of a project. Students immerse themselves in the process of identifying client needs through designing and developing appropriate solutions to fit those needs, all in a group setting. During the semester, each individual has the opportunity to lead as the project manager on a part of the project.

Rather than setting the class up as a series of project management activities, the class was designed to put students into situations that simulate the real world as closely as possible. Learners were exposed to the basic concepts of project management early in the course, then developed their skill as part of fulfilling a role on a "real" project.

ITT 565: Management of Instructional Technology is an elective course that has been offered in F2F and online formats. It was first offered online in the spring of 2003. It is requires a prerequisite of ITT 505: Foundations of Instructional Technology. Emphasis is given to project management, assessment of instructional needs, coordination of instructional design, production of instructional materials and supervision of instructional projects.

In contrast to ITT 330, the emphasis is more on teaching management skills. This is facilitated by allowing every student to manage an instructional project. Many of the participants in ITT 565 have real-world working experiences in schools, higher education, and corporate settings. Discussions, reaction papers, project management simulation activities, and projects help move the student from learning simple principles and concepts to more complex models of project management, including more adaptive project management models (Wysocki, 2003).

There were eight students in the traditional ITT 565 course. Eleven students participated in the online version of the graduate course.

## Subjects

A team of graduate students role-played as instructional developers of a web-based project for a client, the ITT department. The undergraduates served as subcontractors to the graduate students.

A team of students from the graduate class developed a request for proposal (RFP) for the development of the university departmental web site. Teams of undergraduates responded to the RFP with their own proposals. The graduate team selected the best undergraduate proposal. All of the face-to-face undergraduate class worked on completion of the winning project.

The communication process used face-to-face planning sessions, teleconferences, synchronous online discussions, and asynchronous discussions, both within and between the graduate and undergraduate teams. Undergraduate students were able to play various roles in the project management process. Both the undergraduate teams and the graduate team were able to gain experience in negotiating with a client. The graduate students developed communication skills for managing projects when the various stakeholders are at a distance and telecommunication is essential.

## Course Design

### Undergraduate Course

The undergraduate course was divided into three main components. The first was a four-week introduction to project management. The second was a group project that consisted of writing a response to a Request For Proposal (RFP). This took four weeks. The third was a group project that consisted of designing and developing a project based on an approved proposal. The remainder of the 16 weeks was devoted to this project.

Based on feedback from previous instructors and students, one of the biggest hurdles in the course has been convincing students of the need to work in groups. Often they are more comfortable working alone on projects and have not had much experience in group work. In addition, many students are concerned about having a non-contributing member in their group affecting their own performance and grade.

The first part of the course was an introduction to project management, using lectures and class activities. This part of the course lasted four weeks and had two main goals. First, the course provided an introduction to general concepts of project management. These concepts included defining a project, organizing for the long-term, and using project management with instructional design. Second, students needed to become accustomed to working in groups. Each class period consisted of group activities. The activities called for groups of varying sizes and required students to be in groups with different people each day. The benefit of this approach was to overcome both the instructor and students challenges and concerns regarding working in groups. These activities provided low-risk opportunities for students to become acquainted with one another and to discover their own strengths and weaknesses regarding group work.

Once the class finished the general introduction to project management, the course changed focus. Now it was time to put students in situations where they had to apply the principles of project management.

Group Project 1 was designed to provide this opportunity. Students took on roles within a simulated organization that allowed them to apply these principles. They worked with the ITT 565: Management of Instructional Technology class. ITT 330 students took on the role of a design team for a large organization. The ITT 565 class served as senior managers for the same organization.

For Group Project 1, the ITT 330 class was divided into three groups of eight people each. Students formed their own groups. Each group was divided into two sub-groups: business management and content management. Each sub-group selected their project manager. Groups were encouraged to create an identity for themselves. They accomplished this by creating names for their groups and devising slogans and logos to represent themselves. Group names were very positive and proactive sounding: Superior Management Consultants, Allstars Web Development, and Acme Industries. Establishing this identity helped to promote teamwork within each group.

Once groups were established, they were ready for their first project. Group Project 1 began when senior managers (ITT 565 students) presented a Request For Proposal (RFP) to the groups. The RFP concerned redesigning and revising the Instructional Technology & Telecommunications web site. Each group was to submit their proposal, with the best proposal "winning" the contract to redesign the ITT web site.

Each group was responsible for writing a proposal. The two project managers for each team were responsible for ensuring their group completed their requirements for the RFP. For each group, the business sub-group researched and wrote the proposal components dealing with budgeting, schedules, and responsibilities, while the content sub-group concentrated on determining the information that the new web site would contain. Having two project managers for each group allowed more people to fulfill the project manager role. In addition, two senior managers from ITT 565 were assigned to each group to provide guidance and answer questions.

As each group concentrated on writing their proposals, they communicated regularly with the senior managers on their progress. They wrote weekly status reports and met regularly with respective senior managers. Group Project 1 culminated with each group presenting their proposal to the entire ITT 565 class.

The ultimate outcome for Group Project 1 was a project proposal in response to an RFP. Each of the three groups successfully completed their proposals on time and made presentations to the senior management group. The groups were expected to present their proposals in a professional manner, including dressing appropriately and providing documentation.

Setting up the groups and the RFP as a real world simulation created competition between the groups. Students in the groups were motivated in that their projects were not just going to be evaluated and graded by the instructor. The groups were also motivated to succeed because they were drafting a proposal that would be evaluated by their "superiors," with the goal that one of the proposals would be selected for development. The possibility that their proposal would result in their design actually being adopted by the ITT department provided additional motivation.

The senior management team from the ITT 565 project management class was very helpful in evaluating the proposals and providing feedback to the groups. One challenge that arose was that the ITT 330 groups were very confident of the quality of their proposals. Although each group's proposal was very strong, they each also had limitations and flaws. The graduate class did a good job of identifying both the strengths and weaknesses of the proposals. However, the ITT 330 class had a difficult time accepting the negative feedback, even though this feedback was appropriate. It was important for the instructor to provide a real-world context for the comments from the graduate class.

The groups were evaluated on this project in the following ways. First, their proposals were evaluated by the instructor as well as the senior management team according to how well they fulfilled the requirements of the RFP. This included proposing an appropriate solution, developing and following a timeline, assigning responsibilities with a Work Breakdown Schedule (WBS), and establishing a budget. In addition, group members evaluated each other according to how well they fulfilled their responsibilities within the group.

The second group project was a larger effort in which the class was given a large, multi-faceted project to design and develop a web site for the ITT department. While the first group project was a relatively small effort, Group Project 2 was designed to provide the opportunity to take a project proposal and actually deliver a finished solution.

Group Project 2 began with a completed project proposal given by the senior management to the ITT 330 project teams. The project consisted of designing and developing a new web site for the ITT department. This site was to focus on marketing the department to prospective students, including incoming freshmen and transfer students. The site needed to showcase the technical abilities of the department and so would consist of various multimedia elements such as video and Flash animations.

Students were placed into entirely different groups for this project. This was done for two reasons. First, this project required four different project teams rather than three, one for content, video, web development, and Flash. Second, the instructor felt that it was important to break up cliques and conflicts that formed in the first group project. Also, changing groups forced students out of their comfort zones and more accurately reflected what happens in the real world.

The new groups were formed by surveying students to see what their skills were in the various technical areas. Based on their responses and observations from Group Project 1, the instructor placed students in each of the four groups. Once the groups were identified, each group selected a project manager. The project managers for each group could not be one who served as a project manager for Group Project 1. In addition, it was necessary to identify one person to serve as the project manager for the entire project. This person would coordinate the efforts amongst the groups and be the main liaison between the ITT 330 class and the senior managers in ITT 565.

Each group was required to establish their own WBS and timeline. The group project managers were responsible for assigning tasks within the group and ensuring their groups met project deadlines. The class project manager worked closely with the group project managers to make sure the entire project was on schedule. Often, one group's deadline was dependent on another group. For example, the web group was able to create a prototype of the site, but had to wait for the content group in order to create the final pages.

The project had three milestones, each of which had to be presented to and approved by the senior management team. The first was a WBS and accompanying timeline. Each group provided this to the class project manager, who then combined them into a master schedule and Gantt chart. The second was a working prototype and scripts. The third was a final presentation with a completed finished web site. Each group was able to complete their tasks on time, mainly because of the interdependence between the groups.

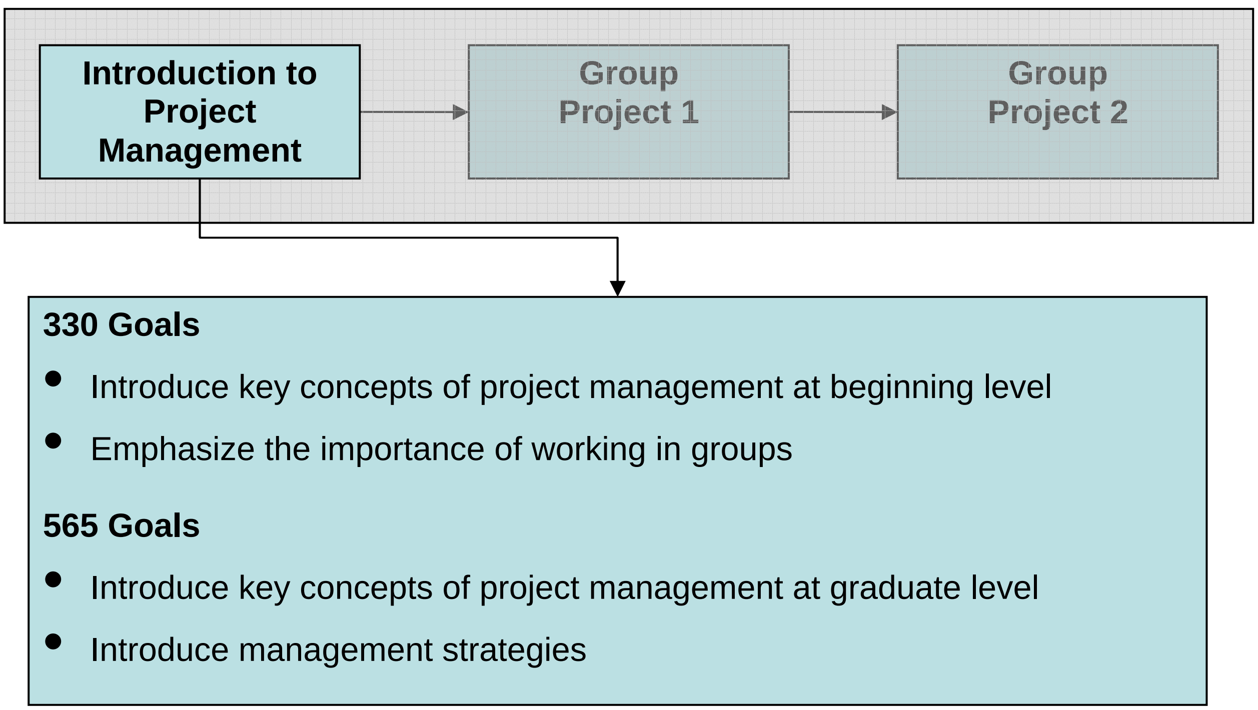
## Online Graduate Course

**Project Flow**

The collaborative project was constructed in three phases: general introduction to project management, the initial group project to produce an RFP and respond with a proposal, and the final project to produce an RFP and respond with a proposal and final product.

The initial stage of the project for all three classes was to provide a basic grounding in the principles of project management. This was provided at a more advanced level for the graduate 565 classes. Since not all students in the 565 classes had the undergraduate 330 class (not all had been ITT undergraduates), it was necessary to review basic concepts in the context of the role of managers. The goals for this initial stage are presented in Figure 1.

*Figure 1*. Goals of general introduction

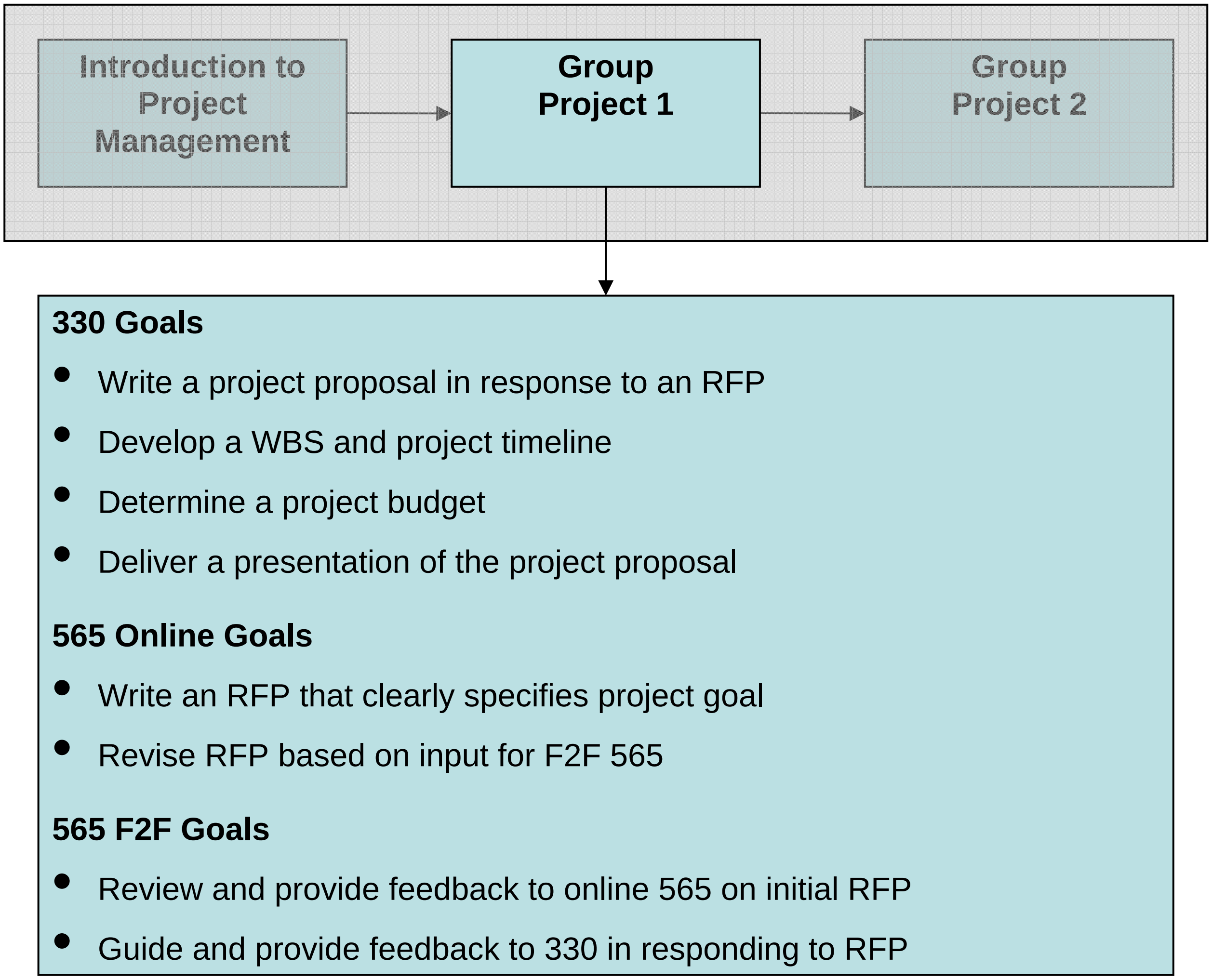



The next stage of the model (Figure 2) was to have the online graduate class develop an RFP for a project that was related to the final product, but broader in scope. The outcome for the undergraduate class was that they would respond to the RFP with a proposal. They would not continue the project any further.

The F2F graduate class served a dual role. They provided feedback to the online group and selected the final RFP that was presented to the undergraduate class.

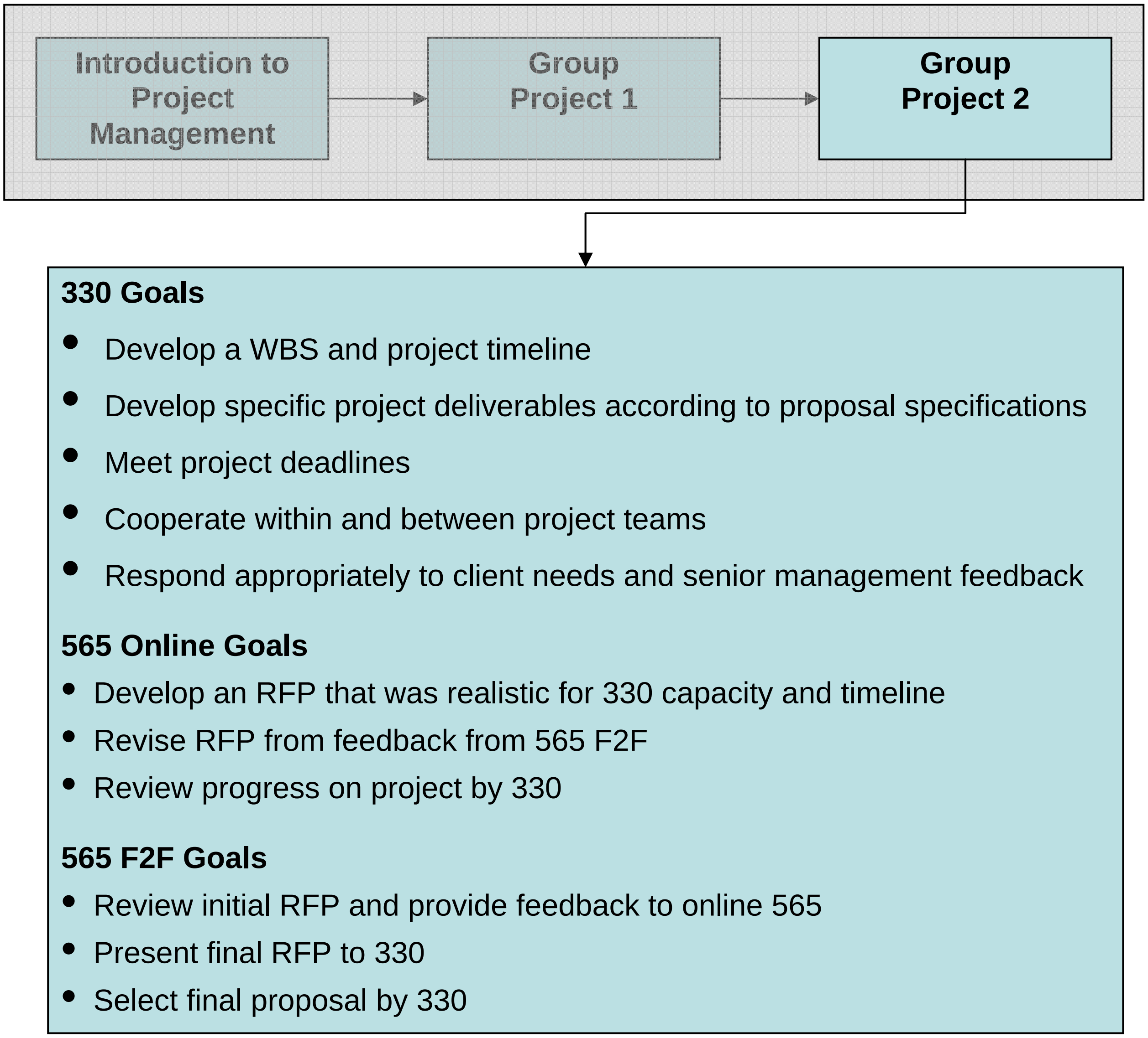
They also reviewed the proposals and provided feedback to the undergraduate class, and also provided feedback into the selection of the winning proposal by the instructor.

*Figure 2*. Goals of project 1




The final stage was to develop a realistic RFP, have the 330 class respond to edit and then produce the final product based on the selected proposal. This second RFP was smaller in scope and involved a redesign of the ITT undergraduate website. The RFP was developed by three different groups in the 565 online class. The best RFP was selected and presented to the 330 class by the 565 F2F class. The 330 class was then divided into three groups and responded to the RFP with proposals. The best proposal was selected with input from the F2F 565 class. The 330 class then worked on the final product, based on the selected proposal. The F2F 565 served as advisory senior management throughout the development of the project. Figure 3 shows the respective goals of the final stage, Project Two.

*Figure 3*. Goals of project 2




## Results

### Undergraduate course

Evaluations for Group Project 2 were different from Group Project 1. In this case, the instructor evaluated individuals according to how well they accomplished tasks given to them on the WBS. In addition to instructor evaluation, heavy emphasis was placed on peer evaluations. Peer evaluations were done in three steps. First, each group member evaluated the other members of their group and their group project manager. Second, each group project manager evaluated their group members, the other project managers, and the class project manager. Third, the class project manager evaluated the group project managers.

Group Project 2 did a good job of demonstrating the complexities of how large projects with multiple deliverables are completed. It showed how important it is to be able to work together in a group setting. Communication skills and conflict management were essential to the success of the project. Each group had concentrated on delivering their projects within the deadlines they had established. Unfortunately, the quality of the final project was not at a level that would allow the site to be adopted by the department. Part of this was due to the time limits of the class itself. Given additional time, the senior managers would be able to provide appropriate feedback so that the groups would be able to revise their products as needed.

**Online graduate course**

Eleven (11) students enrolled in ITT 565 online. Ten (10) of these students responded to the pre and post survey given in the course. The pre-survey was issued during the first week of course, and the post-survey in the last week of the course.

The collaboration effort appeared to improve overall satisfaction of the course, as well as enjoyment in working in groups, and changed their belief in a collaboration environment. In the pre-survey, 90% agreed to the following statement: "Collaboration is conducive to learning" – 100% agreed in the post survey. In the pre-survey, 80% agreed to the statement: "I enjoy working with others on a project", 90% agreed afterward. Ninety percent (90%) agreed in the post survey, compared to 80% in the pre survey that being a project team member was helpful to their learning experience. 100% of students in the post survey stated that being familiar with project management in the ITT program at WIU, and the IT field was important. This is compared to 90% pre-survey.

Some changes that were made this semester from the past format, was that instead of the client being a professor, the client was another class. They exchanged RFPs, while allowing a practice RFP first. This gave each group a chance to respond to each of the areas: web, print and multimedia. The graduate students acted as guides to the undergraduate students instead of being clients that made demands of them. This helped with more communication between the two groups, and less bad feelings that the undergrads were being controlled. It promoted more of a common goal for all three groups. The online group had people in their group that knew people in the face-to-face course, which also gave them physical "representatives" for the undergraduate course. Previously the graduates and undergraduates only interacted in person on a very limited basis. Graduate students also came to the undergraduate course regularly so they could meet about the RFPs and the project.

Each group (graduate and undergraduate) completed a project together, and one on their own. This gave them almost complete freedom on one project in which they could choose to do individually or in groups, and some sense of control with the second project. Undergraduate students were not "forced" to take the advice of the graduate students, which provided less resentment.

Deadlines were also expanded to allow more interaction between all groups. Due dates were delayed until a few weeks into the semester, instead of the first week or two. This allowed more conversation and interaction between all the groups.

All 11 students responded to the final evaluation. Most students enjoyed working with undergraduate students, and listed it as the favorite part of the course. ITT 565 online students offered the following suggestions for improvement: better communication between instructors of ITT 330 and ITT 565, and one posting place for activities. Each group provided a supportive role to the other, which contributed to a productive learning environment and everyone feeling a part of something bigger.

From the instructors' perspective, this was a valid learning experience for the students, and also the faculty. It was a learning experience to see the two graduate courses and the undergraduate course work together, however, working together as faculty members for each course was also a learning experience from the teaching perspective.

**Face-to-face graduate course**

The F2F graduate course was very involved throughout the final process of development. Graduate students were assigned to work directly with the 330 development teams. The entire F2F class was present for the final presentation of the final product. One member of the online class was also able to be present for this final session.

The F2F 565 class completed a final report on their experience in the class, on their own development projects, and on the collaboration project with the other two classes. The comments about the collaboration were generally very positive.

The students liked the experience of being senior managers. They felt they gained experience on what to expect from a design team, how to lead people through a project life cycle, how to critique design team projects, and generally how to be a good manager.

They also felt it was a good experience for the undergraduates and provided those students with a project that was both fun and authentic. The F2F 565 enjoyed the meeting and presentations with the 330 students. They learned the need to be specific in terms of proposals, or the final product might not meet client expectations. Their communications face-to-face and online with 330 and online with the online 565 class helped to improve their communications skills. This was especially important for international students for whom English was not their native language.

Many of the F2F 565 students appreciated the ability to follow up the project status online and on their on time. A couple of students commented that they would have liked to have had more online discussions, but enjoyed the F2F interaction.

All F2F graduate students saw the experience as a very positive experience and a high point of the class. For those that had 330 as undergraduates, they did not see 565 as a repeat of the undergraduate class, but as a natural continuation of their professional development. They felt they were able to grow in the role of project manager, rather than just as an instructional design team member.

**Discussion**

This was the most successful implementation of this collaboration model so far. The experience was rich and rewarding for the undergraduate and online graduate students. While the online graduate students did learn from the experience, work needs to done on improving communications with the undergraduate project team members. The online collaborative discussion board can be improved to make communications clearer.

The next implementation of this model will focus on maintaining many of the same strategies that were used here. Reporting between the online graduate and undergraduate classes will be enhanced to improve communications and allow the online students to feel more involved and more a part of the learning community.

There are some suggestions for similar collaborative projects can be drawn from this study. First, the nature of the project must be authentic, not made-up work. Second, roles must be clearly defined roles for each group. Third, communication must be between the groups, both online and face-to-face. Finally, having a traditional graduate class that can serve as a liaison between the undergraduate and online graduate students can be very powerful. Hybrid versions of the graduate classes could also help serve in this role as long as there is direct face-to-face interaction at various times in the process.

**References**


Clark, R. C. & Mayer, R. E. (2003). *E-Learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning.* San Francisco: Jossey-Bass/Pfeiffer

Collins, A., Brown, J.S., & Newman, S.E. (1989) *Cognitive apprenticeship: teaching the crafts of reading, writing, and mathematics.* In L. Resnick, ed. Knowing, Learning, and Instruction: Essays in Honor of Robert Glaser. Lawrence Erbaum Assoc.

Dorneich, M.C. & Jones, P.M. (1997) *Supporting apprenticeship learning of NMR spectroscopy in a collaborative, web-based learning environment*, Technical Report HCCPS-97-01, online document (tortie.me.uiuc.edu/~dorneich/papers/HCCPS-97-01/HCCPS-97-01.ps)

Hemphill, H.H. & Spencer, H.E. (2004, October 23) *Developing collaboration and mentoring across traditional undergraduate and online graduate classes***.** Presented at the Association for Educational Communication and Technology International Conference at Chicago.

Koals, M.B. (2000) Graduate/Undergraduate mentoring partnerships in a reading clinic environment. *Journal of Reading Education*, v26, n1, p9-13.

Litchfield, B.C. & Keller, J. M. (2002). Instructional Project Management. In Reiser, R. A. and Dempsey, J. V., *Trends and Issues in Instructional Design and Technology*. Upper Saddle River, New Jersey: Merrill Prentice Hall.

Project Management Institute. 1997. Principles of Project Management. Upper Darby, Pa.: Project Management Institute.

Russell, D. & Daugherty, M. (2001) Web crossing: a context for mentoring. Journal of Technology and Teacher Education, v9, n3, p433-46.

Seabrooks, J., Kenney, S., & LaMontagne, M. (2000) Collaboration and virtual mentoring: building relationships between pre-service and in-service special education teachers, Journal *of Information Technology for Teacher Education*, v9, n2, p219-36.

Wysocki, R. (2003). *Effective Project Management.* ($3^{rd}$ ed.) Indianapolis: Wiley Publishing.

# Learners' Socialization Needs:
# A New Leadership Role for Online Instructors

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**Abstract**

*This paper analyzes the function and the responsibilities of online instructors, also named "facilitators". The job title of online instructor can be viewed as a new leadership in a Web-based or an online environment. Online instructors not only deliver knowledge, provide information and technical supports to learners, but also try to meet learners varied needs. In the beginning, the paper examines learners' different needs during online learning, especially the socialization needs, which are recognized as the most influential factor to the success of online learning. The paper then discusses the Meacher Theory, proposed by Hughes (2002), to explain how to apply this leadership for supporting learners' socialization needs. Finally, the paper concluded that it is necessary to generate a new set of skills requirements for online instructors, for the current E-society. A later case study will be implemented to further describe the expectations for the online instructor job.*

## Introduction

The role of the online instructor is important in different group sizes of collaborative learning activities (Dillenbourg, 1999). Online instructors are usually named "facilitators" (Dillenbourg, 1999; Handy, 2000; Kulp, 2000; Salmon, 2003). They are not only responsible for facilitating knowledge in an online setting, but also taking care of learners' socialization needs (Bonk, Kirkley, Hara & Dennen, 2001; Salmon, 2003). According to Bonk, Kirkley, Hara and Dennen (2001), online instructors play their roles in four action areas: pedagogy, social interaction, management and technology. Additionally, Salmon (2003) presented a five-stage model of teaching and learning online, which highlights the learners' socialization needs in the online setting. Hughes (2002) developed the Meacher Theory to analyze the leadership roles of the online instructor. This paper uses the Meacher Theory to propose a new leadership skill set, including its function and its responsibility for learner socialization needs in a Web-based or online learning environment.

## Learners' Socialization Needs

The literature is filled with examples of new online socialization needs. In a Web-based or an online environment, which are often learner-centered (Kirkley, Savery & Grabner-Hagen, 1998; Dillenbourg, 1999; Kodali, 1998), because learners have different online learning difficulties, they have different learning needs, such as needs to discuss course-related content with instructors and with other learners (Kirkley, Savery & Grabner-Hagen, 1998). Learners also need to be active participants in an open-ended activity (Kulp, 2000). Additionally, they need to obtain group- and technology related skills (Handy, 2000).

Further, Salmon's (2003) five-stage model of teaching and learning online discussed learners' different online learning needs in different stages. Following are the examples of learners' needs within in the five stages:

(1) Access and Motivation Stage—learners need information and technical support to access to the Internet and strong encouragement to become actively involved. It is the online instructors who must provide some individual technical support and model the value of online learning (Salmon, 2003). This is consistent with Kodali's view of online instructors as the learners' "facilitator, collaborator, guide, and motivator" (Kodali, 1998, p.iv) .

(2) Online Socialization Stage— learners need some opportunities to build their online identities and need to find other learners to interact with. They need some incentives to change their learning relationships and become concerned about the cultivation of trust and mutual respect in a new learning culture which reflects diverse opinions (Salmon, 2003). To facilitate the development of the learning culture, Bonk, Kirkley, Hara and Dennen (2001) suggested that online instructors should provide many social activities, such as providing greeting statements at the beginning of the front page, sharing personal digital pictures and profiles, and encouraging learners to give comments on weekly discussion to each other.

(3) Information Exchange Stage— learners need to maintain their learning interests and improve their learning skills. A learner needs to be an independent learner confidently involving in interaction with others, and

able to manage possible information overload and time constraints (Salmon, 2003). Examples of information exchange support are stated by Bonk, Kirkley, Hara and Dennen, (2001) who suggested that online instructors not only play pedagogical, social and technological roles, but also have managerial (or administrative) roles to provide instant feedbacks, to monitor learners' learning progress, and to ensure that learners are constructing their knowledge through online discussion boards or E-mail.

(4) Knowledge Construction Stage— learners need to have lots of opportunities to appreciate other learners' perspectives, to create their own meanings about some ideas, to solve real-situated problems, to collect everyone's contributions, and to build knowledge in groups (Salmon, 2003). This is an ongoing activity that was initiated in stage 1 and stage 2. Althauser and Matuga (1998) stated that scaffolding instruction is needed to help learners effectively absorb learning materials and find a way to apply them in daily life.

(5) Development Stage— learners need support to develop their meta-cognitive skills in order to evaluate their learning processes. Because in the online environment they are more responsible for their learning, they must be encouraged to reflect upon the different interactive activities and the social network in the online learning environment (Salmon, 2003). Dillengourg's (1999) stated that collaborative learning happens in a social psychological process, which contains cognitive mechanisms.

Based on Salmon's five stages, we can view the first stage as a fundamental socialization stage. Within the preparation stage, Handy (2000) implied that preparing a comfortable computer supported collaborative learning environment through three stages— Think it through, Getting out of the way, and Not really necessary— requires the deliberate design of routines that support collaboration. On the other hand, the second stage can be viewed as the critical socialization stage. Kodali (1998) suggested that promoting interaction, giving feedbacks, facilitating discussion, creating learner-centered activities, ensuring flexibility and communicating with learners are online instructors' teaching strategies for fulfilling learners' socialization needs (Kodali, 1998). Other stages are like expansive explanations of learners' socialization needs, such as (a)synchronous information exchange tools, individual or group knowledge construction opportunities, and meta-cognition development activities.

To sum up, we can clearly point out that the most important learners' need is socialization. Bonk, Kirkley, Hara and Dennen (2001) stated that socialization is vital to learners in an online learning environment. Other researchers have begun to study whether different group sizes, grading criteria or interactive activities have different influences on learners' socialization. For example, Althauser and Matuga (1998) regarded that out-of-class small-group electronic conferencing (which is synchronous communication) can create a better learning culture and help learners truly share knowledge together. Alternatively, Kirkley, Savery, and Grabner-Hagen (1998) found that E-mail (which is asynchronous communication) can increase discussion duration between learners. What is the nature of learning? Specifically, what is the nature of online learning? We may directly answer this question with "socialization". This means that no matter what kinds of learning, such as case-based or problem-based learning, learners' socialization needs are the main tasks that online instructors have to take care of throughout the whole process of online learning.

## Leadership Supports Socialization Needs

How do online instructors make use of their teaching strategies or leadership to support the learners' socialization needs? What kinds of teaching strategies or leadership do the online instructors have? Strang in 1958 had stated that group leadership has great impact on academic performance and the effectiveness of group participation (Flannery, 1994). Kodali's (1998) research found that online instructors use some instructional components of Reigeluth and Merrill's General Model of Instructional Design, specifically the 'methods' component with it organization, delivery and management variables and the leadership that is required to execute them. Additionally, Hughes (2002) conducted an action research study for examining the effectiveness of the Meacher Theory of Leadership for helping herself be an appropriate instructional leader in both traditional face-to-face and online classrooms. We may find that a new set of skill description for online instructor is necessary in the current E-society because this job is mainly about supporting online learning, especially learners' socialization needs. Hughes applied the Meacher Theory of Leadership (Figure 1) as an example framework of strategies to discuss how online instructors can use leadership to support learners' socialization needs in an online learning environment.

"Meacher" means to combine the concepts of mothering and teaching perspectives; so this theory implies female nurturing and caring functions (Hughes, 2002). In her study, Hughes found herself often applying feminist, moral, and democratic leaderships in online classes. She also applied other kinds of leadership theory, such as transformational, transactional, and servant leaderships. Concerning feminist leadership (or women leadership), Regan and Brooks in 1995 regarded that some female online instructors might be able to easily build trust between learners, and even efficiently solve problems together by using their nurturing skills (Story, 1997). This efficiency is a basis for transactional leadership, which relates to online instructors' managerial or organizational skills independently or in teams. The feminist leadership is also related to online instructor's moral leadership, which might influence learners' values and beliefs; in addition, the application of democratic leadership establishes basic rules or policies for learners interacting with each other (Hughes, 2002). Burns in 1978 stated that transformational leadership is also related to the moral leadership, since it can increase online instructors' motivation and enhance their relations with learners during transforming processes, such as changing learners' sense of personal responsibilities and encouraging learners to contribute their efforts more during discussion (Hughes, 2002). In Figure 1, we can find that she already combined the transformational and transactional leaderships, because she regarded that these two processes happen at the same time. Servant leadership, which means being in charge to make conscious choice by serving people, is another one that Hughes applied, recognizing her role made her responsible for learners' interactions in the online learning environment.

There is no dominant leadership, so online instructors should apply various leaderships based on different situations (Hughes, 2002). These six leadership theories can be viewed as teaching strategies, helping online instructors complete the fundamental and critical social preparation and maintenance tasks. For example, thinking about what moral leadership means can assist the instructor to identify and fulfill the learner's social needs. Through identifying moral topics such as the need to be honest and reliable, the instructor is guided to include reflective prompts on these topics. This paper suggests that applying these six theories can result in building an appropriate social culture for the online learning environment.

## Conclusions and Further Research

Facing different learner socialization needs in a Web-based or online learning environment, the Meacher Theory of Leadership can be one set of skills requirements for online instructors. This paper has pointed out the importance of building a complete skill set, which include social, psychology and other possible dimensions. This skill set can help online instructors examine themselves, for example, in which part of online teaching skills have to be concerned or need to be trained. In the later case study, the researchers will continue review literature and studies for creating the skill sets by describing their functions and responsibilities. The researchers will then conduct a survey to investigate which online instructional skills that K-12 instructors have. Those K-12 instructors will be the research participants, who must have online teaching experiences. After the survey data has been collected, the researcher will report what kinds of skills are currently obtained by what percentage of online instructors. The participants' feeling and expectations of being online instructors can also express on the survey and through the follow-up interviews. In the end of the research report, the researchers will also describe other expectations for the online instructor job. In conclusion, it is necessary to create the skill sets for the online instructors for the need of online socialization in the current E-society.

## References

Althauser, R., & Matuga, J. M. (1998). On the pedagogy of electronic instruction. In C. J. Bonk, & K. S. King (ed.), *Electronic Collaborators* (pp. 183-208). London: Lawrence Erlbaum Associates.

Bonk, C. J., Kirkley, J. R., Hara, N., & Dennen, N. (2001). Finding the instructor in post-secondary online learning: Pedagogical, social, managerial, and technological locations. In J. Stephenson (Ed.), *Teaching and learning online: Pedagogies for new technologies* (pp. 76-97). London: Kogan Page.

Dillenbourge, P. (1999). Introduction: What do you mean by "collaborative learning"? In P. Dillenbourg (Ed.), *Collaborative learning: Cognitive and computational approaches* (pp. 1-19). Oxford, UK: Elsevier.

Flannery, J. L. (1994).Teacher as co-conspirator: knowledge and authority in collaborative learning. *New Directions for Teaching and Learning*, 59, 15-23.

Handy, D. J. (2000). *Internet-based collaborative learning: a case study of an undergraduate honors English class*. Unpublished doctoral dissertation, Washington State University, Washington.

Hughes, D. M. (2002). *Examining the Meacher Theory of Leadership: a new framework for leadership in online classrooms*. Unpublished doctoral dissertation, Rowan University, New Jersey.

Kirkley, S. E., Savery, J. R., & Grabner-Hagen, M. M. (1998). Electronic teaching: extending classroom dialogue and assistance through E-mail communication. In C. J. Bonk & K. S. King (Eds.), *Electronic Collaborators: Learner-Centered Technologies for Literacy, Apprenticeship, and Discourse* (pp. 209-232). Mahwah, NJ: Erlbaum.

Kodali, S. (1998). *Instructional strategies used to design and deliver courses online*. Unpublished doctoral dissertation, Texas A&M University, Texas.

Kulp, R. (2000). *Effective collaborative in corporate distributed learning*. Retrieved on December 8, 2004 from: http://otis.scotcit.ac.uk/casestudy/kulp.doc.

Salmon, G. (2000). *E-Moderating: The key to teaching and learning online*. Sterling, VA: Stylus Publishing.
Story, C. M. (1997, September). Gender issues [Review of the book *Out of women's experience*]. *Roeper Review*, 20.

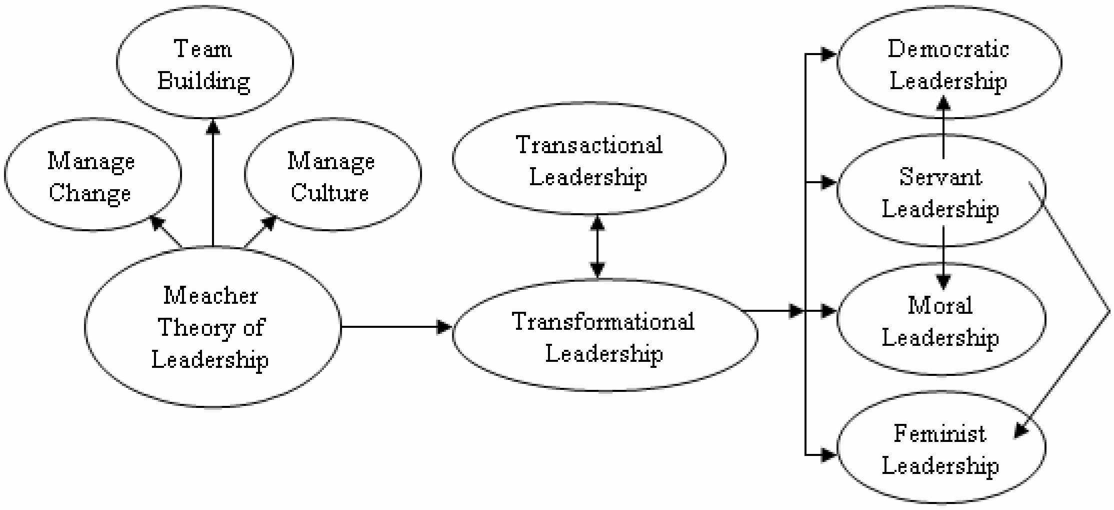


**Figure 1**: The Framework of Meacher Theory of Leadership

# Collaboration and Distance Education: Sharing Development and Ownership of an Online Course Among Three Institutions Using a Course Management System

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## Introduction

The Appalachian College Association is an organization of 35 private liberal arts colleges in the central Appalachian Mountains, which includes more than 3,250 faculty and serves over 39,000 students in the states of Kentucky, North Carolina, Tennessee, West Virginia, and Virginia. The Association provides expanded and enhanced learning opportunities to faculty and students for the purpose of serving the educational and economic well-being of the people and communities of central Appalachia. Through the generous support of the Andrew W. Mellon Foundation, ACA has encouraged collaboration among faculty on the various ACA campuses for several years. The project described in this paper represents a continuation of the ACA/Mellon Foundation support.

Lee University is a private, comprehensive university located in Cleveland, Tennessee, in the foothills of the Appalachian Mountains. Over the past eighteen years, Lee has become the second largest private institution in Tennessee and the largest in the Appalachian College Association. Lee's enrollment has more than tripled from 1,214 students in 1986 to 3,930 students in fall 2005. Two full-time faculty and 6 part-time faculty serve the CIS area.

Lincoln Memorial University (LMU) is a private, liberal arts university located 55 miles north of Knoxville, Tennessee, near the border with Kentucky and Virginia. LMU offers more than 30 academic majors, 3 master's degree programs, and the Educational Specialist degree. Fall 2005 enrollment is 2,802. One full-time and three part-time faculty serve the CIS area.

Milligan College is a private, liberal arts college in northeast Tennessee offering more than 25 academic majors and 3 master's degree programs. Milligan has an enrollment of 964 students. Two full-time faculty serve the CIS area.

## Why Collaborate?

The three private institutions described above, separated from each other by a distance of approximately 150 miles, needed to offer elective courses in Computer Information Systems (CIS). All three institutions faced the same problems: offering students a variety of courses, especially current topics in the CIS field, with a limited number of full-time CIS faculty. Among the three schools there are only five full-time faculty positions offering 99 courses per year. This means that there is a significant shortfall in full-time instructor availability. These institutions rely on nine part-time faculty to help satisfy the demand. This means that each of the institutions has a very difficult time trying to offer their students current and relevant courses in the field. Traditionally, smaller institutions such as these have had difficulty attracting and retaining terminally degreed faculty because their salaries do not match those offered by the business world or a larger university. Each institution has difficulty obtaining sufficient enrollment for special topics and elective courses.

Collaboration allowed these faculty members to combine their talents and expertise in the subject matter in teaching the course. A sense of collegiality was felt and professional development was enhanced as the faculty worked together to develop and administer the course. Collaboration also brought to students on each local campus a diversity of culture and experience and helped build a more robust enrollment for the course.

Two of the participants in this collaboration had previous experience with ACA-sponsored course collaboration. During 2002 and 2003, Lee University, LMU, and the University of Charleston offered online two courses in Computer Operating Systems for students on all three campuses. About 30 students participated in each of the courses, which included both online instruction and operating system lab exercises on each of the three campuses.

**How We Collaborated**

The first step in the collaborative effort was to secure support from the academic administration at each of the institutions. Meetings were held with the Vice President for Academic Affairs on each campus. Issues discussed included ownership of the course, financial responsibility for tuition, course workload assignment, course enrollment levels, course hosting responsibilities and technical support for the course management system. Administrative support for collaborating on this course was granted by all three institutions at the Academic Vice President level. It was agreed that each institution would enroll its own students, collect its own tuition, and record its own students' grades.

The three institutions settled on a special topics course, a course in Information Security, because this was a very relevant topic at the time. The three instructors met several times at a central location or via telephone conference calls to discuss the development of the course. After reviewing several texts, the faculty chose an appropriate text for the course. During these meetings, the duties and responsibilities of teaching and administering the course were divided among three instructors. Angel was chosen as the course management system due, in part, to the fact that Lee University had just adopted it and had the server space and technical support for the system. Training on the course management system was conducted to equip the faculty with the skills necessary to manage the course.

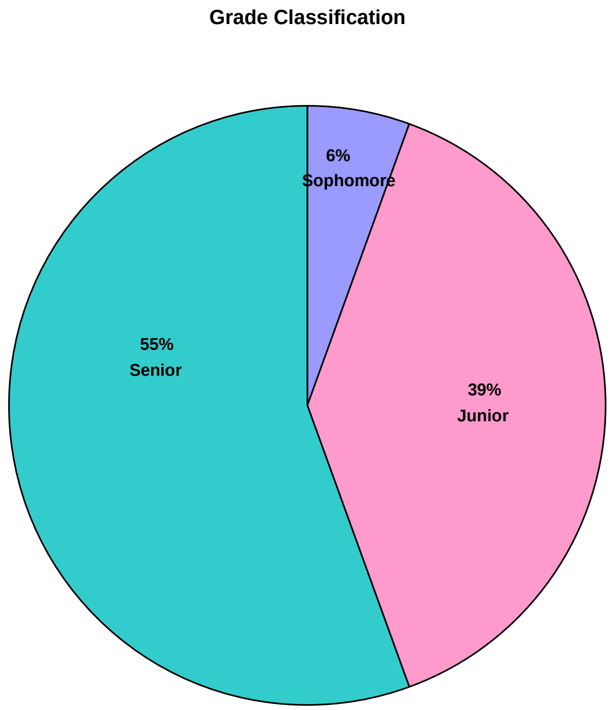
**Course Development**

The faculty agreed on a framework for the course management system layout so that each chapter had a consistent look and feel for the students. The textbook had 12 chapters and each instructor was assigned to 'lead' every third chapter, making only four chapters for which any one instructor was responsible. Their responsibilities included answering student questions, grading the chapter assignments dropped in the digital drop box, and creating appropriate test questions for the chapters. One of the instructors still had full-time responsibilities as Chief Information Officer on his campus; the other two instructors carried full-time teaching loads in addition to this course.

The faculty developed a common calendar for the course by collapsing the academic calendars at the three colleges into one. Students were expected to work through each individual college break by adhering to the combined calendar for the course. The faculty worked together to develop the syllabus, define the student requirements, set up assignments and determine the exam style. It was determined that exams would be proctored, with each faculty member meeting his/her own students at their home institution to complete the three online exams. Each faculty member was responsible for creating one of the three exams with input from the other faculty members about appropriate questions to include on the exam.

**Enrollment in the Course**

Twenty-two students enrolled in the course. As the chart below shows, 17 percent of the students were female and 83 percent were male.

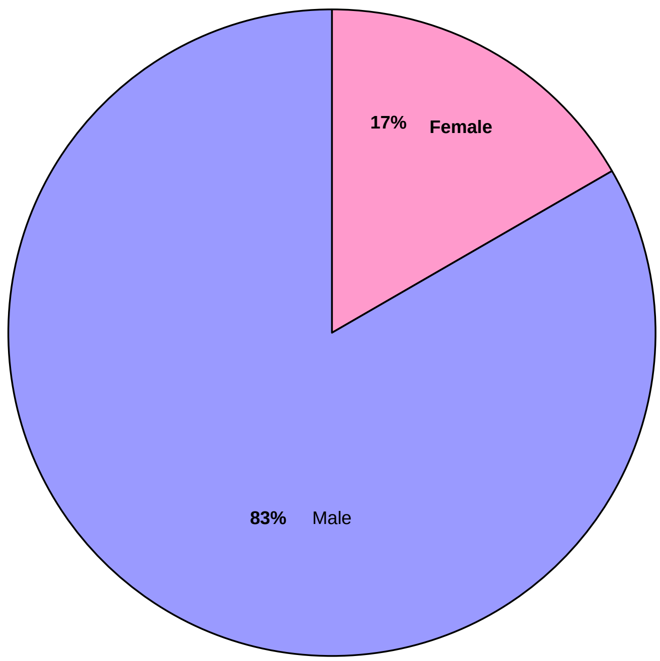



As the chart above shows, the course enrollment consisted of 55 percent seniors, 39 percent juniors and 6 percent sophomores. There were no freshmen in enrolled in the course.

**Delivering the Course**

Each campus held an organizational meeting during the first week of the semester to introduce the course and to make sure the 22 students enrolled in the course could access the course management package. The instructors explained all policies and procedures of the course at this time. Each chapter in the course contained lectures, two online discussion questions (students had to respond to one question per chapter), and one written case assignment per chapter which the students completed and dropped in a digital drop box.

**Gender Diversity in Online Course**




A major research paper was also a part of the class. To encourage the students to think about this paper before the last minute, we required them to summarize fifteen journal articles (two per week) to be submitted to the digital drop box. These summaries were only one-half page long with the citation. Done correctly, the student developed the paper over the course of the semester from the journal summaries. The instructor at the student's home institution graded both the journal articles and the research paper. One school met as a group to hear student presentations on their research papers.

There was an online discussion forum set before each of the three examinations to allow students to ask questions about the chapters on which they would be tested. All three instructors were present in each of the online forums, which were open to the students for a period of one hour. This hour was announced well ahead of time and if a student could not be present, they were encouraged to submit any questions ahead of time and return to the online discussion forum at their convenience to review the instructor responses.

Each institution met with their students during one or two available meeting times during the exam week to administer and proctor the exam. The instructors secured each exam with a password and the students were only given the password when they were in the formal examination setting.

The course management system provided the instructors and students with a variety of tools, such as internal communication, password security for the course, personal assignment calendars, drop boxes for assignment submission, online discussion forums, online testing, and student gradebook access. The course management system approach to distance learning provided the instructors and the students with a convenient approach to presenting material, monitoring student progress, and providing immediate feedback. Case study analysis and online discussion forums were employed to provide critical thinking and problem solving experiences. The online discussion forums and e-mail were used to develop relationships and community between the students and the instructors as a means to reduce the feeling of geographical isolation. Giving each student the opportunity to lead an online discussion session provided for the development of leadership skills. A calendar system within the course management system provided the students the opportunity to exercise time management skills. At the end of the course, students evaluated both the content and the delivery method used in the course.

**Issues and Problems**

As with any course, the execution did not go without a hitch. Since the course was listed on each college's schedule of classes as an online course or a TBA course, there was no uniform meeting time scheduled to administer the exams. Therefore, multiple sessions had to be set to proctor examinations. A couple of students had Internet access problems and personal problems, which prevented them from completing assignments according to the course schedule. Some students procrastinated on getting assignments completed in a timely manner and several students did not demonstrate a high level of critical thinking in completing the assignments. When the students submitted exams, the spam filter blocked some of the submitted test results and these were retrieved manually.

Both instructors and students encountered problems with the course management package. Student lack of understanding of the digital drop box resulted in confusion about where to place assignments and resulted in several assignments being placed in incorrect folders. In order for graded assignments from the digital drop box to be posted automatically to the gradebook, a grade could only be assigned to the first item a student dropped in the appropriate drop box. Occasionally a student would resubmit an assignment for one reason or another. They may have made editing changes or dropped in the wrong assignment originally. For a grade to show in the gradebook, instructors had to place the grade on the first assignment the student dropped in the digital drop box whether it was the correct assignment or not.

The instructors' lack of understanding of the course management system gradebook resulted in slow posting of student grades and calculation of mid-term averages. Students had to submit assignments more than once to get them in the correct drop box so that the gradebook could calculate the grades correctly. Students lacked an understanding of discussion forum threads, which resulted in poor discussions and inconsistent threads.

**Evaluating the Course – The Student Perspective**

Students had an opportunity to complete an online evaluation of the course at the end of the semester. As an incentive to complete the evaluation, instructors offered to add points to the final course grade for those who completed the survey. The form used, which was created by Virginia Tech for evaluating on-line instruction, was used by permission for this course. Eighteen of 22 students completed the evaluation.

Six students reported taking this course because it was required in their major, six because it was a free elective in their major, five because it was a general elective and one because it was a required course outside their major.

Students evaluated teacher performance by rating questions according to the following scale: 1) poor, 2) fair, 3) good, and 4) excellent. The questions and their average ranking by the students on the 4-point scale are as follows:

| | Question | Average score |
|---|---|---|
| 1. | Apparent knowledge of the subject matter | 3.56 |
| 2. | Success in communicating or explaining subject matter | 3.22 |
| 3. | Degree to which subject matter was made stimulating or relevant | 2.89 |
| 4. | Fairness in assigning grades | 3.33 |
| 5. | Concern and respect for individuals as students | 3.67 |
| 6. | Administration of class and organization of materials | 3.11 |
| 7. | Overall ratings of these instructors | 3.17 |
| 8. | Encouragement and management of class interaction | 3.22 |
| 9. | Responsiveness to inquiries outside of class | 3.56 |

One student commented he felt the course was not well organized, but blamed the course management package rather than the instructors. Another commented that the course was extremely well organized. Fifty-six percent of the students who completed the survey stated that the course procedures were clearly posted and that necessary information was received on time from the instructors. Fifty percent reported that clear instructions were given for using all materials. Several students stated that they missed the interaction with faculty and other students that come from a traditional course setting. Some students commented that they missed the lectures the professor would normally have given. Although discussion forums were opened before each test with all three instructors participating, the students stated that they missed face-to-face reviews for tests and did not see the discussion forums as an acceptable substitute.

Students were asked to rate questions related to online instruction by indicating whether they 1) strongly disagree; 2) disagree; 3) agree; or 4) strongly agree with the following statements.

| Question | Average score |
|---|---|
| I would recommend this online course to others | 2.72 |
| I would recommend these instructors to others taking an online course | 3.17 |
| I would recommend that others take a totally online course | 2.35 |

Comments on the course evaluation showed that some students misinterpreted the nature of the course thinking it dealt with security application rather than security theory. Many students were ill prepared for the rigors of online learning and the amount of responsibility it puts on the learner. The online nature of the course required much more reading than most students were used to doing. Students also made suggestions for additional materials that could enhance the course such as required completion of end of chapter review questions. Students seemed to feel that unless certain end of chapter exercises were specifically assigned, they were not at liberty to complete them. Student evaluations indicated online communication was useful in the course, but they needed more orientation to the course and to the technology used in the course.

**Evaluating the Course – The Faculty Perspective**

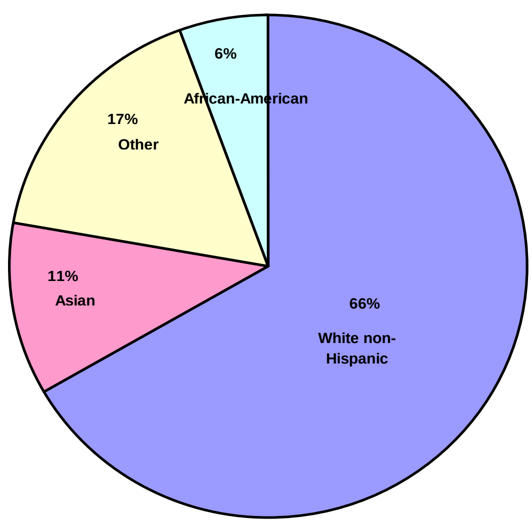
The instructors met to evaluate the course after it was completed. Several items were identified as ways to improve the next course offering. Faculty felt they should have started developing and preparing the course earlier in the previous semester. Perhaps more practice with the course management system would have alleviated some of the problems with both the digital drop box and the gradebook portion of the package. Faculty felt that students might have performed better in the threaded discussions, in using the digital drop box and in meeting deadlines if they had had more instruction about expectations and proper usage of the course management system at the beginning of the course.

Video conferencing might have added to the overall course experience if a uniform meeting time had been set for the course in advance. The course could have been enhanced by holding chat sessions to discuss chapter content and other relevant issues.

Because of inadequate numbers of full-time faculty among the three institutions, this collaborative effort served as a support system for faculty with an otherwise heavy teaching load. The collaboration also allowed the faculty from the three institutions to draw on the diverse interests and skills of each other.

This course filled a need for students to have access to new and developing topics in their field. It also provided them the flexibility to complete the course around their work and class schedules. This approach allowed students from all three institutions to participate in a class, rich in diverse viewpoints and experiences. Although 66% of the students enrolled in the course were white, non-Hispanic, the collaborative effort brought more ethnic diversity to the class than teaching the course individually at any one of the institutions.

Ethnic Division in Online Course




Overall, the faculty involved felt it was a good experience both professionally and academically and would agree to repeat the course, or teach a similar course, with some modification. Other institutions, both small and large, could adopt similar strategies to solve problems of curricula with low local student demand, no local faculty expertise, overextended faculty, or the need for more diversity on their campuses.

# Inside Out: A Computer Science Course Gets a Makeover

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**Abstract**

*This paper outlines the radical restructuring of a Computer Science course on Software Testing. Authors describe the course's evolution from a predominantly lecture-based format to one based on projects and in-class activities. This was accomplished by adding videotaped lectures students watch outside of class. All course materials are available under a Creative Commons license to academics, commercial trainers, and self-studiers around the world.*

Software testing is a relatively narrow subfield of software engineering, but many of the challenges we've faced in teaching it are commonplace in science, technology, engineering, and mathematics (STEM) education. We've developed an instructional approach that is working well in our academic setting and that we believe can extend to other STEM courses at university and to commercial training.

Still a work in progress, the current version of the course differs from the traditional lecture course in several ways:

- We moved lectures out of the classroom. We tape them in advance and post them on a website. Students watch lectures before coming to class. Frequent low-stakes quizzes motivate students to keep pace and watch the videos.
- Classroom contact hours are for coached activities, discussions, and student presentations.
- Students apply the lessons of the course to a well-known program, typically an open-source program in development. We use the same program throughout the term: students join its development team and apply the skills and knowledge they gain in the course in ways that help the project. The artifacts they create are often useful later, in job interviews. This offers many of the same benefits of service learning, but in a way that is logistically simpler and less demanding for the instructor than some service learning projects.
- Students are incentivized, but not required, to work in groups on all types of homework. Students write examinations on their own, but most students prepare for exams in teams.
- We draw exam questions from a published pool, handed out as a study guide. Students prepare for exams by writing answers to the study guide questions. Because students have had plenty of open-book preparation time and opportunity for peer-review, we can require more carefully considered, better written answers.
- The course materials are available to the public (at http://www.testingeducation.org/BBST) under a Creative Commons license. Other university and commercial instructors use them in their courses, providing feedback and additional content.

This report describes the evolution of this course, lessons learned, and progress to date.

## The Commercial Course

The course started as in-house training based on *Testing Computer Software* (Kaner, 1988), which evolved into the best selling book in the field (Kaner, Falk, & Nguyen, 1999). Kaner and Nguyen developed a public version, initially offering it to working software testers and career-changers through the American Society for Quality and University of California (Berkeley) Extension in 1993/1994. That course was reviewed, rewritten, and extended by several colleagues, some of them co-authors (Kaner, Bach, & Pettichord, 2001; Kaner, Falk, & Nguyen, 1993). The course matured into a commercially successful practitioner-training course. By 2000, Kaner had taught it over 100 times, many of those at leading software companies. Nguyen, his staff, and other licensees, taught it many times more.

Commercial client expectations of courses like these are limited. Clients, fellow trainers, and consulting companies who sell training services have repeatedly advised us that clients will be satisfied if each staff member in training gains one idea s/he considers useful from a three-day course, and very satisfied with one useful idea per day.

Clients expected lecture-style instruction that covered a wide range of ideas and techniques at a crisp pace. Despite the popularity of this style of course, full-day lectures are not well-suited to helping students develop new skills or develop a deep enough understanding of the material to assess what testing technique is most likely to be effective under which circumstances (Bligh, 2000). The style and the time compression flood the students with information and allow little time for individual practice or reflection. Kaner introduced some activities into his courses—brief, simple activities were well received, but there was often client resistance to tasks that were more challenging or clusters of tasks designed to approach a technique from several angles to better support transfer from classroom examples to workplace application. These activities had to be done in class—students often have to catch up on their other work at night and don't have time to do homework in short full-day courses. The more time on in-class activities, the fewer topics can be covered.

## The Academic Course

In 1999, Kaner accepted a professorship at Florida Institute of Technology, with the goal of deepening software testing education beyond what can be achieved with practitioner-level training. As part of this work, he founded Florida Tech's *Center for Software Testing Education & Research* (http://www.testingeducation.org). One of the Center's projects has been transformation of the introductory software testing course from commercial to academic. From there, we are developing materials useful for other university instructors, commercial instructors, and self-studiers. We (Kaner and Fiedler) began collaborating on this project in 2001.

University courses differ from commercial courses in key ways:

- The course lasts over a longer period of time, introducing material at a much slower pace (a few hours per week), with plenty of time for practice and reflection outside the classroom.
- Students expect to do homework.
- Students expect the instructor to assess their work and provide detailed feedback on their performance.
- Frequent assessments give the instructor objective feedback on the quality and effectiveness of instruction as well as insight into the knowledge of the students.
- Students generally welcome coached practice in class and appreciate it when the instructor takes extra time to make sure they are mastering key concepts in the course. They are more interested in the congruence between the level of support provided in class and the level of emphasis on the exam than on the length of the checklist of topics covered.

Kaner typically teaches the introductory testing course at Florida Tech twice per year. The opportunity to assess student and instructor performance enabled an assessment-driven evolution of the course from 2000 to 2005. Our key questions were:

- What is the broad scope or subject matter of the course?
- What do we want to achieve in the course? (What are our learning objectives?)
- How will we assess the students' knowledge and progress?
- What learning experiences will better prepare students for these assessments and for the workforce?

Instructional theory books often present these as sequential questions. In practice, we evolved the course on all three dimensions in parallel.

### Subject Matter

To put the instructional approach in context, we start with a few details about the craft of software testing and the challenges doing and teaching it.

We see software testing as a process of technical investigation of the product under test conducted to provide stakeholders with quality-related information.

The classic definition of software testing is "the process of executing a program with the intent of finding errors" (Burnstein, 2003; IEEE, 1983; Kaner, Falk, & Nguyen, 1999; Myers, 1979, p. 5). Another second classic definition is evaluation of the product (IEEE, 1990). A third, helping the project manager decide when to put a product into production or release it to the public (Marick, 1997). There are several others (Kaner, Bach, & Pettichord, 2001). The common thread among the definitions is that software testers gather factual information about the product's quality on behalf of their (in-house or external) clients.

Testing is often focused on the external behavior of the program, without reference to the underlying code. This is called black box testing. In contrast, white box or glass box tests are designed on the basis of the implementation details of the code. One class of glass box testing is programmer testing, testing done by the programmer of her or his own code.

In deciding the curriculum for our recently-accredited Bachelor's degree in Software Engineering, Florida Tech decided to require students to complete two testing courses, the first focused on black box testing, the second applying the first course's lessons in test design and critical thinking to programmer testing.

The course described in this report is the black box testing introduction.

Black box testing involves a cognitively complex collection of tasks. Here are a few of the challenges:

- For any nontrivial program, the population of possible tests is vast. A common example of this presents a simple, well-structured program that runs about 20 lines but requires 100 trillion tests. At five minutes per test, running all of these tests would take a billion years (Myers, 1979). Along with running tests, testers must interpret the results, troubleshoot and report failures, document their work, provide assessments and other reports, and so on. These are all worthy tasks but they are unachievable in the time available. Therefore, testers must prioritize ruthlessly, choosing which worthwhile tasks to skip or drastically subset.
- Another problem that is surprisingly rarely discussed in schools and process improvement meetings is that it is very often very challenging to decide whether the program actually passed or failed a test. The task is simplified when there is a complete, authoritative specification but these are rare in commercial development. Additionally, every test is complex. Consider this example. Suppose you test a program that adds two numbers, and write an automated test that feeds the program under test the numbers and checks the sum. Feed the program 2 and 3, the result is 5. This looks like a passed test, but suppose that it took the program 10 hours to compute the sum—that would be unacceptable, but the automated test tool might well pass the test (correct sum) without noticing the excessive time. Every test has many possible results (not just the sum and the time). It can change memory, change the state of connected devices, send messages, and so on. A leading office automation product manufacturer showed Kaner the diagnostics in its firmware. The company's staff run diagnostics after every test when doing some types of automated testing. The challenge is that there are 1100 different diagnostics. It is impractical to check them all after any test: it takes too much time and running the diagnostics changes the state of the device under test. Thus any test can appear to pass by some measure even if it actually fails. We've also seen examples in which the program appears to fail a test, but is actually behaving correctly. Assessing the results of a test—especially deciding what to assess—requires judgment.
- There is also broad disagreement about how to measure and report testing progress (Kaner, 2001; Kaner & Bond, 2004).

Testers must choose and apply methods appropriate to their goals and feasible within their project's constraints. The vast population of possible tests takes the cost of complete testing beyond even the broadest imaginable constraints *and therefore* a key aspect of testing work is prioritization among worthy tasks that cannot all be done. Another key testing task is communicating investigative results, such as bug reports, project status reports, and product assessments. These reports can be controversial, may be taken as personal criticism, and especially for bug reports, must be so clearly written that someone else can do detailed technical work on the basis of them. In the course of their work, testers create products of their own, such as suites of automated tests (significant bodies of code in their own right) and test documentation (which may run thousands of pages). Testers must be able to determine their own and their stakeholders' requirements for such work products.

**Learning Objectives**

We were guided in developing learning objectives by Angelo & Cross' (1993) *Teaching Goals Inventory.* The course changed format several times, but the objectives have been fairly stable.

- Students should learn a variety of testing techniques and a variety of dimensions along which they differ—and to understand the variation well enough to decide which technique is more promising for a given situation, why, and how to apply it.
- Students should apply (and further develop) communication skills, for example in appraising and writing effective bug reports, reporting status, and analyzing specifications.
- Students should gain practical experience and create artifacts that can help them demonstrate competence in employment interviews.
- Students should work in teams, developing and presenting material to each other and cross-checking each others' work. Collaborative work is common in industry (Bransford, Brown, & Cocking, 2000) and particularly common for industrial testers, whose primary work products are documents that influence others to act (fix bugs, change schedules, change designs, etc.) and who often review each other's work for impact, clarity, and appropriateness of emotional tone.
- Students should apply strategic thinking, including prioritizing tasks, designing tests and reports for specific audiences, and assessing requirements for complex testing tasks.

**Presentation of the Content**

The primary strength of the commercial course was a polished set of lectures with many real-life anecdotes. According to Bligh's (2000) summary of the literature on lecture effectiveness, lectures can be as effective as other instructional techniques for transmitting basic information about a topic, but they are less effective than some other methods for teaching behavioral skills, promoting higher-level thinking, or changing attitudes or values. In terms of Anderson et al’s (2001) learning objective taxonomy, lectures would be most appropriate for conveying factual and conceptual knowledge at the remembering and understanding levels. Our students need to learn the material at these levels, but as part of the process of learning how to analyze situations and problems, apply techniques, and evaluate their own work and the work of their peers.

Carefully crafted lectures offer several other benefits. Experienced, charismatic lecturers can share examples to help students learn complex concepts, tasks, or cultural norms (Ford, 2002; Hamer, 1999; Kaufman & Bristol, 2001).

Lecturers can convey the *lecturer's* enthusiasm for the subject, which improves student satisfaction with the course (Williams & Ware, 1977). They can also organize and integrate a complex set of material. As Forsyth (2003, p. 50) eloquently puts it, "Lectures provide the scholar with the means of not just disseminating information but also transforming that information into a coherent, memorable package. Scholars, when they reveal their unique interpretation of questions they have spent years researching and contemplating, are an unmatched source of information and interpretation."

Rather than offering live lectures, we tape and publish them on the course website. This in itself is hardly new. It is common to offer stored lectures as part of a distance learning program (Rossman, 1999). Web-based lecture segments are being used to supplement Computer Science courses (Fintan, 2000). Studio-taped, rehearsed lectures with synchronously presented slides (as we do) have been done and described elsewhere (e.g., Dannenberg).

Students commonly report that they prefer live lectures (Firstman, 1983; Maki & Maki, 2002). However, it appears that, on average, students learn as well from video as from live lecture (Bligh, 2000; Saba, 2003). (We say on average because there appear to be individual differences associated with learning style or skill and there are also major effects of online interaction on distance learning not relevant to the live course model we're working with.)

Faculty often comment that live lectures allow them to interact with students in ways that taped lectures do not. We feel the same way, but (a) in practice, relatively few of our students make comments or ask questions in class and (b) we are sometimes surprised by our assessment results of what students failed to learn from some of our lectures. It is true that live lectures allow more interaction than taped lectures viewable on the web, but the non-lecture activities we can develop in our classrooms provide far more time and opportunity for interaction than live lectures.

- Live lectures also present some disadvantages that can be addressed in stored lectures (lectures that can be accessed by students at any time):
- Short-term memory capacity varies among learners, especially as they age. Live lectures can't be rewound: what was said is in the past; if it is not remembered, it is lost (Langer, 2002). In contrast, students watching a recorded video can—and do (He, Gupta, White, & Grudin, 1998)—jump backwards in the video to review what was said.
- Students whose first language is not English often have difficulty keeping up with live lectures and can also benefit from the ability to replay material.
- Live lectures can become fragmented as students ask questions (and are responded to). Not all student questions are informative for everyone, and not all questions come at the most opportune time. In the stored lectures we currently create, there are no students on tape and thus no interruptions.
- Live lecturers sometimes drift or ramble. Stories are not always directly relevant and some take so long that students lose the message. Video lectures can be partially scripted (with a teleprompter), with departures from the script to add spontaneous remarks. An example that takes too long can be cut during post-production, or shortened in a retelling / retaping of the example.
- Students can replay a stored lecture while studying for an exam or working on an assignment, reviewing the material in the context of a specific problem or task they are working with.

In summary, there are advantages and disadvantages to taped versus live lectures. At this time, we are not convinced that one is better than the other. However, by moving lectures out of class, we create a semester of space for non-lecture interaction with our students. By making the lectures part of the homework, we effectively double the teaching time available to us in the course.

We supplement the lectures with worked examples on the website and required readings. The examples typically show detailed application of a test technique to a published software product. Worked examples can be powerful teaching tools (Clark & Mayer, 2003) especially when they are motivated by real-life situations. They are fundamental for some learning styles (Felder & Brent, 1996). Exemplars play an important role in the development and recollection of simple and complex concepts (Brooks, 1978; Medin & Schaffer, 1978; Smith, 2005). The lasting popularity of problem books, such as the Schaums Outline series, attests to the value of example-driven learning, at least for some learners. At the moment, our examples are pure, non-interactive text. We intend to change these to narrated videos that show the test and the failure in a (taped) real-time demonstration.

The required readings include the course texts (currently Kaner, Bach, & Pettichord, 2001; Whittaker, 2002) and several published articles. We link to the articles on our website when possible, but distribute others at a Florida Tech specific, password-protected site that restricts distribution of the copyrighted articles to Florida Tech students registered for the class.

**Assessment and Learning Activities**

Anderson et al. (2001) published an extensive revision and update of Bloom's (1956) taxonomy. Their taxonomy is two-dimensional, with *knowledge* and *cognitive processing* dimensions.

- On the *Knowledge Dimension,* the levels are *Factual Knowledge* (such as the definition of a software testing technique), *Conceptual Knowledge* (such as the theoretical model that predicts that a given test technique is useful for finding certain kinds of bugs), *Procedural Knowledge* (how to apply the technique), and *Metacognitive Knowledge* (example: the tester decides to study new techniques on realizing that the ones s/he currently knows don't apply well to the current situation.)
- On the *Cognitive Process* dimension, the levels are *Remembering* (such as remembering the name of a software test technique that is described to you), *Understanding* (such as being able to describe a technique and compare it with another one), *Applying* (actually doing the technique), *Analyzing* (from a description of a case in which a test technique was used to find a bug, being able to strip away the irrelevant facts and describe what technique was used and how), *Evaluating* (such as determining whether a technique was applied well and defending the answer), *and Creating* (such as designing a new type of test.).

For most of the material in the testing course, we want students to be able to explain it (conceptual knowledge, remembering, understanding), apply it (procedural knowledge, application), explain why their application is a good illustration of how this technique or method should be applied (understanding, application, evaluation), and explain why they would use this technique instead of some other (analysis).

One of the key contributions of taxonomies like Bloom's is that they focus us on assessment techniques that are appropriate to the instructional objective.

To help our students learn at a variety of levels, we had to support that learning with a clearly-signaled variety of assessment techniques. These include review quizzes, study-guide driven examinations, applications to the product under test through homework and in-class activities, and additional classroom activities such as orientation exercises and structured discussions.

*Review quizzes.* Review quizzes are simple objective tests (such as multiple choice or fill-in-the-blank). The typical quiz has ten questions. A student who watches the video before class should pass each quiz. We give a quiz when we want to remind students to watch the lectures before coming to class or when we want to focus students' attention on individual details, such as key definitions. The quiz-review discussion after the test creates a natural opportunity for discussion of the details of interest.

Study-guide driven examinations. At the start of the course, we give students a list of 100 questions. All midterm and final exam questions are drawn from this pool. We have sometimes used the same approach in the computer law, ethics & society course and the metrics & modeling course. The Fall 2005 list is at http://www.testingeducation.org/k04/BBSTreviewfall2005.htm. The full pool that we draw sets of 100 from is at http://www.testingeducation.org/k04/EssayExam.htm and is frequently updated.

In previous iterations of the course, about half of the questions called for definitions, the other half for short or long essay questions. We are now experimenting with a lower proportion of definitions, relying on the quizzes to focus students on definitions and other basic facts. Our choice of 100 questions is based on student reactions to longer and shorter lists. If the list seems too long, students won't use it, or not to the level that we want. If the list is too short, the course is (in our view) too easy and too narrow (Kaner, 2003).

We encourage students to refer to the study guide and work through the relevant questions as they take each new section of the class. These help self-regulated learners monitor their progress and understanding—and seek additional help as needed. Students can focus their studying and appraise the depth and quality of their answers before they write a high-stakes exam. Our experience of our students is consistent with Taraban, Rynearson, & Kerr (2000)—many of our students seem not to be very effective readers or studiers, they seem not to be very strategic in the way they spend their study time, and as a result, they don't do as well on exams as we believe they could. We *do* *not* intend to use this kind of study guide in every course. As we overhaul more courses, we will make strategic decisions as to which courses should offer this form of studying assistance, and which should assume that students have progressed past the need for it.

Given that we use this approach, we gain some benefits (Kaner, 2003):

- This approach gives students notice of the questions and time to prepare thoughtful, well-organized, peer-reviewed answers to them.
- In turn, this allows us to require well-written, thoughtful, well-organized answers on time-limited exams. This maps directly to the testing course's goals of fostering better written communication.
- We can also give students complex questions that require time to carefully read and analyze, but that don't discriminate against students whose first language is not English because they have the questions well in advance and can seek guidance on the meaning of a question from anyone they choose. Additionally, this creates a cooperative learning task involving complex concepts for the whole, in which these students participate—this should help limited-English-proficiency students improve their language skills (Crandall, 1993).
- Students don't have to spend time during the exam to carefully read the question, try to understand it, and then develop an outline for the answer. They did all that during preparation (or should have). Therefore, the instructor can write an exam with more questions to answer per hour, achieving higher coverage of the course material.
- Using complex questions allows us to insist on precise reading. For example, we often include a question that explicitly states that the student should ignore the possibility of invalid values when generating a set of tests. Those students who create tests for invalid values *lose points*. In the class that we return graded exams and discuss the grading, we draw attention to this error and remind students that testers must be able to read specifications precisely, for example to note what is within the scope of their analysis and what is not. Similarly, when a question asks for three examples, we stop reading after the third, and we say so in the review session. (We tell students these things before the test, but many students seem not to notice it until after the consequence has happened to them or another student they care about.)
- Students can study together, focusing on the structure provided by the study guide. Collaborators review and critique each others' answers, improving the quality of answers and raising the level at which the course content is understood.

We have been surprised by recent published reports that study guides (or "pedagogical aids") either provide no help to students or change their performance by as little as two percent. For example, Dickson, Miller, & Devoley (2005) required students to use the study guide that came with their introductory Psychology textbook, and assessed students' knowledge using a multiple-choice exam. The students who used the study guide scored about 2% higher (a small but statistically significant difference) than students in another section who did not use the study guide. Gurung (2003, 2004) reports even less favorable results of using study guides. Perhaps the difference is that their examinations are multiple choice, while ours are essays that require more demonstration of cognitive structuring of the material. Certainly, other study-assisting activities like concept mapping have significant positive effects on learning. See Zele, Lenaerts, & Wieme (2004) and their many references for more on concept mapping.

*Applications to the product under test.* The course has a designated software application under test. The Spring 2005 students tested *Open Office's* word processor. Previous semesters focused on the *Open Office* spreadsheet or presentation program, or on the Mozilla *Firefox* browser. Each student joins the open source software project. Applying what we learn to a sample application has been an important aspect of the testing course. In each of the proposed classes, we look for ways to credibly tie the course material to practical applications. Here are some of the benefits in the testing course.

- It makes the concepts we teach "real" to the students by situating them in the development of products that are well-known and well-regarded (Lave & Wenger, 1991).
- Students gain insight and real-world experience that they can (and do) talk about in job interviews.
- Students create work products that they file with the project (such as bug reports in the project's bug tracking database, or test cases in the collection of test planning materials). They can cite these, show them off and explain them during employment interviews. Feedback from students and industry recruiters tell us several students effectively use these work products in interviews. Knowing that there are stakes outside of the classroom is a strong motivator for some students to do excellent work.

- This approach also facilitates transfer of students' new knowledge and skills to the workplace, because they are doing the same tasks and facing some of the same problems they would face with any commercial software (Clark & Mayer, 2003).
- When students create work products for a project, we can take imperfect examples and rework them in class, step by step, to show what a better job would look like. In the most desirable case, a few students submit work that is blasted as incompetent by an irascible programmer or project manager. That creates a real-world context for the friendly, corrective lecture by the teacher who offers coaching on how to do something like this much better next time. Worked examples can be powerful teaching tools (Clark & Mayer, 2003) especially when they are motivated by real-life situations.

Students work with the product under test in several classroom activities and in their homework assignments.

*Classroom activities.*

We spend classroom contact hours on coached, small-group activities. For example, groups of up to 4 students apply the lecture material to a real product (*Open Office*) or discuss a hypothetical problem or work on other puzzles, generally problems that the lecture would prepare the student for but that go beyond the lecture itself. We teach in a lab room, with one computer per student. In class, students work together in groups. Activities are open book. Students are encouraged to look up information on-line. The instructor moves from group to group asking or answering questions, giving feedback, or offering supplementary readings that relate to the specific direction taken by an individual group.

Only some of these activities involve the application under test. Others introduce students to the material before the lecture (preparing them for the lecture), develop a theoretical point made in lecture, address a question in the study guide, address a question raised by a student, let them try out a test tool, or help the students work through a complex section of one of the course readings. Students often present results to the class in the last 15 minutes of the 75-minute class. They often hand in their work for grading.

The diversity of activities we imagine is partially inspired by the diversity of examples in the *Activities Handbook(s) for the Teaching of Psychology* (Benjamin & Lowman, 1981; Benjamin, Nodine, Ernst, & Broeker, 1999; Makosky, Sileo, Whittemore, Landry, & Skutley, 1990; Makosky, Whittemore, & Rogers, 1987). We're still learning how to develop good activities and how to document them. Our documentation is free-form so far. Gagnon & Collay (2001) provide what looks like a good structure for thinking about and documenting activities. We intend to experiment with it, and possibly adopt it, over the next year.

*Orientation exercises.*

One interesting type of activity gives the students a problem to work through that they probably won't adequately solve—but that will be solved in the next lecture (Kaner, 2004). "Cognitive conflict or puzzlement is the stimulus for learning and determines the organization and nature of what is learned" (Savery & Duffy, 2001).

*Structured discussions.*

In one of the in-class activities, students get a table. The rows name 16 attributes of good tests (such as power of the test and credibility of the test). The columns list 10 common test techniques. No technique is good on all of the attributes. For example, higher-power tests (tests more likely to expose errors) often use extreme values that are not representative of normal use. The task is to mark the three attributes that a test technique is designed to optimize (domain testing is more focused on the power of tests; scenario testing is usually more focused on realistic uses) and to mark two attributes that testers don't pay attention to when they design a test using this technique. Along with filling out the chart, the student writes a paragraph for each technique, explaining the choices. Students discuss the chart in one class, take it home and think about it, then discuss it again in the next class and submit their work as individuals or as a group. This year, Fall 2005, we will probably spend a third class day on this and ask students to resubmit their analysis close to the end of the course.

This is a difficult but important assignment. It also illustrates the use of an activity to foster a narrowly focused discussion among a group of students.

*Drill exercises.*

In his initial work under NSF Award EIA-0113539 ITR/SY+PE: Improving the Education of Software Testers, Kaner expected to be able to bring testing students to mastery of some techniques through practice with a broad set of examples. Padmanabhan (2004) applied this to domain testing in her Master's thesis project at Florida Tech, providing students with 15 classroom hours of instruction, including extensive practice. All students were able to solve the problems in her final examination, which presented problems similar to those solved in class. However, when we added a problem that was just slightly more complex and required application of an idea that had been described in lecture but not practiced, every student failed to discover problems that (in our view) should have been obvious if the student understood the method, rather than followed a rote procedure. This result (and some less formally conducted prior failures) was surprising to us, initially very disappointing, a strong motivator to read further in the STEM education literature and ultimately redesign the testing course.

In retrospect, I realize that we replicated a common finding in mathematics education. Drill helps people master a specific task, but doesn't lead to generalization and transfer (Bransford, Brown, & Cocking, 2000).

We still think that examples and solved problems are very useful, and we still want to present students with strong exemplars, but our goal is to find ways to help students fit them in a broader context, to facilitate effective generalization and successful transfer. Even though students gain hands-on experience with the test techniques (and the other subject matter of the course), the in-class work and the take-home assignments are not drill. Students are not applying a known approach to several similar problems. They are figuring out the details of the approach themselves, applying ideas presented in lecture and comparing notes.

Take-home assignments. We give students about 5 take-home assignments. They have a week or two to complete an assignment. It often comes with a grading rubric. Eventually, all of them will come with rubrics and some will come with samples of answers to similar assignments. A typical assignment applies test techniques to the product under test, gathering information about the product, its markets and/or its risks, working through a standard or trying out a tool and writing an experience report. Students are welcome to work together in groups of two or three.

**Notes on Video Implementation**

We are amateurs at photography and video production, not particularly talented, but enthusiastic. Our videos reflect that. Here are some good examples of our work.

- This one (http://www.testingeducation.org/k04/video/FunctionTest.wmv) on function testing is a self-contained video that includes a detailed demonstration of the technique.
- These two (http://www.testingeducation.org/k04/video/BBSTguiAuto2.wmv and http://www.testingeducation.org/k04/video/OverviewPartB.wmv) illustrate our current layout and pacing.

We've made progress in laying slides out to be more readable, in editing the video to avoid jarring transitions, and in pacing the lecture and the slide transitions, but we have a long way to go. We expect to continue to make incremental progress (remaining obvious amateurs) in technical production, but we hope to make the content more engaging in a few ways. First, we expect to provide more demonstrations, like the function testing one. Second, we want to add more engaging stories, like http://www.testingeducation.org/k04/video/BBSTscriptTest2.wmv. Unfortunately, these take a lot of work. Third, we're intrigued by infomercials, which often heighten interest through interactions among several actors, including scripted discussions that pose questions to address specific, predictable areas of confusion or resistance to a new idea.

We record the videos at home using a mid-priced digital camcorder (a Sony DCR TVR-38). We download the videos to a Dell XPS Gen5 computer with a dual-core Pentium chip with hyperthreading. Processor speed and the ability to do multiprocessing are important for editing and rendering (saving the edited video in a final format, in our case QuickTime or Windows Media Video). A video that renders in an hour (on the Gen5) rendered in up to 8 hours on slower machines. When an error, such as corrupted input, a memory leak or other bug, halts the rendering process, rendering seems to either fail right away or near the end of processing. On the predecessor to the Gen5 (an Alienware Roswell with a Matrox video coprocessor), failures were common—redoing the rendering could add 30 hours of rework for a 45-minute lecture segment. Producing videos on schedule, on time for students to be able to watch them before the scheduled class, is much more challenging the slower the rendering process and the less reliable the computer. We use the Windows systems in order to use *Adobe Premiere Pro*. Both of us have our own Macintoshes and Windows systems (and have for years). We prefer the Macs, but our pilot studies (two full lectures and some other fooling around) convinced us that *Premiere* was more reliable—at least in the way we worked with video editing—than *Final Cut Pro*, and *Premiere* isn't being updated for the Mac. Looking at current prices for our setup, it costs about $8000 for a fast and reliable computer with lots of memory, three hard disks (source data, resulting video, other data and work area), *Premiere*, and some utilities like *SnagIt* (for screen shots and videos of running programs).

Creating a lecture includes preparation tasks as well as taping and editing a video. These include polishing the slides to get the flow of the lecture right, (very imperfectly) balance the time to be spent per slide, laying out the slides to be readable after video rendering in a compressed format, writing out detailed notes for the lecture and rehearsing the lecture before taping.

Giving the lecture, on tape, also takes time. We might tape the presentation of a single slide several times until it finally feels right, then move to the next slide. An hour of final tape might take 3 to 10 hours of videotaping, followed by 4.5 to 15 hours (about 1.5 hours per hour of tape) of editing.

From "start" to finish, where "start" means we already have good slides and a fairly clear idea of the lecture (with lecture experience with these slides), lecture material to support one classroom contact hour (perhaps 30-50 minutes of video) took about 35 hours last year (the unreliable and slightly slower Alienware system). On the newer system, we hope to stabilize at 25 hours video preparation time per class.

Along with video preparation is preparation of all of the other supporting materials. Freeing up all of the classroom contact hours for labs and seminars means that we have to create laboratory and seminar activities, develop ways to evaluate them, and provide feedback to the students.

The overall preparation time cost, borne primarily by the faculty member, is enormous and far beyond what we suspect any university would pay for. It is a labor of love. For us, the driving passion is for improvement of the state of the practice in the broad field of software testing. In a field that is educationally underserved (academically and commercially), providing high-quality free course materials to the community at large might have an impact on the development of basic knowledge and skill in the field.

To enable this broad distribution, we have to keep the intellectual property rights to our course. That makes it possible for us to license the material any way we want, including Creative Commons. Some schools (K-12 and university) have begun asserting ownership of copyrightable teaching materials created by their faculty. In these cases, the school might not approve of publishing courseware that they own, for free.

We planned for this by setting up to do all of the work at home, using our own equipment, and so far, we have done all of the videotaping and editing at home. Eventually, Florida Institute of Technology approved a stored course policy that allows us to keep ownership of materials we create at school so long as we don't rely heavily on school resources (The final policy is almost the same as the proposal we reported in Kaner, 2002). This has allowed us to supplement our materials with work done by research assistants in Kaner's lab at Florida Tech and will allow us to do more work at school and more in collaboration with other faculty, in the future.

## A Broader Market

The course appears to be working well in our classes at Florida Tech. We are still evaluating comparable performances (such as final exams from previous teachings of the course, compared to those from the new approach). Our impression from informal comparison is that the students are generating better work. We are also getting favorable student evaluations.

In addition to local teaching, we make the course available on the Web, for free. About 120 people have signed up for a low-traffic, moderated email list for people who teach a testing course using our materials. Some teach it at university, others at their own company. Some are self-studiers trying to gain insight from discussions among the teachers. The list has been in operation for about six months, but we are still just getting started on serious discussions. Eventually, we expect feedback from this list and from a second list (discussion by students) to provide a steady stream of insights into the weaknesses of the course.

Informal feedback so far is positive and enthusiastic, but it is clear that these materials are far from ideal for self-study and that several instructors (especially commercial trainers) could use more help on evaluating the results of tests and assignments.

## Closing Notes

This has been a time-consuming course to create, and we're not done. We have more lectures to tape, plus more grading samples, examples, and other instructional supports.

We see the work as worth the effort, partially because it appears to be improving our on-campus students' learning and enthusiasm, but especially because it is being reused around the world and will be used even more broadly as it gets more polished. We also expect the availability of a good free course to stimulate improvement in the leading commercial courses, in order to compete well with our free offering. Some commercial instructors are already incorporating some of our materials in their courses (which they are welcome to do under our Creative Commons license). Others, we are told, have started their upgrading process without using our material.

We see this work as promising enough that we are already planning the next few courses. Eventually, we hope to offer an open source curriculum in software testing, rather than just one or two courses. As software development work disperses ever more around the world, a set of high quality courses available to everyone for free offers the possibility of a reasonably high baseline level of knowledge of the field everywhere—or as competition develops, of several good baselines that present competing visions of the field and its operations.

## References


Anderson, L. W., Krathwohl, D. R., Airasian, P. W., Cruikshank, K. A., Mayer, R. A., Pintrich, P. R., et al. (2001). *A Taxonomy for Learning, Teaching & Assessing: A Revision of Bloom's Taxonomy of Educational Objectives* (Complete Edition ed.). New York: Longman.

Angelo, T. A., & Cross, P. K. (1993). Teaching Goals Inventory. Retrieved October 10, 2005, 2005, from http://www.uiowa.edu/~centeach/tgi/index.html

Benjamin, L. T., & Lowman, K., D. (Eds.). (1981). *Activities Handbook for the Teaching of Psychology* (Vol. 1). Washington, DC: American Psychological Association.

Benjamin, L. T., Nodine, B. F., Ernst, R. M., & Broeker, C. B. (Eds.). (1999). *Activities Handbook for the Teaching of Psychology* (Vol. 4). Washington, DC: American Psychological Association.

Bligh, D. A. (2000). *What's the Use of Lectures?* (American ed.) San Francisco: Jossey-Bass.

Bloom, B. S. (Ed.). (1956). *Taxonomy of Educational Objectives: Book 1 Cognitive Domain*. New York: Longman.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (2000). *How People Learn: Brain, Mind, Experience and School (Expanded Edition)*. Washington, D.C.: National Academy Press.

Brooks, L. R. (1978). Non-analytic concept formation and memory for instances. In E. Rosch & B. B. Lloyd (Eds.), *Cognition and categorization* (pp. 169-211). Hillsdale, NJ: Erlbaum.

Burnstein, I. (2003). *Practical Software Testing*. New York: Springer.

Clark, R. C., & Mayer, R. E. (2003). *e-Learning and the Science of Instruction*. San Francisco, CA: Jossey-Bass/Pfeiffer.

Crandall, J. (1993). Content-Centered Learning in the United States. *Annual Review of Applied Linguistics, 13*, 111-126.

Dannenberg, R. P., (n.d.). Just-In-Time Lectures. Retrieved March 12, 2005 from http://www.jitl.cs.cmu.edu/jitrbd.htm.

Dickson, K. L., Miller, M. D., & Devoley, M. S. (2005). Effect of Textbook Study Guides on Student Performance in Introductory Psychology. *Teaching of Psychology, 32*(1), 34-39.

Felder, R. M., & Brent, R. (1996). Navigating the bumpy road to student-centered instruction. *College Teaching, 44*, 43-47.

Fintan, C. (2000). *Lecturelets: web based Java enabled lectures.* Paper presented at the Proceedings of the 5th annual SIGCSE/SIGCUE ITiCSE Conference on Innovation and Technology in Computer Science Education, Helsinki, Finland.

Firstman, A. (1983). A comparison of traditional and television lectures as a means of instruction in biology at a community college.: ERIC.

Ford, D. G. (2002). Teaching anecdotally. *College Teaching, 50*(3), 114-115.

Forsyth, D., R. (2003). *The Professor's Guide to Teaching: Psychological Principles and Practices*. Washington, D.C.: American Psychological Association.

Gagnon, G. W., & Collay, M. (2001). *Designing for Learning: Six Elements in Constructivist Classrooms*. Thousand Oaks, CA: Corwin Press.

Gurung, R. A. R. (2003). Pedagogical Aids and Student Performance. *Teaching of Psychology, 30*(2), 92-95.

Gurung, R. A. R. (2004). Pedagogical Aids: Learning Enhancers or Dangerous Detours? *Teaching of Psychology, 31*(3), 164-166.

Hamer, L. (1999). A folkloristic approach to understanding teachers as storytellers. *International Journal of Qualitative Studies in Education, 12*(4), 363-380.

He, L., Gupta, A., White, S. A., & Grudin, J. (1998). *Corporate Deployment of On-demand Video: Usage, Benefits, and Lessons* (No. MSR-TR-98-62). Redmond, WA: Microsoft Research.

IEEE. (1983). *IEEE Standard 829-1983 (Reaffirmed 1991) Standard for Software Test Documentation* Piscataway, NJ: IEEE Standards Dept..

IEEE. (1990). Std 610.12-1990, Standard glossary of software engineering terminology. Piscataway, NJ: IEEE Standards Dept.

Kaner, C. (1988). *Testing Computer Software* (1st ed.). New York: McGraw Hill.

Kaner, C. (2001). *Measurement issues and software testing (Keynote address).* Paper presented at the QUEST 2001 Segue Software User's Conference. Retrieved April, 2005. from http://www.kaner.com/pdfs/measurement_segue.pdf.

Kaner, C. (2002). The proposed Florida Tech stored course policy. *Computer Graphics, 36*(2), 15-17, 21-22.

Kaner, C. (2003, February). *Assessment in the Software Testing Course.* Paper presented at the Workshop on the Teaching of Software Testing (WTST), Melbourne, FL.

Kaner, C. (2004, February). *Carts before horses: Using preparatory exercises to motivate lecture material.* Paper presented at the Workshop on Teaching Software Testing, Melbourne, FL.

Kaner, C., Bach, J., & Pettichord, B. (2001). *Lessons Learned in Software Testing*: Wiley.

Kaner, C., & Bond, W. P. (2004). *Software engineering metrics: What do they measure and how do we know?* Paper presented at the 10th International Software Metrics Symposium (METRICS 2004). Retrieved September, 2005 from http://swmetrics.mockus.us/metrics2004/lbp/KanerBond.pdf.

Kaner, C., Falk, J., & Nguyen, H. Q. (1993). *Testing Computer Software* (2nd ed.): International Thomson Computer Press.

Kaner, C., Falk, J., & Nguyen, H. Q. (1999). *Testing Computer Software* (republished 2 ed.). New York: John Wiley & Sons.

Kaufman, J. C., & Bristol, A. S. (2001). When Allport met Freud: Using anecdotes in the teaching of Psychology. *Teaching of Psychology, 28*(1), 44-46.

Langer, N. (2002). Enhancing adult learning in aging studies. *Educational Gerontology, 28*(10), 895-904.

Lave, J., & Wenger, E. (1991). *Situated Learning: Legitimate Peripheral Participation*. Cambridge, England: Cambridge University Press.

Maki, W. S., & Maki, R. H. (2002). Multimedia comprehension skill predicts differential outcomes of web-based and lecture courses. *Journal of Experimental Psychology: Applied, 8*(2), 85-98.

Makosky, V. P., Sileo, C. C., Whittemore, L. G., Landry, C. P., & Skutley, M. L. (Eds.). (1990). *Activities Handbook for the Teaching of Psychology* (Vol. 3). Washington, DC: American Psychological Association.

Makosky, V. P., Whittemore, L. G., & Rogers, A. M. (Eds.). (1987). *Activities Handbook for the Teaching of Psychology* (Vol. 2). Washington, DC: American Psychological Association.

Marick, B. (1997). *Classic testing mistakes*. Paper presented at the Software Testing Analysis & Review Conference (STAR 97). Retrieved October 10, 2005 from http://www.testing.com/writings/classic/mistakes.html.

Medin, D., & Schaffer, M. M. (1978). Context theory of classification learning. *Psychological Review, 85*(207-238).

Myers, G. J. (1979). *The Art of Software Testing*. New York: Wiley.

Padmanabhan, S. (2004). *Domain Testing: Divide & Conquer.* Unpublished M.Sc. Thesis, Florida Institute of Technology, Melbourne, FL.

Rossman, M. H. (1999). Successful online teaching using an asynchronous learner discussion forum. *Journal of Asynchronous Learning Networks, 3*(2).

Saba, F. (2003). Distance education theory, methodology, and epistemology: A pragmatic paradigm. In M. G. Moore & W. G. Anderson (Eds.), *Handbook of Distance Education* (pp. 3-20). Mahwah, New Jersey: Lawrence Erlbaum Associates.

Savery, J. R., & Duffy, T. M. (2001). *Problem Based Learning: An Instructional Model and Its Constructivist Framework* (No. CRLT Technical Report No. 16-01). Bloomington, IN: Indiana University.

Smith, D. J. (2005). Wanted: A New Psychology of Exemplars. *Canadian Journal of Psychology, 59*(1), 47-55.

Taraban, R., Rynearson, K., & Kerr, M. (2000). College students' academic performance and self-reports of comprehension strategy use. *Reading Psychology, 21*(4), 283-308.

Whittaker, J. (2002). *How to Break Software*. Boston: Addison-Wesley.

Williams, R. G., & Ware, J. E. (1977). An extended visit with Dr. Fox: Validity of student satisfaction with instruction ratings after repeated exposures to a lecturer. *American Educational Research Journal, 14*(4), 449-457.

Zele, E., Lenaerts, J., & Wieme, W. (2004). Improving the usefulness of concept maps as a research tool for science education. *International Journal of Science Education, 26*(9), 1043-1064.

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# DESIGN OF A PROTOTYPE CONSTRUCTIVIST LEARNING ENVIRONMENT FOR VETERINARY MEDICINE STUDENTS

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**Abstract**

*Veterinary Medicine Diagnostic Tool (VMTD) is a prototype constructivist learning environment. Four among six components of Constructivist Learning Environments (Jonassen, 1999) were considered in designing the prototype of VMDT. VMTD centers cases to drive students to acquire knowledge and skills by solving problem cases, provides related cases to increase cognitive flexibility, includes support tools such as question editors, and contains resources that are useful for solving problems.*

## Introduction

Diagnostic reasoning is among the most important problem solving skills that veterinary students need to learn because the primary work of professional veterinarians is to diagnose patients. However, veterinary students often find it very difficult to acquire this requisite skill. Before students come to the clinical pathology classroom, they are often taught to memorize factual knowledge and medical terms in anatomy, physiology and other relevant areas. After this, they are suddenly required to diagnose cases by applying many varying types of knowledge in order to interpret lab data in the clinical pathology classroom. Although case-based instruction provides veterinary students opportunities for experiences that are similar to those of practicing veterinarians, this sudden change may cause significant frustration and difficulty for students, as they have not been previously exposed to such knowledge application. Case diagnosis is very complex and requires a large amount of domain knowledge, strategic knowledge, and performance knowledge. In order to support the veterinary students' construction of these types of knowledge and skills in a more effective manner, we designed the Veterinary Medicine Diagnostic Tool (Figure 1). In the present paper we describe professional veterinarians' diagnostic reasoning process, the feature of the system, and how it supports knowledge construction of diagnostic reasoning.

### Task Analysis of Diagnostic Reasoning

In order to analyze professional veterinarians' cognitive behavior in case diagnosis, a series of interviews with two professional veterinarians was conducted using the PARI method, a type of cognitive task analysis (Hall, Gott, & Pokorny, 1995). PARI is an acronym of Precursor, Action, Result, and Interpretation. Although a complete description of the PARI model is beyond the scope of this abstract, a more detailed explanation can be found in the book of Task Analysis Methods for Instructional Design (Jonassen, Tessmer, & Hannum, 1999). By posing questions to two professional veterinarians and asking them to "think aloud", we were able to identify the domain knowledge, strategic knowledge, and performance knowledge needed to successfully diagnose a case. Veterinarians first come up with a differential diagnosis based on an interpretation of the initial state of the patient and generate various questions that need to be investigated and verified. It is after this differential diagnosis that the veterinarians order the lab tests considering the cost associated with them, interpret the lab data, and come to the final diagnosis.

### Theoretical Basis of the VMDT Design

VMDT is designed based on the model for designing Constructivist Learning Environments (CLEs) that consists of a problem and "intellectual support systems" (Jonassen, 1999). The six essential components in the model for designing CLEs are as follows.

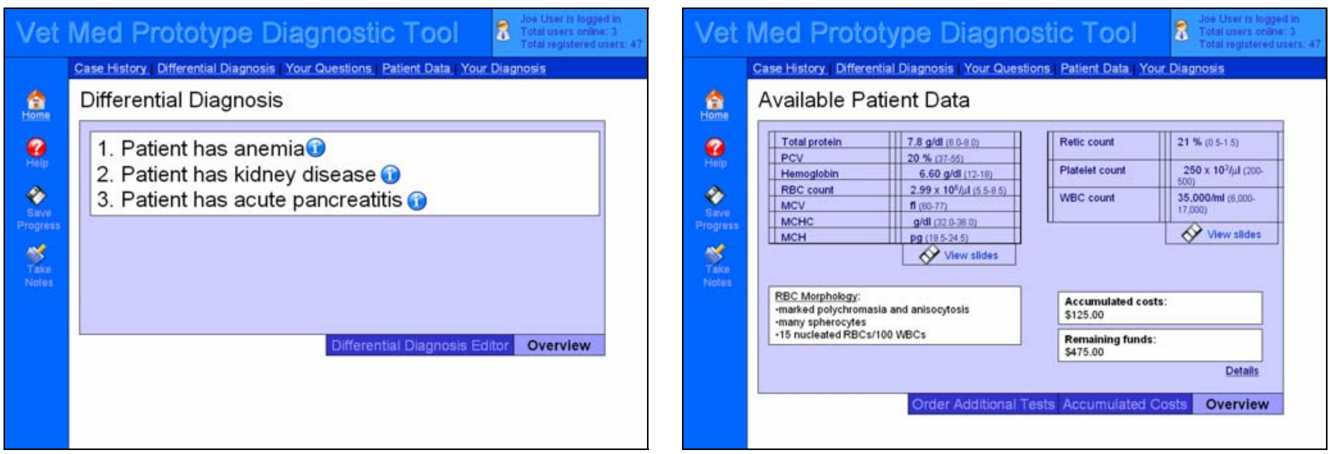
- Question/Case/Problem/Project
- Related Cases
- Information Resources
- Support Tools
- Conversation and Collaboration Tools
- Social/Contextual Support

Four among six components of CLEs were considered in designing the prototype of VMDT. In the model for CLEs, the problem is the center of the environment and drives students to acquire the requisite domain knowledge to solve the problem. The problems in CLEs should be what practitioners do in real work settings and should require students to engage in authentic cognitive challenges that are similar to those of practitioners in the real world (Jonassen, 1999). However, students lack many of the experiences that are very important in solving problems. Thus, the model for CLEs requires a type of case library of related cases in order to scaffold student memory with represented experiences and to enhance the complexity of cases by providing multiple perspectives. In addition to the case library, essential parts of CLEs are information resources that are important and necessary for solving the problem and tools that support student problem solving and dynamic activities.

**Vet Med Diagnostic Tool**

The Diagnostic Tool is a prototype for a case-based learning environment that requires veterinary students to diagnose cases in a manner that is analogue to practitioners. VMDT consists of authentic cases that the professional veterinarians encounter in their work settings. After receiving the case about the animal's wellness and symptoms, the learner starts building his/her differential diagnosis by selecting possible diagnoses provided in the Differential Diagnosis Editor. Then, the learner is required to generate questions that need to be asked to validate each diagnosis. This action is the same as the veterinarians' initial diagnosis process. In real work settings, the veterinarian will ask implicit questions to him/herself to verify his/her initial diagnosis before ordering lab tests to run. Then, the learner decides what lab tests he/she wants to run based on their questions. Once the learner orders the lab tests, the patient data will appear in the screen along with slides. In reality, there are many constraints such as costs in ordering lab tests. The Vet Med Diagnostic Tool has a built-in cash register to track the cost of each test. After the learner finishes reviewing the lab data, he/she will finalize his/her diagnosis in the "Your Diagnosis" area and is then required to provide justification and reasoning behind their final diagnosis. At each stage of working through the problem, the learner has opportunities to save their work and return to the point where he/she left off. Also, helpful information such as relevant articles can be accessed.

Figure 1. Vet Med Diagnostic Tool




The Vet Med Diagnostic Tool supports veterinary students construct their knowledge and skills for diagnostic reasoning through a real case diagnosis. They are engaged in the thinking process like practitioners in real working settings and must provide the reasons for their actions and diagnosis.

**Reference**

Hall, E. P., Gott, S. P., & Pokorny, R. A. (1995). A procedural guide to cognitive task analysis: The PARI methodology, Tech. Report AL/HR-TR-1995-0108. Brooks Air Force Base, TX: Human Resources Directorate.

Jonassen, D. H. (1999). Designing constructivist learning environment. In Reigeluth, Charles M. (Ed.), Instructional-design theories and models: A new paradigm of instructional theory, Vol. II (pp 215-239), Mahwah, NJ: Lawrence Erlbaum.

Jonassen, D. H., Tessmer, M., Hannum, W. H. (1999). Task Analysis Methods for Instructional Design. Mahwah, NJ: Erlbaum.

# Introduce a Compressor/Decompressor Technology to Enhance the Multimedia Presentations

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**Abstract**

*This paper introduces information about using codec technology in order to produce an appropriate video presentation. The information from the study serves as a tool for users to choose the appropriate technology for their video presentations. Several comparison tables are provided in order to help users to choose an appropriate technology for their presentations. In general, we found that the bigger size files have less compression and the smaller size files are more compressed. Also, the bigger size files have higher quality than the smaller size files.*

## Introduction

With more fast and large hard disk computers and powerful multimedia programs widely available, teachers and students are able to use multimedia presentations with the help of computers more efficiently and effectively. Multimedia consists of more than one combination of text, audio, graphic, animation, and video. Using multimedia presentations by teachers will hold students' interest in the classroom. Many educators believe that using multimedia is essential when working with today's video generation (Jonassen, 2000). Video presentations can help students in a visual way that reinforces what verbal or static graphic alone cannot. With the available storage and delivery technology, presenters can choose various delivery technologies such as a hard-disk, a floppy-disk, a zip-disk, a CD, a DVD, and the Internet. However, constructing a computer-based video in multimedia presentations more likely requires technology like codec.

### Why do we need a video codec?

To create a Digital Video (DV), use of an appropriate codec is necessary. Otherwise, the file size of the DV will be very large. The common types of DV camcorders that are used for storing video on camcorder are Digital8, MiniDV, MicroMV, and DVD. DV consumes a lot of hard disk space; for instance, a MiniDV tape consumes about 215MB of disk space per minute, or about 13GB per hour (Johnson, Stauffer, & Broida, 2004). This means that the user must have enough available space on a computer to transfer the video data from a DV camcorder. An IEEE 1394 (also known as FireWire and in Sony parlance, i.LINK) interface helps teachers transfer video data from a DV camcorder to a computer. For instance, a teacher may easily transfer one hour of video data from a DV camcorder to a computer through an IEEE 1394 interface. And then, the teacher may simply present the 1 hour video from the hard drive. However, if the teacher has to move to another classroom, it would be difficult for the teacher to bring the entire computer for the presentation. Codec technology will solve this problem. It helps to reduce the file size without noticeable loss of quality to distribute the video to CD (650MB), DVD (4.7GB), and the Internet.

### What is a codec technology?

Codec is a short form of compressor/decompressor that manages compression. The goal of video compression is to represent the same content using less data (Adobe Premiere Pro: Classroom in a book, 2004). It has various types of computer algorithms that compress and decompress audio, video, and image files. All codecs can be divided into two categories: lossless and lossy. Lossless compression means that we do not lose any data when we compress or decompress the video. On the other hand, with lossy compression, when we compress a video and then decompress it, we do not retrieve the original quality of the video (Currier, 1995). In general, codecs are used to decrease a file size without noticeable loss of quality. For instance, in our experiment an MPEG compresses a video file to a much smaller size with a ratio of 9:1 or more without a noticeable loss of quality.

Unfortunately, to open and watch the compressed video, the same codec must be used to decompress the video. If the end-users' computer does not have the appropriate codec to decompress the video, they will be unable to open or watch the compressed video clearly. Thus, to select an appropriate codec, a presentation developer should be able to use the most common codec for end-users' computers, or at least provide a codec which is used by the developer.

**What makes an appropriate codec?**

How do we select an appropriate codec from the available codecs? Choosing an appropriate codec for multimedia presentations can be a difficult task. In general, presenters might want both a small file size and high quality. Buehler (2003) focused on four areas on which a codec can be judged: image quality, file size, compatibility, and usability. In this paper, we have focused on three factors: image quality, file size, and compatibility, for selecting an appropriate codec for multimedia presentations.

- Image Quality: Presenters do not want to lose their quality of video unnecessarily. They probably want to show their video without noticeable loss of quality for the audience. They want to keep as good quality as they possibly can. In general, image quality does significantly affect the file size. If they adjust an image quality simply to produce a small file size video without a good codec, it will reduce a file size, but presenters will lose quality of video unnecessarily.
- File Size: Presenters do not want to produce a large file size video unnecessarily. They do not want to produce a huge video like 2GB for a 10min video presentation. Depending on storage like Zip-disk (100MB), hard-disk, CD-Rom (650MB), DVD-Rom (4.7GB), and WWW, they absolutely need a reasonable file size that can be presented. It is extremely difficult to deliver a 2GB video file on the Web.
- Compatibility: Presenters want to produce a compatible video to watch easily for end-users. They do not want to present a video which requires hardware or software to watch it. If presenters have a good codec to preserve good quality with extremely reduced file size, but if end-users can't watch it without purchasing a specific hardware or software, is it a good codec?

## Methodology

For our experiment, we created one short video. The sequence consisted of live scenes of flowers swaying in the wind, and was taken by a Sony Digital Handycam (DCR-TR V33). For capturing the video sequence from the DV Camcorder to the computer, we used Adobe Premiere with IEEE 1394 (FireWire) interface. The capture settings were as below:

- Capture format: DV/IEEE 1394 Capture
  Compressor: Microsoft DV (NTSC)
  Frame size: 720 * 480
  Frame Rate: 29.97 FPS
  Length: 5 seconds
  Original file size: 18,700 KB

**Procedure**

Different codec technology in the Adobe Premiere 6.0 and Premiere Pro was applied on the video sequence in order to present the useful information of codecs with the three factors. In Adobe Premiere 6.0 and Premiere Pro the following file formats are available: Microsoft AVI and DV AVI, Animated GIF, MPEG Real Media, QuickTime, and Windows Media (See Figure 1).

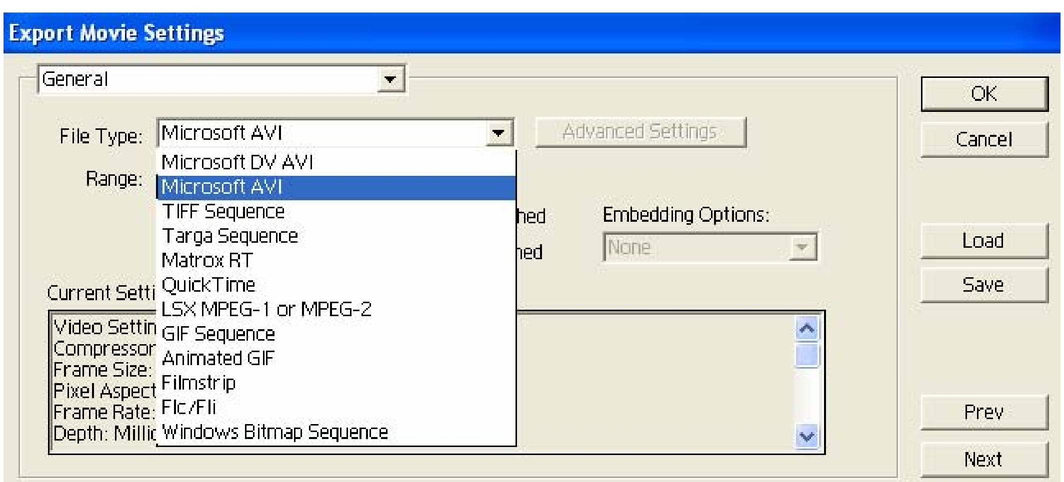


*Figure 1*. The Export Movie Setting for selecting a file type in Adobe Premiere 6.0.

We focused on three video file formats: QuickTime, AVI, and MPEG, for evaluating variable codecs.

- QuickTime: QuickTime was originally developed for the Mac, but it has been widely used on the PC. It has a MOV file extension and is one of the oldest and the commonly used for Web-based content. An end-user might have to install QuickTime player to view a video because it doesn't come installed with Windows.
- Microsoft AVI (Audio Video Interleaved): AVI is defined by Microsoft. It has an AVI file extension and is the most common format for video on the PC. An end-use might have to update new Windows Media Player to view a video.
- MPEG (Moving Picture Experts Group): MPEG is one of the oldest compressed video formats in the business. It is commonly used on the WWW and in PC-based video. DVDs and digital camcorders both use MPEG compression. (Johnson, Stauffer, and Broida, 2004).

Then we used each file type with variable codecs for our experimentation (See Figure 2).

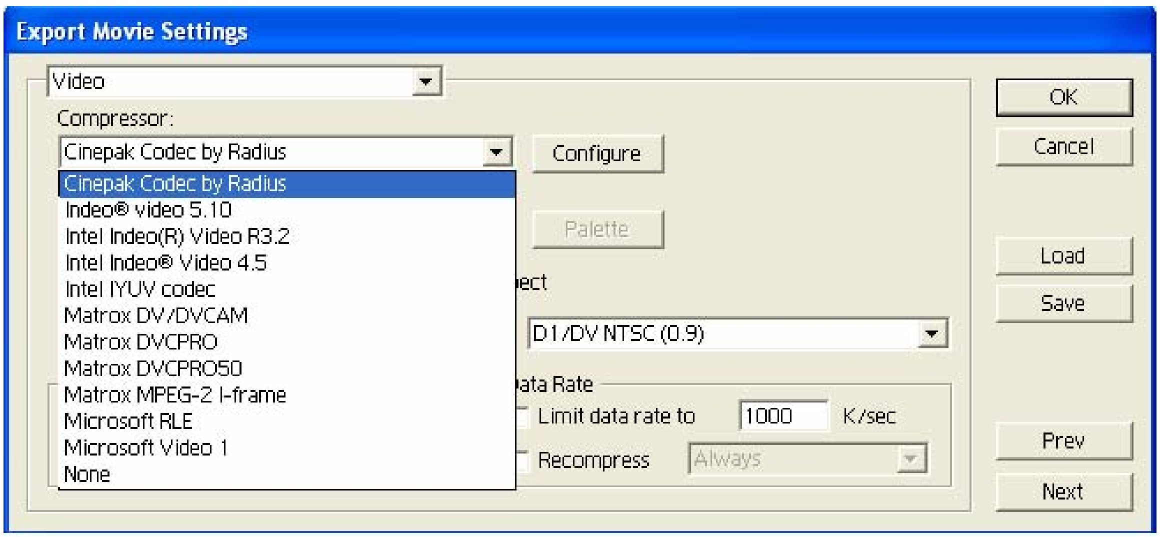


*Figure 2*. The Export Movie Setting for selecting a compressor in Adobe Premiere 6.0.

To use variable codecs, we used two different computers; one does not have a hardware capture board with Adobe Premiere Pro (See Table 1), the other has a hardware capture board, Matrox RT 2500 with Adobe Premiere 6.0 (See Table 2). We used the frame size, 720 * 480 as capturing frame size of original video for producing final video.

Finally, we investigated WMV and Real Media file formats (See Table 3) with different settings in Adobe Premiere Pro (See Figure 3) for comparing distribution over the WWW.

- WMV (Windows Media Video): WMV is Microsoft's highly compressed video format and it has a WMV file extension. WMV is one of the latest, but it quickly spreads across the WWW. An end-user might have to update new Windows Media Player to view a video.
- Real Media (RM): Real Media is a proprietary format owned by Real Networks. It has a RM file extension and is used for distributing video over the WWW. An end-user might have to install RealPlayer to view a video because it doesn't come installed with Windows.

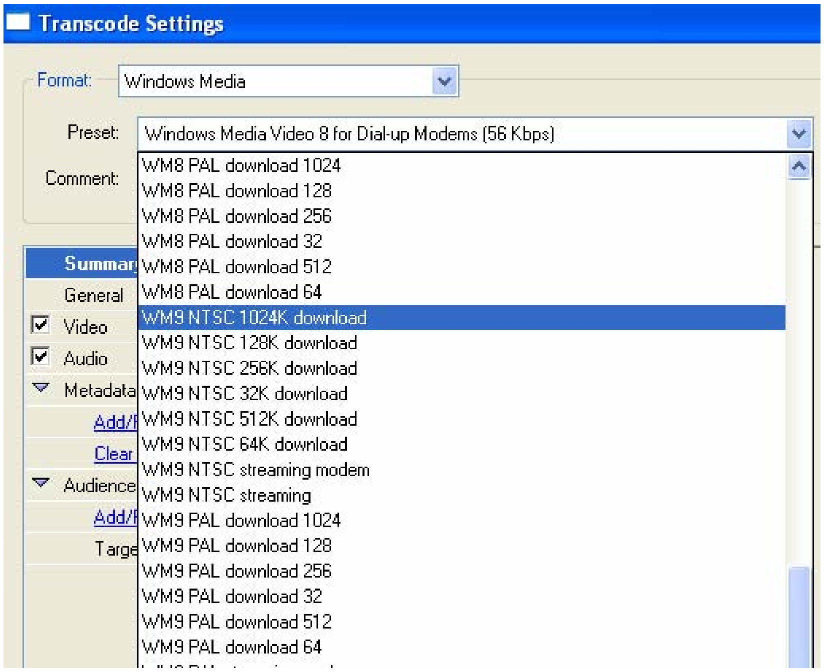


*Figure 3*. The Transcode Setting for selecting Preset in Adobe Premiere Pro.

Ratings

The measurements of the codecs with three factors, image quality, file size, and compatibility, were as below.

- Image Quality: To judge image quality is a very difficult task, so we decided to use the frame size, 720 * 480, to judge the video for Table 1 and 2. But for Table 3, we used the frame size, 320*240, to judge the image quality over the WWW. We used three ratings for measuring this factor, Excellent, Good, and Fair. The images below show how we judged the video.

- Excellent:

- Good (Video shows very few artifacts):

- Fair (Artifacts are noticeable at some frame, but watchable video):

- File size: We showed the file size in KB (Data storage capacity).
- Compatibility:
  - Yes (Watchable video with QuickTime Player 5.0.2, Real Media Player 9, or Windows Media Player 9.0)
  - No (Require to install additional software to decompress or purchase hardware)

**Result**

We provide three tables to summarize our investigation. Table 1 showed the results of using Adobe Premiere Pro without a hardware capture board. Table 2 showed the results of using Adobe Premiere 6.0 with a hardware capture board, Matrox RT 2500.

Table 1 *Compare codecs without a hardware capture board*

| | Compressor | Quality | | Size | Compatibility |
|---|---|---|---|---|---|
| QuickTime | Cinepak | Excellent | | 13,717 KB | Yes |
| | H.261 | Excellent | | 10,572 KB | Yes |
| | H.263 | Excellent | | 6,461 KB | Yes |
| | Sorenson Video | Excellent | | 17,299 KB | Yes |
| Microsoft AVI | Cinepak Codec by Radius | Excellent | | 14,982 KB | Yes |
| | Indeo Video 5.10 | Excellent | | 18,357 KB | Yes |
| | Indeo Video 4.5 | Excellent | | 20,236 KB | Yes |
| MPEG | MPEG-1 | Good | | 1,259 KB | Yes |
| | MPEG-1-VCD | Fair | | 915 KB | Yes |
| | MPEG2 | Excellent | Video | 3,743 KB | Yes |
| | | | Audio | 140 KB | |
| | MPEG2-DVD Video | Excellent | Video | 2,498 KB | Yes |
| | | | Audio | 958 KB | |
| | MPEG2-SVCD | Excellent | | 1,705 KB | Yes |

*Note:* The table did not include several codecs which had larger than original file size as below.
- QuickTime: Component Video, H.263, Intel Indeo Video 4.4 , Motion JPEG A, Motion JPEG B, MPEG-4 Video, Photo-JPEG, Planar RGB, PNG, Sorenson Video 3, and Video.
- AVI: Microsoft RLE and Microsoft Video 1.

Table 2 *Compare codecs with a hardware capture board, Matrox RT 2500*

| | Compressor | Quality | Size | Compatibility |
|---|---|---|---|---|
| QuickTime | Cinepak | Excellent | 13,668 KB | Yes |
| | H.261 | Excellent | 9,841 KB | Yes |
| | H.263 | Excellent | 6,107 KB | Yes |
| | Sorenson Video | Excellent | 15,216 KB | Yes |
| Microsoft AVI | Cinepak Codec by Radius | Excellent | 15,005 KB | Yes |
| | Indeo Video 5.10 | Excellent | 16,676 KB | Yes |
| | Matrox MPEG-2 I frame | Excellent | 13,439 KB | Yes |
| MPEG | LSX MPEG-1 | Excellent | 3,685 KB | Yes |
| | LSX MPEG-2 | Excellent | 3,747 KB | Yes |

*Note*: The table did not include several codecs which had larger than original file size as below.

- QuickTime: Animation, BMP, Component Video, DV NTSC, Graphic, Intel Indeo Video 4.4, Motion JPEG A, Motion JPEG B, Photo-JPEG, Planar RGB, PNG, TGA, TIFF, and Video.
- AVI: LEAD MCMP MJPEG, Microsoft RLE and Microsoft Video 1.

In addition, we investigated Window Media Video (WMV) and Real Media file types with different settings for comparing distribution over the Internet. Table 3 showed the results of using Adobe Premiere Pro without a hardware capture board.

Table 3 *WMV and QuickTime file formats with different settings in Adobe Premiere Pro.*

| | Preset | Compressor | Quality | Size | Compatibility |
|---|---|---|---|---|---|
| WMV | NTSC 64K download | WMV9 | Fair | 66 KB | Yes |
| | NTSC 256K download | WMV9 | Good | 152 KB | Yes |
| | NTSC 1024K download | WMV9 | Excellent | 800 KB | Yes |
| | NTSC Streaming Modem | WMV9 | Good | 448 KB | Yes |
| | NTSC Streaming Broadband | WMV9 | Excellent | 2,556 KB | Yes |
| Real Media | NTSC 64K download | RM9 | Fair | 60 KB | Yes |
| | NTSC 256K download | RM9 | Good | 149 KB | Yes |
| | NTSC 1024K download | RM9 | Excellent | 633 KB | Yes |
| | NTSC Streaming Modem | RM9 | Fair | 179 KB | Yes |
| | NTSC streaming Broadband | RM9 | Excellent | 1,477 KB | Yes |

## Conclusion

In general, we found that the bigger size files have less compression and the smaller size files have more compression. Also, the bigger size files have higher quality than small size files. The summary of the study is shown in the following list:

- H.263 codec was the best for QuickTime file format with a sufficiently decreased file size without noticeable loss of quality.
- Cinepak Codec by Radius for AVI file format slightly decreased file size without noticeable loss of quality. However, if presenters have a hardware capture board like Matrox RT 2500, Matrox MPEG-2 I frame codec would be an additional option for AVI file format.
- MPEG-2 codec of MPEG file format significantly decreased the file size without noticeable loss of quality. As for DVD-Rom usage, MPEG-2 was better because of its excellent quality even though its size was not decreased as MPEG-1.
- Several codecs, which had larger file size than the original file size, might require purchasing hardware or software for encoding video. We did not provide the information about those codecs.
- In general, both WMV9 and RM9 codecs for delivering video on the WWW reduced file size and yet remained good quality.

## References


*Adobe Premiere pro: Classroom in a book*, (2004). San Jose, CA: Adobe Systems Incorporated.

Buehler, T. (2003). Codec Comparison. Retrieved October 29, 2004 from http://graphics.csail.mit.edu/~tbuehler/video/codecs/index.html

Currier, B. (1995). Digital Video Codec Choices, Part 1. Retrieved October 29, 2004 from http://www.syntheticap.com/qt/codec1.html.

Jonassen, D. H. (2000) *Computers as mindtools for schools: Engaging critical thinking, 2nd ed.* Columbus, Ohio: Merrill Publishers.

Johnson, D., Stauffer, T. & Broida, R. (2004). *How to Do Everything with Your Digital Video Camcorder.* McGraw-Hii/Osborne.

# Using a concept map as a tool in vocabulary learning: a Web-based self-instruction program for Limited English Proficiency (LEP) students

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**Abstract**

*This paper introduces a Web-based self-instruction program that utilizes concept maps to teach vocabulary to Limited English Proficiency (LEP) students. Based on the assumption that concept maps are an effective method of organizing and introducing English vocabulary, this program is designed to assist students in conceptualizing and internalizing words. This instructional program consists of combinations of text, audio, graphics, animation, and video and can be accessed on the Web.*

## Introduction

Designing new learning tools using technologies can be a real challenge for teachers and instructional designers. Advanced computer technology helps educators to design learning environments that involve more complex interactions between learners and instructional content (Reiser, 2001). With computer technology, the Web has become a common choice in higher education institutions (Anderson, Bauer, & Speck, 2002). The various media, such as text, graphics, audio, and video for delivering content, has attracted many students to use the Internet for distance education (Ali, 2003).

Recently students who have limited English proficiency (LEP) are currently the fastest-growing population in public schools in the United States. According to Smith-Davis (2004),

> *Between the years 1991 and 1999, the number of language-minority school-aged children who are now living in the United States rose from 8 million to 15 million, and the number of K-12 students who are classified as being limited-English-proficient (LEP) increased from 5.3 million to 10 million students. Despite the fact that only eight languages-Spanish, Vietnamese, Hmong, Cantonese, Cambodian, Korean, Laotian, and Navajo-comprise 85% of linguistic diversity, 350 language groups are actually spoken in the school districts of the United States (p.21).*

Many of these LEP students suffer repeated failure in the classroom, fall behind in grade, and drop out of school if they are not provided services to overcome language barriers. Students who are not proficient in English sometimes inappropriately placed in special education classes. Also, because of their lack of English proficiency, qualified students often do not have access to high track courses of Gifted and Talented programs (U.S. Department of Education Office for Civil Rights).

It is suggested that concept maps be used in vocabulary learning to help both ESL (English as Second Language) teachers and LEP students. Concept maps are a good way to help teachers organize knowledge for instruction and a good way for students to find the key concepts and principles in lectures, readings, or other instructional material (Novak, 1998). Concept Maps are one of the visual organizers being explored as instructional and evaluation learning tools. This paper focuses on how apply concept maps as a tool in vocabulary learning on the Web.

### What is a concept map?

Concept mapping or concept maps, in general form, have a long history of being used to support teachers and learners to represent knowledge in graphics. In education, Novak (1977) designed a system of concept maps that has been widely applied in the evaluation of students' learning in the school system (Novak & Gowin, 1984). Novak's work was based on the constructivist theory of learning, which holds that the learner constructs his/her own knowledge. The term of a concept map often is used as a form of a Web diagram for representing a knowledge structure. In other words, concept maps are often used as a tool to help teachers and students to represent their knowledge graphically. A concept map, in general form, consists of nodes which represent concepts and links which represent the relationship between these concepts (See Figure 1).

Much research has found that concept maps are effective tools to evaluate students' learning. Novak (1991, 1998) and researchers mention some benefits of concept maps:

- Concept maps help teachers to organize and present knowledge for instruction and students to grasp the key concepts and principles in lectures, readings, or other instructional materials.

- Concept maps help students to be better at meaningful learning and to reduce the need of rote learning.
- Learners needed to construct their own maps and learn this method of organizing their own knowledge.
- Concept maps can be helpful to move the learner from mere representational meaning to richer conceptual meaning.
- Concept maps play a key role as a tool to represent knowledge held by a learner, and also the structure of knowledge in any subject matter domain.

There are a variety of maps, such as spider concept map, hierarchy concept map, flowchart concept map, and systems concept map. In this paper, hierarchy concept maps have been chosen to help LEP students' vocabulary learning.

**Concept maps as a tool in vocabulary learning**

According to Novak (1998) concept maps are visual organizers that promote can be used as instructional and evaluation learning tools to promote meaningful learning Through the visualization of subject matter in a format that illustrates the relationships between prior knowledge and new concepts, both the instruction and learner are able to organize and comprehend new concepts (vocabulary in this case) in an effective and efficient manner.

The acquisition of new English vocabulary, one of the important skills necessary for LEP students, frequently involves much representational learning, but the full conceptual meaning of technical vocabulary may take years, and for some students little more than representational meaning may be achieved. When definitions for vocabulary words are learned by rote, representational learning does not automatically advance to conceptual learning. However, representational learning may provide language labels that may serve to facilitate concept learning (Vygotsky, 1978; Novak, 1998). Unfortunately, much school learning that should be concept learning is little more than representational learning for many students. Students learn definitions for concepts, but they do not acquire the meanings for the concepts. For instance, many students learn that a "family" is any group of people who are related to each other, especially a "mother," "father," and their "children," but learners often cannot explain what that definition means in ways that make sense to them.

In this paper, the creation of a concept map to help LEP students' vocabulary learning (as shown in Figure 1) is suggested.

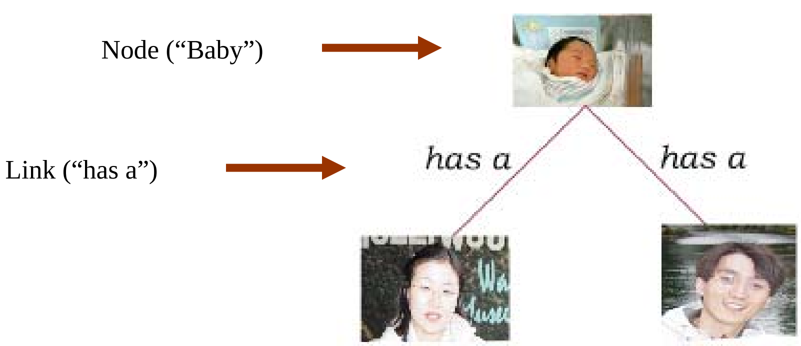


*Figure 1*. The structure of concept Maps

Instructional design model

The purpose of the paper is to introduce a Web-based self-instruction program that has been designed to teach English vocabulary using a concept map to LEP students in a way that helps them fully understand the vocabulary. Using a concept map, this self-instruction program is aimed at helping LEP students understand and learn vocabulary in the context the relationship between one word and another.

The use of visual text and graphics are some of the most popular tools in the Web-based learning. Graphics are able to represent important information and are often used for supporting text (Newby, Stepich, Lehman, & Russell, 1996). The most widely used asynchronous distance learning tool is that of online courses primarily posted in visual text and static graphics (Liles, 2004).

Hopkins and Bean (1999) suggested the verbal-visual word association strategy to help students move beyond the rote memorization of words and their definitions. In this study, one self-instructional module that teaches what the definition of "family" is for students with multimedia methodology is provided.

According to cognitive load theory (Sweller, 1999) and Mayer's idea of multimedia learning (Mayer, 2001), the "modality effect," "replacing visual text with spoken text," and the "cueing effect," "adding visual cues relating elements of a picture to the text," combine to enhance the effectiveness of multimedia instruction (Tabbers, Martens, & Merrienboer, 2004). In addition, some researchers have stated multimedia explanation that have "fewer rather than many extraneous pictures and words" is easier for students to understand (Mayer & Moreno, 2002). Mayer and his colleagues have conducted a decade's worth of research investigating the nature and effects of multimedia presentations on human learning.

The Web-based self-instruction program consists of combinations of text, audio, graphics, animation, and video on the Web. This multimedia presentation gets and holds students' interest; many educators believe this is essential when working with today's video generation (Jonassen, 2000).

The instruction in this program is made up of a lesson section (See Figure 2), practice session (See Figure 3, and quiz section (See Figure 4) by Macromedia Flash MX.

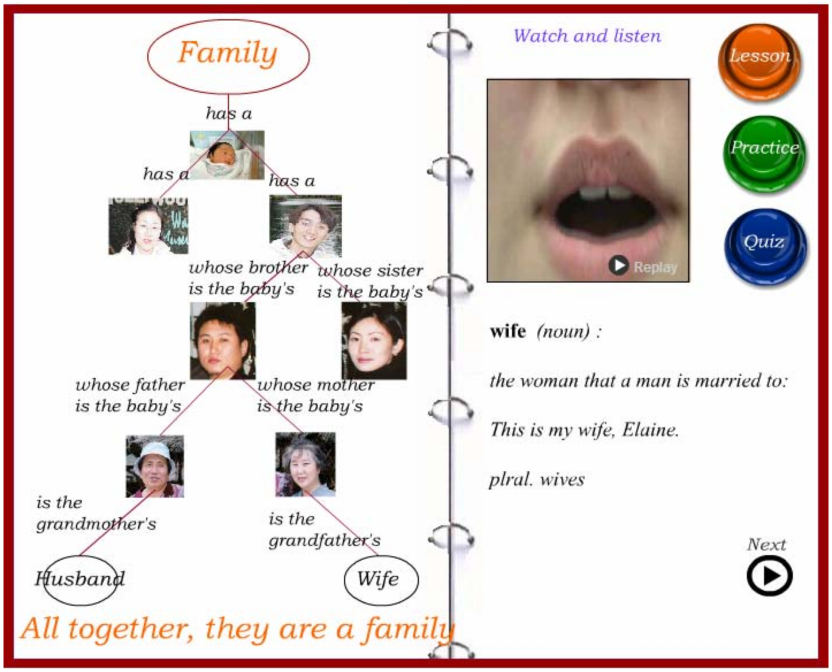


*Figure 2*. Illustration of frames of the lesson section

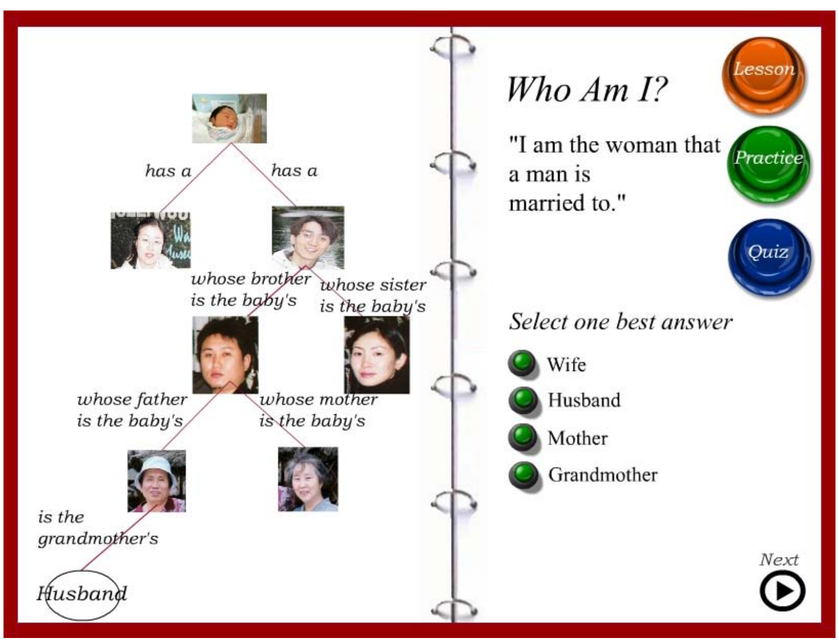


*Figure 3*. Illustration of frames of the practice section

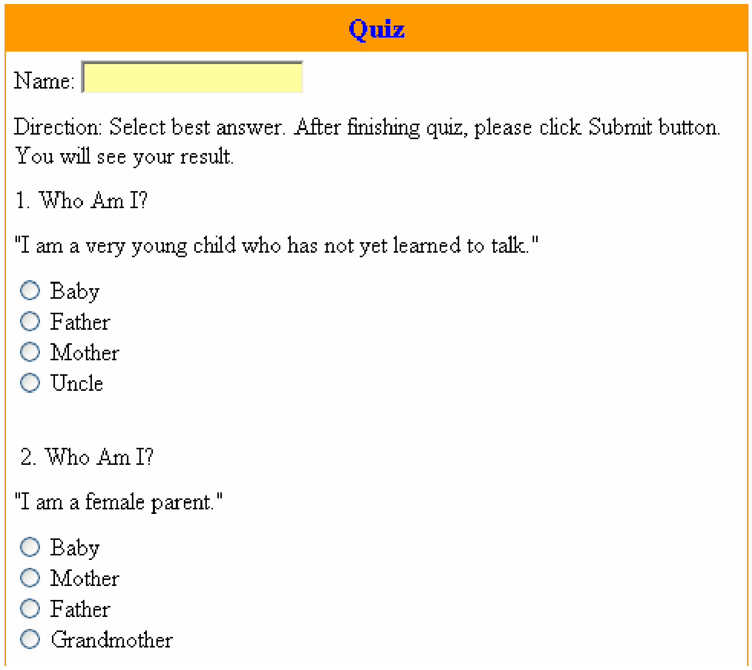


*Figure 4*. Illustration of frames of the quiz section

The lesson section consists of three frames as shown in Figure 5. First, the left frame shows how to build a concept map with words.

Presenting vocabulary using a concept Map

Demonstrating how to pronounce words with video clips

Illustrating what the words mean with visual text

*Figure 5*. The frames of the Web-based self-instruction program

Students will be able to see how to connect one node, which represents a word, to another node, which represents one other word, with a link. These visual maps will attract the learners' attention and make them focus on what they need to perceive and how they can organize and link their prior knowledge (old vocabulary) and the new knowledge (new vocabulary). Next, the right-top frame shows, via video clip, how to pronounce the words. Students will be able to watch and listen to this video. The video will demonstrate the correct movement of the mouth and lips in the pronunciation of the word. Finally, the bottom-right frame shows what the word means with text. Even though the definitions of words are given, the emphasis of this approach is not on rote learning.

The practice session is similar to the lesson session. It will help students to practice using their knowledge through the concept maps. The questions require students to recall their knowledge and to apply new information in mastery learning.

The final section, which contains quizzes, will help teachers to evaluate students' learning and prepare the next lesson for learners.

An example of the entire program can be found at http://teacherportfolio.indstate.edu/daesang/ConceptMap.html.

## Conclusion

This Web-based self-instruction program will aid LEP students acquire English vocabulary in a meaningful and relevant manner. Through the use of this program, which utilizes concept maps and includes three sessions, the instructor is able to organize vocabulary in a meaningful way, and learners can easily see the relationships between words, connect prior knowledge to new vocabulary, and grasp a deeper understanding of the vocabulary in a conceptual context. This is turn can lead students to retain the vocabulary in a meaningful manner and not simply "memorize" words out of context. It is also hoped that the multimedia, self-instructional format of this program will attract the attention of students and motivate them to acquire the targeted vocabulary.

## References


Ali, A. (2003). *Instructional design and online instruction: Practices and perception*. TechTrends, Washington, 47(5), 42.

Anderson, R., Bauer, J., & Speck, W. B. (2002). *Assessment Strategies for the Online Class: From Theory to Practice*, New Directions for Teaching and Learning, Number 91, Jossey Bass, San Francisco.

Hopkins, G., & Bean, T. (1999). Vocabulary learning with the verbal-visual word association strategy in a Native American community. *Journal of Adolescent & Adult Literacy, 42*, 274.

Jonassen, H. D. (2000). *Computers as Mindtools for Schools: Engaging Critical Thinking*. Upper Saddle River, New Jersey: Pearson Education, Inc.

Liles, B. (2004). Going the Distance. *Sound & Video Contractor*. Overland Park. 22(3), 48.

Mayer, R. & Moreno, R. (2002). Aids to computer-based multimedia learning. *Learning and Instruction*, 12. 107-119.

Mayer, R. E. (2001). *Multimedia learning*. Cambridge, UK: Cambridge University Press.

Newby, J., Stepich, A., Lehman, D. & Russell, D. (1996). *Instructional technology for teaching and learning: Designing instruction, integrating computers, and using media.* Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

Novak, J.D. (1977). *A Theory of Education*. Ithaca, Illinois: Cornell University Press.

Novak, J.D., & Gowin, D.B. (1984). *Learning How to Learn*. New York: Cambridge University Press.

Novak, J. D. (1998). *Learning, creating, and using knowledge: Concept maps as facilitative tools in schools and corporations.* New Jersey: Lawrence Erlbaum Associates.

Reiser, A. R. (2001). A history of instructional design and technology: Part I: A history of instructional media, Educational Technology. *Research and Development, 49*, 53.

Smith-Davis, J. (2004). The New Immigrant Students Need More than ESL. *The Education Digest. 69*, 21.

Sweller, J. (1999). *Instruction design in technical areas*. Camberwell, Australia: ACER.

Tabbers, K. H., Martens, L. R., & Merrienboer, J. J. (2004). Multimedia instructions and cognitive load theory: Effects of modality and cueing. *British Journal of Educational Psychology*. 74(1). 71-82.

U.S. Department of Education Office for Civil Rights. (n.d). Retrieved March 1, 2005 from http://www.ed.gov/about/offices/list/ocr/qa-ell.html

Vygotsky, L. S**.** (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

# The Constraints and Possibilities of Working Memory in the Design of Learner-centered Web-delivered Learning Environment

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**Abstract**

*In this paper, we examine the findings of working memory toward the design of web-based learning environments. The rapid growth of web-based learning environments has raised various questions about the design of learner-centered environments. The key to developing effective learner-centered environments is to have a clear understanding of how learners' minds work. In particular, information processing theory can help designers support learners when they process information from instructional materials. At the center of information processing theory are memory models, especially, working memory. In this paper we will pursue a learner-centered approach by using guidelines based on the instructional approach of working memory theory.*

## Introduction

The rapid growth of web-based learning environments has raised various questions about the design of learner-centered environments. The key to developing effective learner-centered environments is to have a clear understanding of how learners' minds work. Though constructivism has in recent years been examined for its implications for the design of online learning environments, earlier theories still have much to offer to designers. In particular, information processing theory can help designers support learners when they perceive, store, and retrieve information from instructional materials (Gillani, 2003). The areas of information processing in cognitive theory are important to multimedia design (Alessi & Trollip, 2001; Moreno & Mayer, 1999).

Information processing theory has, through the years, offered many insights into the design of web-based instruction. At the center of information processing theory are memory models, particularly working and long-term memory. The learners encode and retrieve information and they are confronted with various problems, such as the complexity of the information structure, cognitive overload in terms of infinite information, and designs that fail to consider individual differences. Instructional design guidelines based on the information processing theory should inform the design of web-based instruction. In web-based learning environments, learners are required to engage in challenging cognitive activities, including controlling, shifting, updating, retrieving, and inhibiting what they see on the screen. These functions mainly occur in a working memory, where the major cognitive activities take place (Miyake et al., 2000). Working memory mechanisms have fundamental features responsible for cognitive processing in general (Richardson, 1996) and are a main issue of instructional design guidelines in information processing.

### Working Memory Model

From the perspective of information-processing, learning involves the processes for encoding, storage, and retrieval activities of information within the human cognitive system (Flavell, Miller, & Miller, 2002). Over the past few decades, researchers have examined the psychological research on memory processes based on a widely used information-processing model (Flavell et al., 2002). A human information-processing model represented as sensory register, short-term memory, and long-term memory was originally proposed by Atkinson and Shiffrin (Atkinson & Shiffrin, 1968). Also they postulated that the short-term store could be regarded as a "working memory" which transfers information from the sensory register and the long-term store (p. 90, 92). The information processing begins when the sensory register receives the stimulus from the environment; then the sensory register transfers information to working memory (Schunk, 2003), a system of limited capacity (Emilien et al., 2004; Flavell et al., 2002). While information is staying in working memory for periods of 10 to 20 seconds, related knowledge in long-term memory is activated and integrated with the new information staying in working memory (Schunk, 2003).

Schunk (2003) suggests that short-term memory is working memory and corresponds almost to awareness. Alternately, even though two terms of short-term memory and working memory are typically used together, the recent researchers postulate that differences exist between them (Emilien et al., 2004; Kail & Hall, 2001; Schunk, 2003). Short-term memory and working memory are both central constructs in modern theories of memory and cognition. Short-term memory refers to information in long-term memory that is activated above some threshold (Cowan, 1988, 1995). Short-term memory tasks generally require the preservation or sequential order information, whereas working memory includes short-term memory as well as the attentional processes used to keep some short-term memory contents in an activated state (Emilien et al., 2004). Thus, it might be suggested that short-term memory can be thought of as subcomponent of working memory (Kail & Hall, 2001). Working memory is responsible for active information processing rather than strictly passive short-term maintenance of information (Bruning, 2004).

There are several structural features to represent the working memory. Baddeley (1986) defined "the general concept of working memory" in that "the temporary storage of information that is being processed in any of a rage of cognitive task" (p. 34). Also, working memory involves "the temporary storage and manipulation of information that is assumed to be necessary for a wide range of complex cognitive activities" and plays a more important role than short-term memory in higher order cognitive processes (Kail & Hall, 2001). A number of features of models appear in the contemporary literature on working memory: a dynamic system (Baddeley & Hitch, 1974) and a unitary system (Engle, Tuholsky, Laughlin, & Conway, 1999) or as multiple subsystems each with a different capacity and function (Baddeley & Hitch, 1974). Unlike the traditional working memory described as a gateway between sensory input and long-term memory (Baddeley, 1996), another approach proposes that working memory operates as a working space (Emilien et al., 2004)

Several significant working memory models such as Baddeley and Hitch's model are still elaborated by psychological, neuropsychological and neuro-imaging evidence. In the early years of the model by Baddeley and Hitch (1974), the working memory model consists of three components: an articulatory loop, holding speech-like representations, a visuo-spatial scratch pad, holding imaginal representations and a central executive, which acts as an overseer directing attention and coordinating the activities of the other components. Figure 1 presents a schematic diagram including Baddeley's working memory model. In the current modified model of working memory, the fourth component, the episodic buffer, is proposed. The episodic memory is a limited capacity system depending on executive processing attempts to provide a temporary interface between the three components and long-term memory, and integrates information form a variety of sources of the subsidiary system into chunks or episodes (Baddeley, 2000).

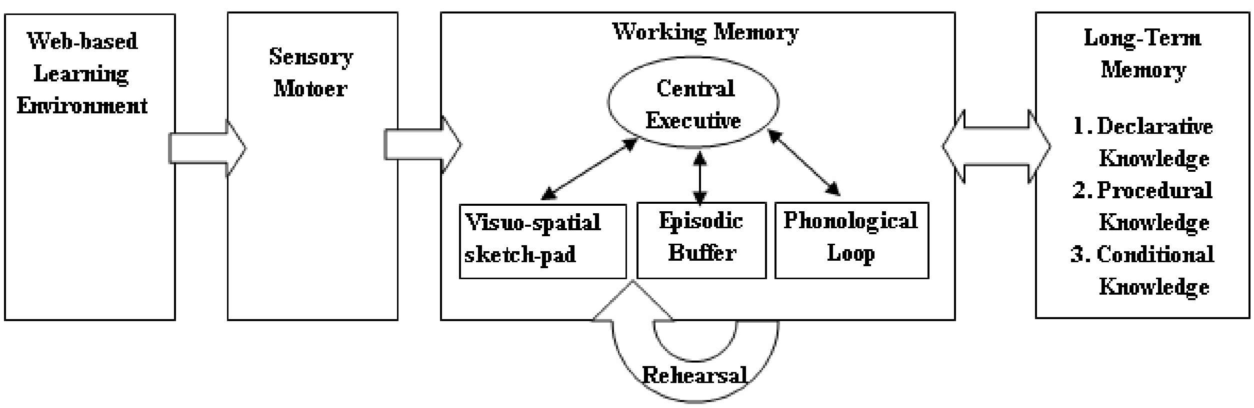


Figure 1. A cognitive model of web-based learning

The current research of working memory is focused on the significant theoretical perspective on executive functions, called the central executive, postulated by Baddeley and Hitch (1974). With regard to the functions of the central executive, research on working memory has been carried out. Executive functioning has to be considered as people's executive function plays a role of allocating memories and conditions in a memory system. The executive function in working memory is thought to control and regulate the flow of information in a working memory system (Baddley, 2000). The central executive, the core of the working memory model, is assumed to be an attentional control system responsible for strategy selection and for control and coordination of the various processes in short-term storage and more general processing tasks (Emilien et al., 2004). That means the central executive plays a role as an overseer directing attention and components: visuo-spatial scratch pad, articulatory loop, episodic buffer.

**Working Memory Constraints**

The cognitive load theory based on the limited capacities of working memory, is being used to facilitate learning using various multimedia. However, this paper's focus is more on the results of cognitive research related to the working memory model and the sub-components toward the design of web-based learning environments.

All theories of working memory assume its limitation in the extent to which working memory is able to hold and process information (Logan, 2004; Stoltzfus, Hasher, & Zacks, 1996). The number, of items that can be recalled perfectly in order, is three to seven, depending on the nature of items (Logan, 2004). According to the present theoretical framework, the working memory capacity limit is actually a limit in the capacity of the focus of attention at any one moment (Cowan, 2002). Working memory is supported by a limited-capacity processing resource that can be allocated to consistently meet the processing and storage demands of cognitive activities (Gathercole, 1999). Thus, when a task is encountered which exceeds processing and storage demands, there will be a trade-off between processing and storage activities. Even though there are many experiments to find out evidence for the trade-off, evidence did not strongly support the trade-offs between processing and storage (Logan, 2004). With respect to working memory, there are various investigations in aspects of working memory including storage capacity, amount of available activation, processing capacity, and ability to allocate resources to both processing and storage components (Gathercole, 1999; Stoltzfus et al., 1996).

With regard to the constraints of the working memory, people have limited capacity. Furthermore, the short duration of piece of information within this state is typically less than one second (Farquhar & Surry, 1995) if people do not pay attention to it. Even if there are constraints in the working memory, working memory is considered as working synergistically with long-term memory, playing a primary role in control and regulation function (Cowan, 1999).

**The Cognitive Design of Web-based Learning Environment**

The findings of information processing research inform us about the possibilities imposed by the properties of the learner's information processing system. In particular, it is focused upon the features of each component in the working memory and the improvement of the instructional design for learner-centered learning in web-based environments. Web-based learning environments should actively employ information processing theories because they can describe and prescribe student performance during learning. These instructional guidelines based on working memory model and the research findings are as the follows:

**Chunk and simplify the instructional message as much as possible**.

Sometimes, we can encounter web-based learning consisting of complex structure, long context and pictures in one screen. However research has indicated that it is necessary to make the message simple and easy to understand (Farquhar & Surry, 1995). Moreover, instructions involving diagrams and text should be restructured into physically integrated formats with as small a number of units as possible because it needs to be mentally integrated to be understood (Sweller & Chandler, 1994; Mayer & Gallini, 1990; Kalyuga, Chandler & Sweller, 1999). Also, learning was enhanced by the elimination of textual material describing the contents of a geometric diagram (Tardieu & Gyselinck, 2002).

Working memory plays an important role in the higher level cognition such as comprehending a text, solving a problem and reasoning while processing new information (Tardieu & Gyselinck, 2002). Especially in problem solving, chunking (or decomposing) information, or processing it is one of the effective cognitive strategies. Web-based learning is often developed to improve student's problem solving skills in specific domain. Learners in problem solving will encounter multiple kinds of information to find a solution. To solve problem, the learner will use various cognitive strategies, such as organizing or comparing the information. Also, in the complex problem solving, learner needs to decompose the problem and analyze the sub-problems and constraints. These strategies to solve sub problems occur in the working memory (Sweller et al., 1998).

**Present instructional materials on the web through multiple representations**

Many web-based instruction design still seems to be determined by the designer's aesthetic consideration rather than by first using cognitive learning theories to represent multimedia objects. Even though the use of multimedia can be effective instructional format for developing web-based instruction, it is obvious that, if the learner's discernible principles will be basis of the instruction design, it will fail to effectively increase learner's working memory capacity during the instruction.

There are several significant results of research related to the relationship or effect of working memory capacity and multiple representations. The materials of web-based learning are basically developed using different types of media, such as video, sound, text, picture, diagram and so on. The materials need to be multiple representations and also to correspond between text and pictures (Mayer & Moreno, 1999) because working memory has separate subsystems—such as the visuo-special sketchpad and phonological loop (Baddely, 2002)—and can perform the processes of text, pictures, and sound in parallel (Tardieu & Gyselinck, 2002). Thus, if these components mentally integrate the information, the working memory processes the information effectively. According to Mousavi, Low, and Sweller (1995), the presentation of the instructional material using a mixed visual-auditory mode systematically leads to a reduction in the learner's acquisition time, problem-solving time, and number of errors. Using multimedia materials, both the visual and auditory modalities can improve the independent capacities of the verbal and visuo-spatial working memory components, effectively increasing working memory capacity. Also, Kalyuga et al., (1999) suggested that audio-visual presentation is only effective when each modality presents differing information that can be combined to assist learning, rather than the audio text duplicating the visual text, because the duplication of information is superfluous and places and additional load on working memory using the audio and visual format in computer-based multimedia instruction. Also, they suggested that when dealing with split-source diagrams and text, text should be presented in auditory rather than written form, text should not be presented in both auditory and written form, and in text written form search for diagrammatic referents should be reduced by using appropriate markers or guides.

**Develop structure that will easily iterate the learning process.**

The web-based learning environment needs to be structured to help the iteration of the learning process. It is possible to support different strategies for the iterative learning activities. Repeating information to transmit it from working memory to long-term memory is a process as a known as rehearsal, which provides a means for saving information from the forgetting processes of decay and interference (Ormrod, 1999). The capacity of working memory has limits from pieces of information before capacity is reached and from the short duration within one second a piece of information can remain without constant and quick rehearsal. Gathercole (1999) postulated that a large component of the age-related change in memory span in closely liked to increases in the rate of sub-vocal articulation. Increased rehearsal rates lead to better prevention of decay of temporary memory traces, and hence to greater memory span. However, the sub-vocal articulation is more effective older children over about seven years of age and adults (Rosser, 1994; Gathercole, 1999).

**Attract students' attention in the web-based instruction.**

In web-based learning, learners meet with various representations, functioning by using media and the latest technology. During the information processing in terms of learner, Farquhar and Surry (1995) posed that students encounter various mental events filling up the working memory state, including learning events and non-learning events. One of the most important roles of working memory is transmitting new knowledge or events into prior knowledge. To effectively transmit the events during the working memory, high cognitive engagement needs to be present between the working memory state and the long-term memory state. Commonly, to reduce the impositions of non-learning events that are not directly associated with the learning process, it is crucial to gain the attention of the learner. The attention can be gained and held by changing stimuli and appealing to the learner's interests.

The role of attention affects the entire process of information processing, such as, to move sensory information from the sensory memory into working memory or to move information from working memory into long-term memory. One of the experiments related to the role of attention in moving information from working memory to long-term memory, Conway and Engle (1994), reported that the relationship between retrieval and working memory is an individual difference in working memory capacity that reflects differences in attentional resources. Limited-capacity controlled attention will play a role in the tasks. This is consistent with the findings of Baddeley (1986) about a central executive as being a general attentional system. Conway and Engle (1994) also postulated that the general attentional system is important to the inhibition of superfluous information as well as for the activation and maintenance of information relevant to the task.

Ormrod (1999) mentioned factors affecting what people pay attention to and what they store in working memory as: size, where attention tends to be drawn to large objects; intensity, where more intense stimuli attract attention; novelty, where attention is given to stimuli that are novel or unusual; incongruity, where objects that are incongruous are noticed; emotion, where stimuli with strong emotional associations capture attention; and personal significance, where people tend to pay attention to stimuli in terms of their personal importance.

**Elaborate on examples to draw consequences for practice.**

In a Stark, Mandl, Gruber, and Renkl (2002) study, the authors recommended the form of incomplete examples that should be supported by additional explications. Generally learners profit from these kinds of examples if they elaborate them and induce schemata relevant for problem solving. As the authors discussed, example elaboration decreases cognitive interference and overload as well as causing a positive effect to the student's learning behavior. Stark et al. (2002) reported that elaboration training focusing on aspects of cognitive elaboration enhanced the quality of example elaboration and thereby significantly improved learning outcomes. Also they concluded that if the instructional goal is to maximize learning success, then a stronger support of meta-cognitive example elaboration should be taken into consideration.

**Be consistent with components in the learning environments**

A basic cognitive skill is to automatically use the brain's limited resources effectively (Bruning, 2004). If learner can perform automated process during cognitive task, it requires very little attentional capacity in working memory. The automaticity requires that repeated practice during activity. Therefore, to design the web-based learning environment, it is necessary to be consistent with each component and required activity.

**Consider individual differences in working memory capacity**

One interesting model related to working memory is the activated portion of long-term memory (Anderson, 1983; Cowan, 1988). Conway and Engle (1994) suggested that working memory capacity and the amount of activation available to long-term memory are equivalent, though there are differences among individuals about the level of activation. Moreover, "capacity or activation was argued to change very little with changes in knowledge structure" (p. 355). Therefore individual knowledge can increase in the amount of information that learner can store and recall. However, a relatively small number of links at each level of the hierarchy is shown in individual retrieval. That means individuals show retrieval differences, even if learners have the high working memory span. In other words, each learner has a different amount of activation available to long-term memory. Conway and Engle (1994) concluded that the knowledge units represented in the working memory (as the activated portion of long-term memory) would be affected not only by attention, the ability to keep information active, but also by the ability to prevent irrelevant and competing information from interfering with working memory.

In the aspect of individual difference, it is necessary to understand age-related development of working memory. The understanding of target audience's cognitive capacity in a web-based learning environment is also important. According to the research (Kirschner, 2002), aging may decrease working memory's capacity, executive function, processing speed, and learner's ability to inhibit irrelevant or distracting information. The decline of working memory impedes the acquisition of complex skills in the following ways (Van Gerven et al., 2002). First due to a reduction of the working-memory capacity, less information elements can be processed, second, the overall processing speed decreases, and a third decline concerns the ability to inhibit irrelevant or distracting information. The age-related decrease of working memory implies to instructional design for web-based learning environment that web-based instruction should be carefully designed in an effective way toward the complex information depending on the age of target subjects.

## Conclusion

Web-based learning environments have become a popular learning delivery system for many learners. As mentioned above, when the learning environment is developed, the process of design must focus on the learner's cognitive characteristics. The effectiveness of learner's performance can be enhanced by considering the implications of cognitive theory. The working memory model is still work in progress. Researchers elaborate model in terms of adding new components and examining the characteristics of each component—in the working memory model and the relationship between learning activities and working memory features. However, studies that examine the effectiveness of working memory components for designing web-based learning environment and guide the design are lacking in the educational technology literature. Educators can better develop effective instruction using working memory research. Continuing research will focus on analyzing the results of instructional research of memory to improve our understanding of learning processes during attending web-based learning.

## References


Alessi, S. M., & Trollip, S. R. (2001). *Multimedia for learning: Methods and development.* Boston, MA: Allyn & Bacon.

Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In K. W. Spence & J. T. Spence (Eds.), *The Psychology of Learning and Motivation* (Vol. 2, pp. 89-105). New York: Academic Press.

Anderson, J. R. (1983). *The Architecture of cognition*. Cambridge, MA: Harvard University Press.

Baddeley, A. D. (1986). *Working memory*. New York: Oxford University Press.

Baddeley, A. D. (1996). Exploring the central executive. *The Quarterly Journal of Experimental Psychology, 49A*(1), 5-28.

Baddeley, A. D. (1996). The fractionation of working memory. *Proceedings of the National Academy of Sciences, USA*, *93*, 13468-13472.
Baddeley, A. D. (2000). The episodic buffer: A new component of working memory? *Trends in Cognitive Sciences*, *4*, 417-423.
Baddeley, A. D., & Hitch, G. J. (1974). Working memory. In G. A. Bower (Ed.), *The Psychology of Learning and Motivation* (Vol. 8, pp. 47-88). New York: Academic Press.
Bruning, R. H., Schraw, G. J., Norby, M., & Ronning, R. R. (2004). *Cognitive psychology and instruction* (4th ed.). Englewood Cliffs, NJ: Prentice Hall.
Conway, A. R. A., & Engle, R. W. (1994). Working memory and retrieval: A resource-dependent inhibition model. *Journal of Experimental Psychology: General*, *123*(4), 354-373.
Cowan, N. (1988) Evolving conceptions of memory storage, selective attention, and their mutual constraints with in the human information processing system*.* *Psychological Bulletin*, *104*, 163-191.
Cowan, N. (1995). *Attention and memory: An integrated framework*. London: Oxford University Press.
Cowan, N. (1999). An embedded-processes model of working memory. In Miyake, A. & Shah, P. (Eds.), *Models of working memory: Mechanisms of active maintenance and executive control* (pp. 62-101). Cambridge University Press, Cambridge.
Cowan, N. (2002). Childhood development of working memory: An examination of two basic parameters. In P. Graf & N. Ohta (Eds.), *Lifespan Development of Human Memory* (pp. 39-57). Cambridge, Massachusetts: A Badford Book.
Emilien, G., Durlach, C., Antoniadis, E., Van der Linden, M., & Maloteaux, J.M. (2004). *Memory*. Neuropsychological, imaging and psychopharmacological perspectives. Hove and New York: Psychology Press
Engle. R. W., Thjolski, S. W., Laughlin, J. E., & Conway, A. R. A. (1999). Working memory, short-term memory, and general fluid intelligence: A latent-variable approach. *Journal of Experimental Psychology: General*, *128*(3), 309-331.
Farquhar, J. D. & Surry, D. W. (1995). Reducing impositions on working memory through instructional strategies. *Performance and Instruction*, *34*(8), 4-7.
Flavell, J. H., Miller, P. H., & Miller, S. A. (2002). *Cognitive development* (4th ed.). Englewood Cliffs, NJ: Prentice Hall.
Gathercole, S. E. (1999). Cognitive approaches to the development of short-term memory. *Trends in Cognitive Sciences*, *3*(11), 410-418.
Gilliani, B. B. (2003). *Learning theories and the design of e-learning environments*. Lanham, Maryland: University Press of America.
Kail, R., & Hall, L. K. (2001). Distinguishing short-term memory from working memory. *Memory & Cognition*, *29*(1), 1-9.
Kalyuga, S., Chandler, P. & Sweller, J. (1999). Managing split-attention and redundancy in multimedia instruction. *Applied Cognitive Psychology*, *13*, 351-371.
Kirschner, P. A. (2002). Cognitive load theory: implications of cognitive load theory on the design of learning. *Learning and Instruction*, *12*, 1-10.
Logan, G. D. (2004). Working memory, task switching, and executive control in the task span procedure. *Journal of Experimental Psychology*, *133*(2), 218-236.
Mayer, R. E. & Gallini, J. K. (1990) When is an illustration worth ten thousand words? *Journal of Educational Psychology*, *82*(6), 715-726.
Mayer, R. E., & Moreno, R. (1999). Instructional technology. In F. Durso (Ed.), *Handbook of applied cognition*. Chichester, England: Wiley.
Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" task: A latent variable analysis. *Cognitive Psychology, 41*, 49-100.
Moreno, R., & Mayer, R. E. (1999). Cognitive principles of multimedia learning: The role of modality and contiguity. *Journal of Educational Psychology*, *91*, 358-368.
Mousavi, S., Low, R., & Sweller, J. (1995). Reducing cognitive load by mixing auditory and visual presentation modes. *Journal of Educational Psychology, 87,* 319-334.
Ormrod, J. E. (1999). *Human learning* (3rd ed.). Columbus, Ohio: Prentice Hall.
Richardson, J. T. E. (1996). Evolving issues in working memory. In J. T. E. Richardson, R. Engle, L. Hasher, R. Logie, E. Stoltzfus, & R. Zacks (Eds.), *Working memory and human cognition* (pp. 120-154). New York: Oxford University Press.

Rosser, R. (1994). *Cognitive development: Psychological and biological perspectives*. Boston: Allyn & Bacon.

Stark, R., Mandl, H., Gruber, H., & Renkl, A. (2002). Conditions and effects of example generation. *Learning and Instruction*, *12*, 39-60.

Schunk, D. H. (2003). *Learning theories: An educational perspective* (4th ed.). NJ: Prentice Hall.

Stoltzfus, E. R., Hasher, L., & Zacks, R. T. (1996).Working memory and aging: Current status of the inhibitory view. In J.R. Richardson (Ed.), *Working memory and cognition* (pp. 66–88). New York: Oxford University Press.

Sweller, J. (1998). Cognitive architecture and instructional design, *Educational Psychology Review*, *10*, 251-96.

Sweller, J. & Chandler, P. (1994). Why some material is difficult to learn. *Cognition and Instruction*, *12*(4), 185-233.

Tardieu, H., & Gyselinck, V. (2002). Working memory constraints in the integration and comprehension of information in a multimedia context. In H. Van Oostendorp (Ed.), *Cognition in a digital world* (pp. 3-24). Mahwah, NJ: Erlbaum.

Van Gerven, P. W. M., Paas, F. G. W. C., Van Merrienboer, J. J. G., & Schmidt, H. G. (2002). Cognitive load theory and aging: Effects of worked examples on training efficiency. *Learning and Instruction*, *12*(1), 87-105.

# What Students do when Chat, Email and Discussion Forum are Available at the Same Time?

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### Introduction and Purposes of the Study

There is one important component in distance graduate courses, especially social science courses: students (and instructor) discourses in forms of individual postings or group discussion. There have been quite some studies focused on discourses in distance courses. Most of them focus on pedagogical or social issues (e.g. Fahy, 2002; Garrison, Anderson & Archer, 2001; Hara, Bonk & Angeli, 2000; Henri, 1992; Zhu, 1996). Few studies explore media usage in detail. In addition, the mode of communication studied is often predetermined and of a single type. Even researches on computer mediate communication often emphasize on 'holding the CMC mode constant, while varying the purpose of communication within that mode' (Herring & Nix, 1997). One characteristic of this research is to hold the purpose of the communication constant—a team project in distance education courses, while varying the mode of communication—email, chat and discussion forum. This study thus explores situations when multiple computer-mediated communication modes are available and when students have freedom to choose modes as they see appropriate. The author starts from reading and interpreting students discourse and then looks for general patterns of usage under different mode of communication chosen by students. Through these efforts, the author aims to not only understand the diversity and focus of students activities as expressed and shown from discourses, but also interprets the choice and usage of communication media.

### Research Question

The author aims to answer the following questions: When students use which kind of communication mode to perform what kind of activities when multiple modes of communication are available to them at the same time?

### Theoretical framework

Author of this study takes the perspective of a distance educator but mainly applies the theory of speech act analysis as the analytical tool. Due to this interdisciplinary effort, there are multiple theories that contribute to this study.

First, in terms of analytical tools and research methodologies, this study refers to speech act theory mainly used in Discourse Analysis. Early in 1962, Austin introduced the concept of performative verbs and pointed out that words can DO things. In his book How to Do Thing With Words, he listed five types of perfomative verbs: verdictives, exercitives, commissives, behabitives, and expositives. Philosopher of language, Searl (1969) expands and criticizes work of Austin. More recently there have been taxonomies such as that of Francis and Hunston (1992). Herring (1996) studied two distribution lists and the gender differences in terms of speech acts. Herring & Nix (1997) studied IRC chat. They adopted Francis and Hunston (1992)'s category. This study is more influenced by Fraser's taxonomy as introduced in McLaughlin (1984). Fraser emphasized illocutionary act—which is intention of the speaker. He assigned performative verbs into eight categories: asserting, evaluating, reflecting speaker attitude, stipulating, exercising of authority and committing. Compared to other categories, Fraser's taxonomy is more suitable for analyzing argumentative discourse, whose style is closer to that of the academic discussion in education setting.

Also related to discourse analysis but in the field of education, studies that this study refers to are researches on classroom discourse. However, these studies are predominantly on student-instructor interaction instead of student-student interaction, which is the case in this study. A very influential study in classroom discourse was done by Sinclair and Coulthard (1975). The basic pattern of IRF (Initiation-Response-Follow-up) has been adopted by many other researchers to study classroom discourse.

Second, in terms of the pedagogical and social issues, knowledge building is considered as critical to learning and is much related to this study. In MacKinnon's (2000) study, he applied taxonomy of discourse to students' online discussion as the basis of grading student performance. He assigned higher scores to categories of postings that are considered showing higher order critical thinking skills such as compare, contrast, idea to example, example to idea, clarification, elaboration and lower scores to messages considered of relatively lower order thinking skills such as only acknowledging or asking question. There are also other studies focused on a variety of issues such as cooperative learning (Harasim, Calvert, & Groeneboer,1997), social presence and cognitive presence (Garrison, Anderson & Archer, 1999), etc.

## Methodology

### The Data and Sample

The data come from archived student team communication in a graduate level distance course. A course management system is used. This system provides discussion forum, chat, and course email. Students have freedom to choose any or all of the communication modes. All three types of communication are archived. In order to help students understand theories, a series of problem-based team assignments were given. Students formed into small groups of 3 or 4 to solve these problems or fulfill the task together. Two of the teams were chosen for the purpose of this research. Both use all three types of communication modes. Both teams get grade A for the project. The following table shows the detailed information of the two teams chosen:

| | | **Blue Team** | **Green Team** |
|---|---|---|---|
| ***Email*** | #Messages | 19 | 34 |
| | #Words | 1539 | 3372 |
| | #Speech-act Unit | 119 | 258 |
| ***Chat*** | #Messages | 75 | 526 |
| | #Words | 852 | 9728 |
| | #Speech-act Unit | 123 | 863 |
| | # Times | 1 time (37 minutes) | 4 times (1 h 34 min, 1 h 40 min, 1 h 11 min, 1 h 21 min) |
| ***Forum*** | #Messages | 68 | 15 |
| | #Words | 6237 | 2749 |
| | #Speech-act Unit | 408 | 149 |
| **Total words** | | 8628 | 15849 |
| **Task** | | Debate the validity of an instructional theory. The team together carries out a debate on the pros and cons of the theory and should finally synthesize the conclusions of the debate. | To think of an instructional goal that has, in the learner's experience, been particularly difficult for learners to grasp. The group together suggests how to use principles of meaningful learning help design effective instruction for this situation. |

Table1: Team Information

### Data Collection

The data were collected by another researcher in from a distance education course. Students' informed consent was given allowing another researcher to make use of the data. All data are sanitized.

### Data Analysis

There are three analytical devices. The first one is a simple time stamp analysis. The major analysis uses speech act analysis and general themes analysis.

*Time Stamp Analysis*: Time stamps are available for each mode of communication archived. Phases of discussion will be graphed to look for possible patterns.

*Speech Acts Analysis and General Themes Analysis*: The basic unit of analysis is called 'speech act unit'. The criteria for deciding a unit is to see if it performs a separate act intended by the speaker (illocutionary). The samples are divided into speech act units and each unit is assigned a speech act. Based on a pilot study of speech acts of 100 units in the sample, the author designs the following coding scheme revised from Fraser's taxonomy.

| **Speech Acts Coding Scheme Definition and Examples** | |
|---|---|
| **Assert:** State what message sender knows, observes or believes. 'Assert' actions are done on the sender's initiative. When the sender provides information, | **Notify assertion in advance:** The message sender notifies in advance that some information or ideas will be provided. |
| | **Inform:** Provide information usually based on creditable sources. It can include whole or part of an article, abstracts, references, URLs (to resources), or paraphrases, summaries of articles, books, instructor's words, information about assignments, or other resources. They are usually facts or other people's ideas. It also includes the sender's personal information. |
| | **Describe:** Describe phenomenon, state, process, results, events or other people. Describe' is to give a clearer picture Usually these events or phenomenon are not long lasting. |

| | |
|---|---|
| describes…upon the request of other teammates, they belong to the 'reply' category. | **Report:** Report past actions, usually those of the message sender, but not limited to it. |
| | **Predict/expect:** The message sender predicts or expects a future state or event. |
| | **Restate (self):** The sender restates one's own statement in order to emphasize or clarify. |
| | **Claim:** Express (certain or uncertain) ideas, believes or preferences about the subject matter discussed, the task or external resources. Interpret external resources. Evaluate one's own previous statements or work. It exists in the form of statements or drafts and submitted assignments (can be pasted, attached, or put in a personal www account). |
| **Hope:** Hope something (team project related) good will happen. | |
| **Suggest:** The sender makes a proposal concerning either subject matter of the discussion or the task at hand. It suggests what the whole team could do. | |
| **Express Emotion:** Express personal emotions such as sadness, happiness, enjoy, anger, frustration… | **Express-positive:** express positive emotions such as happiness, enjoy. Emoticons and paralinguistic cues that express happiness can be included. |
| | **Express-negative:** Express negative emotion such as anger, frustration…Emoticons and paralinguistic cues that express these feelings can be included. |
| | **Express-neutral:** State with a strong feeling; Express surprise; Exclaim. |
| **Commit:** Commit to an action, usually a task-oriented action in a team project. | |
| **Restate (Other):** repeat or paraphrase other teammate's previous statements. | |
| **Acknowledge:** to acknowledge receipt of other teammate's message. | |
| **Socialize:** Open/close a conversation, pay/maintain positive and negative face, lose one's own face for group benefit, be modest, show concern/ sympathy/ understanding/ humor… | |
| **Evaluate/ Express Attitude:** Agree/disagree or qualify/assess a previous statement, done on the sender's initiative. | **Evaluate-positive/agree:** Positively evaluate a previous statement; accept a previous statement. |
| | **Evaluate-negative/disagree:** Negatively evaluate a previous statement; disagree with a previous statement. |
| | **Other Remark:** Not clearly show agreement/disagreement. Look at the discussed idea from a new perspective; add additional ideas. |
| **Inquire:** Requesting originates from speaker but elicits information or ideas or just yes/no answer from the message receiver. | |
| **Reply:** the sender responds to the 'inquire' act. | |
| **Request Action:** Ask others to do something. Can be direct or very polite. Can be a difficult or an easy task. It is addressed to an individual. | |
| **Respond to request action** | **Accept**: Accept the request for action. |
| | **Decline**: refuse the request for action. |

Table 2: Coding Scheme for Speech Acts

In addition to speech act analysis, the author further makes general themes analysis. Different from speech act analysis which looks at individual activities, general themes are designed to show the general 'content' and 'theme' of conversation. The following is the coding scheme for the general themes.

| **General Themes Coding Scheme Definition and Examples** | |
|---|---|
| **Social:** Speech acts that aim to maintain a good relationship or a team spirit. Include *socialize*, a very general *evaluate positive* that does not address a particular point in the discussion, and any other speech acts that talk about personal life instead of the discussion focus. | |
| **Central content of Conversation:** Talk about the subject matter of the project/ assignment | **Clarify Assignment Issues/Discussion Focus:** Talk about understandings of the expectation of the instructor: what is the assignment about, what should be the focus |
| | **Theory Building:** Paraphrase, summarize a theory or concept; State one's belief/understanding (claim) of a theory/concept; Use a theory/concept to explain phenomenon; Use examples to explain a theory/concept. Drafts or submitted assignments in any forms are counted as theory building. |
| | **Content:** Any other speech acts that address the assignment/discussion topic related content. It can be discussion on focus or structure of the final delivery. |
| **Logistics**: Talk about team process, such as when to meet, when to submit the report… (Talks about modes | |

| |
|---|
| of communication will be counted separately). |
| **Technical**: Any speech acts that address the technical issues in the communication. |
| **Communication:** Any speech acts that discuss choice or preference for modes of communication. (It can be part of Logistics, but are counted separately in this category.) |

Table 3: Coding Scheme for General Themes

## Results

### Time Stamp Analysis Result

Based on the time stamps, the two teams' posting present the following pattern.

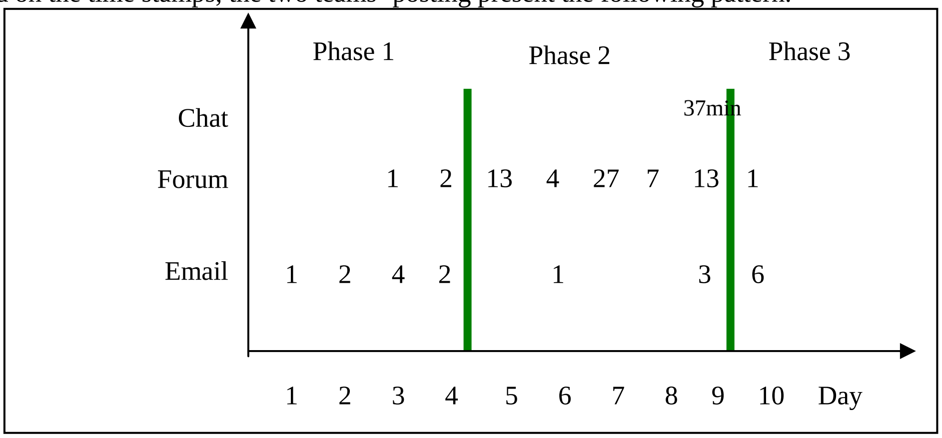


Figure 1:Green Team Result

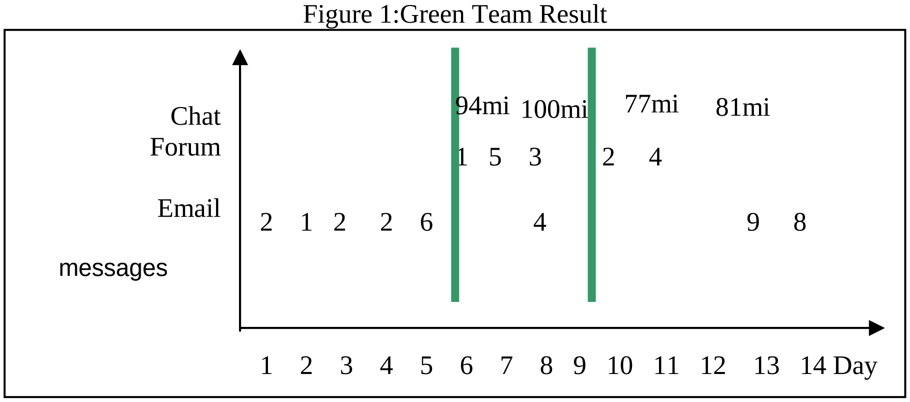


Figure 2: Blue Team Result

### Speech Act Analysis and General Theme Analysis Result

*Results for the Whole Process*

Frequency of each speech act as and frequency of each general theme are counted for each of the three modes for each of the two teams separately. The following is a summary showing for each team and each mode the top three most frequent speech acts, and the top three most frequent general themes.

| | **Chat (%)** | **Email (%)** | **Forum (%)** |
|---|---|---|---|
| **Blue Team** | 1. socialize 17<br>2. inquire 11.4<br>3. *commit/report* 9.8 | 1. report 16.8<br>2. socialize 14.4<br>3. claim 12.6 | 1. claim 35.8<br>2. inform 15.9<br>3. report 10.1 |
| **Green Team** | 1. inquire 18.9<br>2. *claim* 17.6<br>3. socialize 8 | 1. claim 19.8<br>2. report 16.7<br>3. socialize 15.9 | 1. inform 38.9<br>2. claim 22.2<br>3. report 10.1 |

Table 4: Top 3 speech acts

| | **Chat (%)** | **Email (%)** | **Forum (%)** |
|---|---|---|---|
| **Blue Team** | 1. social 47.2<br>2. logistics 29.3 | 1. logistics 42.8<br>2. social 24.4 | 1. theory building 66.2<br>2. content 15.9 |

| | | | |
|---|---|---|---|
| | 3. content 17.9 | 3. content 21 | 3. logistics 10.5 |
| **Green Team** | 1. content 46.5<br>2. social 18.3<br>3. theory building 17.7 | 1. content 39.9<br>2. logistics 26.3<br>3. social 23.2 | 1. theory building 58.4<br>2. content 30.9<br>3. logistics 6.7 |

Table 5: Top 3 general themes

*Cross Phases Findings*

Frequencies of each speech act and general theme for each mode and teams are further counted in terms of the three phases as shown in Figure 1 and Figure 2. These results are summarized into the following tables:

| | **Phase 1** | **Phase 2 (%)** | **Phase 3 (%)** |
|---|---|---|---|
| **Blue Team** | | 1. socialize 17<br>2. inquire/commit 11.4<br>3. report 9.8 | |
| **Green Team** | | 1. inquire 20.4<br>2. claim 13.5<br>3. report 12 | 1. claim 23.7<br>2. inquire 16.9<br>3. socialize/ evaluate+ 9.1 |

Table 6: Chat--Top 3 Speech Acts in Phases

| | **Phase 1 (%)** | **Phase 2 (%)** | **Phase 3 (%)** |
|---|---|---|---|
| **Blue Team** | 1. report 16.9<br>2 suggest /socialize 13.6 | 1. claim 28.6<br>2. suggest 19<br>3. socialize 14.4 | 1. report 23.1<br>2. socialize 15.5<br>3. commit/inquire 10.3 |
| **Green Team** | 1. claim 17.1<br>2. socialize 16.3<br>3. report 12.4 | 1. socialize 30.7<br>2. notify/ inform/ report 15.4 | 1. claim 22.9<br>2. report 20<br>3. socialize 14.3 |

Table 7: Email—Top 3 Speech Acts in Phases

| | **Phase 1 (%)** | **Phase 2 (%)** | **Phase 3 (%)** |
|---|---|---|---|
| **Blue Team** | 1. report/ claim/ inquire 23.8 | 1. claim 44.2<br>2. inform 20.5<br>3. report 7.8 | 1. claim/inquire 15.4<br>2. report 13.5 |
| **Green Team** | | 1. inform 45.7<br>2. claim 26.7<br>3. notify 12.4 | 1. report 25<br>2. inform 22.7<br>3. inquire 18.2 |

Table 8: Discussion Forum—Speech Acts in Phases

| | **Phase 1** | **Phase (%)** | **Phase 3 (%)** |
|---|---|---|---|
| **Blue Team** | | 1. social 47.2<br>2. logistics 29.<br>3. content 17.9 | |
| **Green Team** | | 1. content 50.4<br>2. theory building 22.2<br>3. logistics 12.7 | 1. content 41.4<br>2. social 29.6<br>3. logistics 15.9 |

Table 9: Chat--General Themes in Phases

| | **Phase 1 (%)** | **Phase 2 (%)** | **Phase 3 (%)** |
|---|---|---|---|
| **Blue Team** | 1. logistics 54.2<br>2. social 25.4<br>3. content 8.5 | 1. logistics/ content 33.3<br>2. theory building 19 | 1. content 33.3<br>2. logistics 30.8<br>3. social 28.2 |
| **Green Team** | 1. content 34.3<br>2. logistics 29.5 | 1. content 61.5<br>2. social 38.5 | 1. content 42.1<br>2. logistics 26.4 |

| | | | |
|---|---|---|---|
| | 3. social 23.8 | | 3. social 21.4 |

Table 10: Email—General Themes in Phases

| | Phase 1 (%) | Phase 2 (%) | Phase 3 (%) |
|---|---|---|---|
| **Blue Team** | 1. Theory building 47.6<br>2. content 28.6<br>3. logistics 14.3 | 1. theory building 88<br>2. content 9.2<br>3. logistics 2.1 | 1. logistics 32.7<br>2. content 31.7<br>3. social 19.2 |
| **Green Team** | | 1. theory building 66.7<br>2. content 28.6<br>3. logistics 2.9 | 1. theory building 38.6<br>2. content 36.4<br>3. logistics 15.9 |

Table 11: Forum Themes Phases

## Conclusion

Conclusion 1: Medium choice and usage vary over time. Time stamp analysis shows both teams presented similar patterns—Email use spanned from the first day to the last day of discussion, with intensive use on the two ends of the project and with much less frequency in the middle of the project. Discussion forum was rather heavily used in the middle, though there is team difference. Blue team used a lot of discussion forum and used chat less. Green team heavily used chat instead of forum. Three broad phases are thus identified. This result adds another dimension to the study: how phase of discussion interacts with acts, themes, and medium.

Conclusion 2: The general themes vary over phases. However, one persistent theme is "logistics". Communication tools that aim to facilitate student collaboration should be designed to facilitate team logistics. To look across the phases, it is found that Phase I and Phase III have more social and logistics themes. Students establish relationship in Phase I. They confirm and appreciate the relationship in the final phase. They also establish team norms and decide working communication modes in Phase I. They wrap up in Phase III. Phase II is for theory building and content themes, though these two themes persist in the final stage. While this conclusion might be obvious, distance instructors should be conscious of this result and be conscious of which stage his/her students are in and provide support and guidance desired in the specific stage.

Conclusion 3: The frequency of speech acts varies over modes of communication. The findings show that the top three frequent speech acts differ across modes, i.e., students do different things in different modes of communication. Students use both chat and email to socialize, while in discussion socialize was not an important speech act. Students also use chat when they need an immediate answer to a question, thus "inquire" emerged as a top speech act. Students use email to "report" both personal past events and things they have done for the team. Therefore, the group email is a good source for a conscientious instructor to know what students are doing and have done. "Inform", "claim" and "report" were main activities in the Discussion Forum. The forum seems to be a place for learners to provide information and state opinions, usually in long paragraphs.

Certain acts that do not surface the top three also are significant for understanding medium choice. Chat seems to be a place for expressing emotions. This may be due to the fact that immediate feedback can be received, and students may feel more of a personal touch when 'listening' and 'being listened to' in chat. Going through the chat archive may help the instructor understand feeling of students better than from other modes.

Conclusion 4: There are variations brought by team working style. In the two samples we choose, the Blue team seems a cautious and organized team. They use Discussion Forum as the major venue for discussion. They lay out eight topics for the project, and they respond to those topics consistently. The Green Team is a passionate team. They make full use of chat and each time they brainstorm for more than one hour. Their topics and focus can change with the chat going on. Different team styles may be good for different tasks. Instructor should consider team styles and task characteristics and give responding guidance, support and feedback.

Conclusion 5: Media choice and usage is a complex process. Choice of media is complicated by the combination of phases of tasks, communication mode characteristics, and the human usage. It is not realistic to conclude on an absolute optimum choice/usage of modes. Multiple variables should be considered.

### Contribution of this Research

Distance educators are faced with two challenges: the challenge of designing instructional strategies and students activities, and the challenge of choosing or creating optimum technical environment. This research starts from the technological perspective (more specifically, the communication media) and relates it to pedagogical issues. Technological and pedagogical are no longer separate considerations for distance researchers. For example, for instructors, asking students to use certain mode of communication is not only a matter of choosing the most convenient one or choosing the one that the instructor is familiarized with or prefers, it should include considerations of which mode or combination of modes of communication work best for the students and the learning tasks. For system designers, consideration for designing a discussion forum will include additional issues such as what type of message labels can we build into the forum to facilitate students discussion and problem solving in addition to the single Subject line. This research also examines multiple media at the same time and explores the complexity of media choice.

In addition, results of frequent students speech acts can also be the basis for designing more sophisticated grading rubrics for course that depend heavily on online discussion. Such rubrics have already been used (MacKinnon, 2000). However, it needs more attention and further refinement based on scientific results.

## References


Austin, J. L. (1962) *How to Do Things with Words*. Cambridge, Mass.: Harvard University Press.

Fahy, P. J. (2002). Epistolary and Expository Interaction Patterns in a Computer Conference Transcript. *Journal of Distance Education, 17(1), 20-35*.

Francis, G. & S. Hunston (1992). Analysing everyday conversation. In M. Coulthard (Ed.), *Advances in Spoken Discourse Analysis* (1-34). London: Routledge.

Garrison, D. R., Anderson, T., & Archer, W. (1999). Critical Inquiry in a Text-based Environment: Computer Conferencing in Higher Education. *The Internet and Higher Education, 2(2-3), 87-105.*

Garrison, D. R., Anderson, T., & Archer, W. (2001). Critical Thinking, Cognitive Presence, and Computer Conferening in Distance Education. *The American Journal of Distance Education, 15(1), 7-23*.

Hara, N., Bonk, C. J., & Angeli, C. (2000). Content Analysis of Online Discussion in an Applied Educational Psychology Course. *Instructional Science, 28(2), 115-152*.

Harasim, L., Calvert, T. and Groeneboer, C. (1997). Virtual-U: A Web Based System to Support Collaborative Learning. In B. Khan's. *Web-Based Instruction*. Englewood Cliffs, NJ: Educational Technology Publications

Henri, F. (1992). Computer Conferencing and Content Analysis. In A. R. Kaye (Ed.), *Collaborative learning through computer conferencing: The Najaden papers* (pp. 115 - 136). New York: Springer.

Herring, S. (1996). “Two variants of an electronic message schema.” In S. Herring (ed.), *Computer-Mediated Communication: Linguistic, Social and Cross-Cultural Perspectives* (pp. 81-106). Amsterdam: John Benjamins.

Herring, S. & Nix, C. (1997). "Is "serious chat" an oxymoron? Pedagogical vs. social uses of Internet Relay Chat." *Paper presented at the American Association of Applied Linguistics*, Orlando, FL, March 11.

MacKinnon, G. R. (2000). The Dilemma of Evaluating Electronic Discussion Groups. *Journal of Research on Computing in Education*, 33(2), 125-131.

Malouf, Robert (1995) Towards an analysis of multi-party discourse. Retrieve August 1, 2004, from http://hpsg.stanford.edu/rob/talk/talk.html.

McLaughlin, M. L. (1984). *Conversation: How Talk Is Organized*. Beverly Hills: Sage Publications

Searle, J. (1969) *Speech Acts: An Essay in the Philosophy of Language*. Cambridge, Eng.: Cambridge University Press.

Sinclair, J. McH. & R. M. Coulthard. (1975*) Towards an Analysis of Discourse. The English Used by Teachers and Pupils*. London: Oxford University Press.

Zhu, E. (1996). Meaning Nogotiation, Knowledge Construction, and Mentoring in a Distance Learning Course. In *18th International Convention of the Association for Educational Communications and Technology* (pp. 819-844). Indianapolis, IN.

# Transparency in Education: Fostering Active Participation in the Educational Process

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## Introduction

The purpose of this paper is to describe why current school reform initiatives that attempt to involve stakeholders through information disclosure are not working and how transparency impacts the information disclosure process. School reform initiatives and policies, like the *No Child Left Behind Act*, often seek to promote more involvement from parents and other community members. These reforms forward notions of school choice and mandatory reporting of standardized test scores as ways to involve stakeholders in the educational process. However, these measures can paradoxically limit involvement by singling out what is discussed about student achievement and school improvement to the content of what is disclosed. Parents and other community members, i.e., stakeholders, need more than selective information in order to become active participants. Active participation requires access to multiple sources of pertinent information and opportunities to provide feedback.

## Corruption Control

Schools are often required by their state government to disclose information about their financial condition and how they use tax revenues. State mandates and federal law have extended the disclosure of information to student proficiency levels, dropouts, and the qualifications of teachers. These disclosure requirements come under the umbrella of corruption control in order to ensure the quality of education. Their purpose is to protect the community and inform consumers by allowing sunshine to reveal any wrongdoing or incompetence. Corruption control focuses on "clarity of roles and responsibilities; public availability of information; open budget preparation, execution, and reporting; and assurances of integrity" (Oliver, 2004, p. 5). While there exists certain mechanisms in schools like transportation, food service, accounting, and payroll that can be made transparent based on these guidelines, most educational processes do not neatly fit into a traditional model of corruption control.

Promoting transparency as corruption control is often thought to promote better consumers through disclosing information that can allow for informed school choice. However, consumers are often passive participants in the educational process because they are oftentimes merely receivers of information. They are often fed one-size-fits-all information without the supporting details as to what generated the information. For example, a standardized test score is disclosed to stakeholders without any differentiation based on audience and with no link to instructional practices and other variables that may have impacted the score.

Transparency is also discussed in many contexts as a means for achieving accountability. However, promoting accountability often has a limiting end that denies complexity. Accountability requires simplification, such as a bottom line in business. For example, in order to hold teachers accountable for student performances on a standardized test means to deny the complexity inherent in the student-teacher relationship and the numerous variables found in a classroom. Therefore, general information, such as a standardized test score or a grade for a class without the supportive details as to what generated the score or grade has limited usefulness because it does not encapsulate the range of variables in a given context. On the other hand, specific or detailed information disclosed without accompanying generalizations can leave the stakeholder bewildered.

## Active Participation

While transparency as corruption control requires oversimplification and promotes passivity on the part of stakeholders, transparency as active participation embraces complexity allowing for an open process built on feedback. Focusing solely on corruption control does not allow for active participation on the part of stakeholders because the information often flows in only one direction and its content is selective to only a few school processes. Active participation, however, requires information with varying levels of specificity about more educational processes and expanded mechanisms to provide feedback. Because stakeholders have varying needs, a process of moving from general to specific information allows stakeholders to retrieve the level of information relevant to them. In order for this to occur connections are required between different pieces of information. For example, when a school discloses its standards and benchmarks, they could be more useful to stakeholders if connected to student work samples.

Transparency as active participation is necessary in education because the structure of schools is not conducive to one-way flows of information (Weick, 1982). Weick (1982) describes schools as loosely coupled systems in that they resemble collections of independent cells rather than a tightly integrated bureaucracy. In a loosely coupled system active disclosure is often the only means of allowing other stakeholders to gain access to information about what is going on in other independent cells. Therefore, the connectivity of information and the ability to provide feedback also impacts stakeholders inside of schools ability to actively participate. Examples of information that all stakeholders need—both inside and outside of schools—are curriculum roadmaps, standards associated with curriculum, exemplars of student work, criteria for assessing assignments, lessons plans, progress reports, discipline and attendance reports, and samples of past and present student work.

The acquisition and dissemination of timely information can be enhanced through technology. In schools these systems are commonly referred to as administrative or student information systems. Classroom websites and similar online environments are also examples of resources that enhance participation in the educational process. These systems provide the necessary connectivity through the ability to link, or *hyperlink*, general and specific information. They also allow for increased opportunities for feedback through email, discussion groups, and blogs. As with discussions on distance education, technology plays an important role in transparency, yet it is what one does through the technology that often deserves more attention.

When the aim of transparency is active participation, feedback is a distinguishing quality. Feedback is generated through two-way communication. Active participation requires the exchange and interpretation of information by all parties. For example, students, parents, and teachers must jointly interpret student performance in the classroom. All three parties must make sense of shared information if all three are going to actively participate in the educational process. The school has a responsibility to create structures and environments that encourage the free and open exchange of information, such as frequent conferences and e-mail. If the environment is not conducive to feedback, transparency as a means for active participation is corrupted. When information flows in one direction, compliance rather than participation becomes the norm—no matter how much information is available.

Transparency as active participation cannot be reduced to rules and procedures. It is realized in a school as a value expressed through a pattern of action. This pattern of action is learned through trial and error. Stakeholders need structures of interaction that bring them together to exchange information. However, each school must learn what information and what structures of interaction induce active participation on the part of their stakeholders. These structures and forms of information vary with different communities. The pattern is discovered in the doing not through an abstract programmatic approach with predetermined plans.

If all stakeholders are granted access to the information and are allowed to interact with other stakeholders, they can respond to, ask questions of, or clarify the educational process. For example, parents can monitor lesson plans to see what is being taught, how it is being taught, and if students are doing what is expected of them outside of the classroom. When students and parents are granted access to grade books, they can view student progress, understand grading criteria, and balance outcomes with expectations. With all of this information, opportunities for active participation are increased because stakeholders are better equipped with the "what" and "how" of the educational process.

**References**

Oliver, R. W. (2004). *What is transparency?* New York: McGraw-Hill.
Weick, K. (1982). Administering education in loosely coupled schools. *Phi Delta Kappan. 63,10*. 673-76.

# Designing Web-Based Instruction: Instructors' Response to Cultural Influence

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**Abstract**

*This study investigated instructors' perceptions of their responsibilities, interactions, and resources in web-based education in Korea and the United States. Analyses of interview data showed that Korean instructors perceived their major role as that of a supporter of knowledge acquisition and as a facilitator of interaction between students and content; however, they viewed this role as ideal but impractical. The U.S. counterparts perceived their role as that of a moderator and viewed their interaction with students as a critical component in web-based education. This study investigated cultural differences related to web-based education and contributes to the limited body of knowledge on this aspect of web-based education in both countries. Also, this study may help designers create web-based instruction in relation to different cultural contexts. Although this study is limited to nine professors in the U.S. and Korea, the qualitative interviews can be expanded to a large community of online educator and learner to determine assessment of these experience, perceptions, and attitudes about teaching and designing web-based courses online through a web-based delivery platform. Knowledge of the distance education, understanding the potential of using a web-based course and various instructional platforms for teaching in cross cultural contexts, and being aware of the responsibility involved in teaching online course can help facilitate a meaningful and positive learning experience for educators and learners in both countries. Future studies are strongly recommended to broaden the understanding of multi-level cultural contexts and their role in web-based education.*

## Introduction

The convergence of technological and pedagogical developments has helped a new paradigm of teaching and learning emerge (Vonderwell, 2003). Web-based education, in general, refers to delivering instruction via web-based resources and communications to students who are at a relative distant geographical location. As current technology speeds up the connection of physically separated learners and instructors, web-based education is becoming a main education delivery format throughout many different countries including Korean and the United States.

As Walsh and Reese have noted, "web-based distance education employing the new educational technologies can improve the quality of a university's educational offering, provide economic benefits, and offer a strategic advantage in piercing new markets" (Walsh & Reese, 1995). Many distance-delivered university programs that integrated with technologies can offer the adult learners a number of opportunities (Hara & Kling, 1999).

However, the instructional intent and the ways to apply web-based education would not necessarily be identical among institutions in different countries since educational results may be influenced by cultural differences. Consequently, the web-based learning environment would take a unique form depending on characteristics of the students, faculty, and institutions in each country. Over recent years there has been a dramatic increase in the number of Korean universities that use web-based resources in undergraduate courses. This implies the Web-based education has become an important, independent component in the Korean education system just as it has in the U.S. Given this widespread development, this study examined how the practices are implemented in the two countries and how the instructors from each perceive the practices of their respective web-based education systems.

The investigators interviewed instructors currently involved in web-based education delivery in either Korea or the U.S. to determine what their relative practices in web-based education and also determine how they perceive their responsibilities, interaction, and resources. Examining instructors' perceptions provided an in-depth understanding of the similarities and differences between the web-based education practices of the two countries.

The purpose of this study is to examine perceptions of instructors in Korea and the U.S. related to their instructional practices while delivering web-based education. Mainly, the comparisons were focused on aspects of instructor's role, interaction, and supporting instructional resources.

## Methodology

### *Subjects*

The participants of this study consisted of nine instructors from Korea and the U.S. who had an experience of web-based education at least for two semesters. Five Korean instructors, four males and one female, ranging from thirties to forties in age, were interviewed over the telephone. Four U.S. counterparts, three males and one female, ranging from forties to sixties in age, were interviewed in person. All the Interviews were audio-taped and transcribed. The interview length was about one hour thirty minutes The Korean instructors were from four universities located in three geographically different areas of Korea whereas all the U.S. instructors were from a southeastern University. All participants were teaching undergraduate courses in education related studies such as higher education, educational technology, educational human resource development, computer education, special education, and English writing.

In order to interview the instructors, semi-structured interview questions were developed. To answer the following questions:

(1) How the instructors perceive their role or responsibility in web-based education?;

(2) How the web-based interaction is practiced in each country?; and

(3) What kind of resources the instructors use to enhance communication in web-based education?

### *Data Analysis*

The content analysis method is used to investigate the instructors' perceptions of their responsibilities, importance of interactions, and efficacy of resources in their own web-based education system. According to the Rubin and Rubin (1995) approach, the textual data were read by all three researchers and discussed and then the key concepts and ideas were categorized. The similar categories were combined into broader ideas to be analyzed.

## Findings

### Instructors' Role

From the initial analyses, it was found that there were several differences and similarities between instructors from Korea and the U.S. in perceptions toward their role, interaction, and resources in web-based education. All of the instructors, in general, considered their roles to be a course developer, a course manager, and a learning facilitator.

The instructors from both countries thought their role, as content developer was important. One Korean instructor, commented, "It's important that an instructor develops online contents in effective way and delivers well-constructed online materials for target learners." He continued, "I think it is important for the instructors to be responsible for their role as a developer of their instruction contents using authoring tools if we pursue the quality of education, even though it is so much burden." All five Korean instructors responded that they perceived that developing their instructional materials is critical for their instruction and for learners to manage the high quality of their class delivery although they were often limited by time and resources.

The U.S. instructors also perceived the importance of role as a content developer. Dr. B, a U.S. instructor from educational human resource department, expressed that his major role was "to design a course that is usable for students." Another U.S. instructor also similarly noted, "I am responsible for the content, organizing it, writing it, and preventing it. Basically as an instructor you have to do all the curriculum design, all the course design. And, you also have to make sure that you have materials and orders. On the web-based, you usually work with someone who has technical expertise."

The instructors from both countries reflected that one more major role of the web-based education instructor was a course manager and a learning facilitator. Korean instructors noted that "…the responsibility is not only managing web-based course but also engaging students in discussing and giving feedback." and "…instructors support learners for their participation in their class and encourage them to learn course contents and information." Dr. C from U.S. stressed that one of his major responsibilities is to facilitate his students, adapting to their individual needs while their doing assignments or projects:

> So my role is in the facilitating part, face to face. I tried to prepare them for the assignment and the project that they had online and then monitored their discussions and evaluated it.… But the way that I teach, I believe this is very important, you are able to adapt and go off into areas to adapt to the students…

Dr. D from U.S. also indicated his role as a facilitator or coach. He stated, “I try to design my classes based on learner-centered instruction design. So I think one of the major role, I think, it would be more like a coach for learning.”

Interestingly, the instructors showed different views on what they want to gain by the web-based education and how they think the ideal role of instructor in web-based education. The Korean instructors perceived their role more as a supporter for knowledge acquisition. For instance, one Korean instructor, Dr. H, who had lots of experiences of contents and system evaluation, noted that many Korean instructors involved in web-based education tended to evaluate their students in terms of knowledge acquisition, saying, “both instructors and learners focus on knowledge and information in their subject contents.” On the other hand, the U.S. counterparts considered that they were primarily responsible for establishing the learner-centered learning environments by mostly assisting their students’ engaging in their class activities and interactions.

From the responses of the participants to the question asking their role in web-based education, it was found that Korean instructors considered their role more as a traditional instructor that who focuses on delivering knowledge on-line. For example, Korean instructor, Dr. I, indicated that one-way videos, either synchronous or asynchronous, had been one of the popular delivery methods for web-based education in Korea. On the other hand, the U.S. instructors viewed their role more as a moderator for enhancing student interaction. However, both countries instructors thought that the good communication and well-organized courses are important facets in web-based leaning environments to make learners satisfied. The respondents from both groups also considered that time management was the most challenging task when developing materials and while monitoring students during course related activities.

***Interaction***

Regarding interaction and integration, instructors from both countries shared that enhancing interaction was a key factor for students’ learning. However, they differed in the extent they actually focus on how to foster students’ interaction.

<u>Interaction perceived as a learning opportunity</u>

All four U.S. instructors thought that interaction-integration to on-line instruction was an essential part for learning. And, they concentrated more on activities designed to promote students’ interaction. A faculty from the special education program in U.S., commented as the following:

> …I am happier with interaction of my students. I can see them, I can read them, and I can redirect them so that they do much better jobs. Some of my students really like on-line discussion. And, some of my students participate in on-line discussion but they don't participate verbally in class. So, on-line discussions give some of my students an opportunity. I can give them more choices...

Similarly, another U.S. instructor indicated that interaction in on-line learning was crucial:

> …I really don't believe that you can conduct a really good web-based course without interaction. Interaction requires the U.S. professors to build many factors and manage that interaction. A lot easier just to bring assignments upon the Web and let their students complete them as they want and grade the papers. But there are rich, I think, educational experiences that are playing interaction and straight discussion on particular topics. Maybe creating things, like streaming media kind of examples actually challenge the students to go deeply into the content…

Interaction in an on-line learning environment was also perceived as enforcement for active and reflective learning. A faculty from U.S., Dr. B, emphasized the effect of integrating interaction as the follows:

> … An on-line environment can enforce students to engage more actively to do or reflect to do their work, or expose themselves to what they are doing, that part of experience. In an impersonal learning environment, sometimes student don’t think that part as a learning experience. I think, that kind of way, an interactive class facilitates web-based tool support of the impersonal class environment is helpful as well…

One U.S. instructor, Dr. D, regarded that integrating interactions can enhance cognitive thinking and higher-order thinking of students:

> …It depends on all variables including learning, students, its like, depends on the concept you are actually training for at that point. But, for me, I think what I would like to get out of interaction is better grasping for the content by the learners and ability to apply that knowledge and higher-order thinking...

Korean instructors had similar agreement as their US counterparts considering interaction as a crucial part of on-line instruction and learning. One Korean faculty stressed the importance of interaction and motivation in on-line class as the follows:

> …I realized, from my experiences of content evaluations on many web-based course materials, those lots of course materials were developed with the interaction or motivational components ignored. Thus, on-line delivery is often too monotonous and not much motivational. Therefore, I think what we should emphasize is to support integrating interaction between students and course materials. The next thing that we should focus on is motivating the participants to maintain their interests for the course…

Similarly, another Korean instructor addressed, "… I think what we should emphasize is to support integrating interaction between students and course materials. The next thing that we should focus on is motivating the participants to maintain their interests for the course..." Also, one instructor from a Teachers' College in Korea, emphasized importance of integrating interaction in her course saying, "I think active engaging in discussion is very important for on-line learning and I really think interactive discussion impacts on learning".

Unlike the U.S. counterparts, the Korean instructor, Dr. I, addressed a concern in integrating interaction to their class as seen in the following comment:

> …But, in reality I saw many of my students were reluctant to engaging in discussion. I think it's because they didn't feel comfortable in expressing their ideas in a logical way, freely asking any questions to me or each other. Probably they don't think seriously on-line discussion…

More interestingly, the Korean instructors seemed to somewhat doubt that on-line interaction can fully follow the positive effect of the face-to-face interaction. He clearly addressed as the follows:

> …I think discussion itself does not increase learning achievement. When we focus on web-based discussion, understanding of concepts and principles may be ignored. Conceptual understanding should be supplemented in a face-to face format. I would stick to my position that understanding of concepts is critical for achievement. Without the understanding of the basic concepts, the discussion is likely to be discussion for discussion…

It is also revealed that most Koran instructors focus more on the interaction between an instructor and students than other types of interactions. They employed face-to-face interaction along with the web-based format for better communication between themselves and students. Dr. I said that as the follows:

> …what is more important is to discuss with students on the questions and assignments which was posted on the web….What I do is to use the web for adding materials. I think the most important thing is to meet with my student and providing instructions to them...

<u>Interaction applied in the classroom</u>

The U.S. instructors emphasized the importance of the social aspects of course activities and learning styles in designing their instruction, and they invested lots of efforts to enhance learning through discussion. On the other hand the Korean instructors indicated that a decent level of interaction is desirable for more individual learning but it is not practical with the existing constraints such as the large size of classes, students' reluctance to participate in interactive activities, and limited support resources.

Most U.S. instructors noted that they focus on encouraging students' discussion. A U.S. faculty stated as the follows:

> …Mostly, I encourage my students to interact with discussions. Reflection component in distance education is perhaps strength. In an impersonal learning environment, that writing and doing their reflection are not always comfortable to undergraduates…

Another U.S. instructor noted about instructional strategies of using student's role as moderators in order to enhance the interaction during their class discussions:

> …I usually assign individuals to moderate discussions. ..They actually have on-going discussions by teams… Students have to moderate, know the discussion, and come ahead of time putting help, looking questions, summarizing discussions...

In contrast, none of the Korean instructors mentioned about the employment of student facilitators for discussions. When asked how participants' interaction could be enhanced, all of the U.S. instructors from U.S. emphasized it was possible by taking into account the social aspects of activities and students' learning styles in designing their on-line courses. He noted as the follows:

> …I think there is also a function of learning styles. We also need to decide how students do best that interaction. I think that you have to know learning styles exist when you design your course so that you can design interaction into the course. I think it works a lot better in some ways that interaction between a student and a student. We know that education in a lot ways is a social experience. When you get into an on-line situation, we take the social aspect. What we have to do is to design that social backup…

Similarly, the U.S. instructor, Dr. B, indicated that how learning styles and social aspect of participants were included in his course designing:

> …Learning styles are also important to decide the best interaction in designing a course and delivering the course among students. What we are trying to do is students' interaction and we know that as a social experience... so, students more often learn with engaging than others. They develop on-line relationships highly engaging. And, they have more opportunities to learn better…

The U.S. instructors emphasized the social aspects of course activities and learning styles in designing their instruction, consequently focusing more on student-to-student interaction, whereas the Korean counterparts appeared to focus more on student-to-instructor interaction. For example, one instructor from the Seoul University indicated his primary emphasis was providing immediate feedback to students' performances. Students- to-content interaction and interactive discussion among participants were not practical in his particular instruction situation in which most of participants are a full time employee and the course is delivered fully on-line. He stated as the follows:

> … I think student-to-content interaction is not practical in Korea. More than 70% of my students have full time jobs and most of them like to understand what a teacher instructs just like the way they do attending in an off-line class even though web-based instruction allow us to induce a dynamic interaction using multi media. Some technical procedures that some interaction objects requires, for example, click events, say, clicking buttons for turning to the next frame, and text areas used for asking personal opinions or ideas, the procedures of these interaction components rather bothers the students. The student felt inconvenient and hard with them. I prefer to allow them to access to my instruction in one- way audio and video format…

Constraints in integrating interaction

The instructors from U.S. addressed a few challenges in managing students' interaction in their web-based distance class. The biggest challenge that the instructors had faced was time managing in dealing with lot of workload resulting form monitoring participants. For example, one instructor from the Educational Human Resource program indicated as the follows:

> …Maybe creating things like streaming media kind of examples, you can actually challenge the students to go deeply into the content. So, the biggest challenge is actually being able to construct that kind of time you can give to the students. Time management issue is important…

Similarly another instructor from the same program stated the time managing problem as the follows:

…The most challenging part of that is keeping tractable because, strictly on-line, there is over-communication and too much information between students and contents and questions. It gets to be the point where I usually setup a discussion group, like a chat room…

Lack of technical support was also considered to be a constraint in delivering a web-based instruction. A U.S. instructor indicated that one-to-one technical guide for posting her instructional material would be a lot of help for her web-based instruction. He as the follows:

…What I need is that somebody walks down, says that it is slow, or what's happening, and comes down and fixes it. I need somebody proactively thinking ahead of me. You know I really don't know that much about technology. Web-CT, I want the technology is transparent, and I want it to be smooth. I don't want to think about why it works or doesn't work. When I press a button it works. That's all…

All Korean instructors, otherwise, indicated participants' inattention to the active involvement in interactive discussions as a serious challenge in integrating interaction into their web-based courses. The large class size was also perceived as a constraint. The instructor from Seoul Digital University reported that an on-line class has normally around one hundred students. The normal class size for the courses, which are offered for freshmen in his university, mounted to as large as 400 to 500 of students. He added that it was very hard to monitor the quality of interactions of that many students.

**Technology Support and Resources**

Three major topics were identified in this study: content development and instructor's challenge, the use of communication tools, and limitations of the technology.

Content Development and Challenge

It is assumed that one of the roles of web-based education instructors was guiding students through the contents developed by the instructors themselves. Although they were agreed with the role as content developer or manager, instructors from both countries reported that they have difficulties to play the role. Also, there are emerging issues related to the use of technology in developing content. For example, an instructor, Dr. D, noted that "when we develop web-based materials, I pretty much develop all of them, but I also have the GA help me." A Korean instructor also said "Commonly, the instructors in charge of web-based courses develop the contents by themselves, so an instructor and a content developer can not be separated in their role."

However, when materials are developed to be delivered on the Web, interestingly, it seemed that the Korean instructors were more aware of the way of implementation and design of the content presented to students on the Web. Otherwise, the U.S. instructors were focused on content itself and presented text-based contents. The sense one has here is of student's necessity. That is, the use of new media technology with contents on the web is perceived a necessity by instructors of both countries. A Korean instructor commented the student's preferences on the web-based learning activities were "most of the students want traditional lecture form on the web-based class…. Students want to listen to professor's voice or video recorded lecture, along with contents on the screen, rather than just see text-based materials."

Both countries' instructors indicated that the process of delivering the materials is little different between a web-based and a face-to-face form. An U.S. instructor noted, "Last couple of years, I have modified material, produced PowerPoint, produced pages of document, and then I pull those together." She continued "I did pretty much doing the same things as I do in a face to face classroom." A Korean instructor also responded, "I am taking charge of a humanity class. The class is focusing on transferring knowledge to students. I think, therefore, when I had transformed the class to the web-based class, there are little difficulties." In the process of content development, a technical issue was considered to be the most difficult challenge for developing the material to most instructors in this study. For example, it indicated that the lack of authoring tools to transform into tradition format of material, insufficient technical ability and experience of instructors, and a time-intensive process.

Instructors' willingness to develop their own course materials has been well responded by the authoring tools in the market that has been getting more user-friendly. However, the instructors appear to have a hardship in developing materials by the lack of the clear directions with the possessed tools and with the lack of desired tools, which is well reflected in the following statement given by a U.S. instructor:

…The difficulty is deciding within what resources we have, what we are going to do, and what we can do. In going back to your questions, before you might decide in this particular course, because we don't have the tools that we need, we might have to decide to teach in a traditional format…

With respect to software to be used in developing course materials, the U.S. instructors mentioned that they commonly use Adobe PDF writer, Microsoft PowerPoint, and video editor. Comparatively the Korea instructors indicated that they often use GVA (Global Virtual Academy) of Youngsan Information and Communication, Active Tutor of 4Gsoft, Macromedia Flash, and video editing software. The Korean instructors indicated that they prefer using domestic authoring tools in order to develop materials for the web-based education. Dr. H commented, "in the Korean market, there are so many solutions to develop multimedia-based contents because instructors are interested in developing contents rather than the LMS (Learning Management System) itself."

Communication Tools

Embedding communication technologies throughout the instruction system is an important consideration along with what to include for the content. When asked what they were using communication tools in the LMS system, most instructors mentioned, discussion board and email. Even though there are more functions to support communication between instructor and students, they were mostly used to general asynchronous functions. We could find the differences between both countries regarding to the uses and perceptions toward the board, variously called as a bulletin board, electronic board, and discussion board in this study. In common, instructors mentioned that they were using the board as the following three ways: discussion, questions and answers, and class notification. One U.S. instructor said how he recommended the use of the discussion board to students as the follows:

> …I say, you can post whatever you want on the discussion board about the mid-term and talk to each other about the mid-term over discussion board, or if they have a project in groups, they use the discussion board to talk each other in the group…

As mentioned above, most of the U.S. instructors in this study focused on students' discussion activity on the web-based education. Mainly, the discussion board can be an appropriate function on the LMS to discuss in asynchronous discussion. Interestingly both countries' instructors said that they are not often using chatting function as synchronous discussion on the web-based education because of the difficulty of arranging the schedule with students. On the other hand, Korean instructors do not offer a variety of approaches to usability of the board on the web-based education. Although they were using the board in their courses, they mentioned the limitation of the usability, which is obvious in the following statements: "it seems that the students don't think the board is necessary". Similarly another instructor noted, "students' reaction to the posted opinions is very slow", and students prefer to get email rather than to check out the board".

With respect to using email, we could more hear from Korean instructors about why they were trying to use. Several reasons came out from them. One was the accessibility issue on the system. Dr. I commented as the follows:

> …I can say one of the reasons, the accessibility on the system setting up the web-based education, such as they can access from any place. However, email is more passive thing for students, on the other hand, an electronic board is more active thing for students because they have basically to go the target location of board through the log- in process and read the postings on the board. … When we sent email to students or they send email to us, we can get fast feedback from them. However, we got very slow responses from them when we are using on the discussion boards…

In comparison, there were less responses from the U.S. instructors about using email. Dr. B mentioned that, "I asked them to come together as asynchronous discussion. Their group worked together and solved the problem… It's easy to manage the internal email. I asked them to only use the internal email."

As far as using email, a different perspective between the two countries was determined toward notification functions of web-based education. The use of function showed the difference. One Korean instructor, H said, "I think the most important function in the web-based education system is the notification to students". He continued that "because students have to log in the system to read a notice by the instructor, and because they feel annoyed to log in every time to read the notice." However, a U.S. instructor emphasized, "It is not unusual for me to give reminders students when things are due" and he explained the reason saying, "Distance learning requires self-directed engagement. Students have to structure for themselves sometimes engaged in that class turning in materials."

Technology for on-and off-line instruction

Based on this finding, it is obvious that web-based education does not need to involve students who are at a geographically remote site to be of benefit to instruction and learning. Web-based resources can be used in support of face-to-face classes as well as distance classes. Lots of universities in U.S. and Korea are employing the learning management system such as Web-CT. It can be used to make supplemental materials available on-line along with off-line class. We could hear from the Korean instructors about the LMS as mixed model for instruction. For example, they were implemented that an off-line course using the LMS for delivering course materials and students group activities. Similarly, instructors at U.S., were using the Web-CT to create an entire web-based course or to supply materials available on the web.

The LMS of institutions in both countries relied on widely used commercial delivery systems for creating and managing instruction. In the U.S., WebCT or Blackboard is examples of such a system. On the other hand, the Korean instructors mostly had support from systems developed by Korean companies. An instructor mentioned that in Korea there was no major company for the LMS. An instructor from Korea said that although there were the LMS systems developed by the U.S. companies in Korea, those were not likely to be selected by universities.

## Discussion and Conclusion

This study reveals several meaningful findings in cross cultural web-based education. Some findings are common on both the US and Korean cultures, while others are unique to each one's own culture context.

First, the data from this study indicated that both countries instructors perceive the integration of the web-based education to be useful as a content delivery platform and a study guide. Both groups of instructors stated that good communication and well-organized courses are important in web-based education and when the course content is well-organized and there is good communication between and among the learners and instructors, learning objectives and goals could be reached by learners. According to Kanuka (2001), "while good communication and well-organized courses are important facets in any learning environment, these factors are even more important when the learning is at a distance" (p. 68). The success of web-based distance education depends on whether the individual instructors are able to provide the appropriate opportunity for, and quality of, dialogue between the instructor and the learner, as well as appropriately structured learning materials (Moore, 1991).

Secondly, in designing web-based instruction, instructors' personal philosophy and attitudes toward web-based learning, perceptions of learning needs from learners, and existing technical capacity to support the web delivery are determined to be practical and critical factors implementing web-based courses in both countries college education.

Thirdly, the researchers from this present study concluded that instructors' perception toward web-based education is affected by the cultural context respecting educational needs and systems. The cultural difference in education affected learner's learning patterns and needs, as well as instructional design toward web-based education. According to Li (2000), the Western culture emphasizes the thinking processes and the learner's psychological characteristics such as learning styles, motivation, and intelligence. Otherwise, the Asian culture considers of the learning as a process of self-perfection by seeking lifelong commitment, diligence, endurance of hardship, persistence, and concentration

The researchers observed that the Korean distance educators consider that providing knowledge and information to learners is the most essential part of learning in both distance and face-to-face classes. And, they concentrated more on developing well-organized Web materials, Website, and instructional design for learners. Also, the researchers found Korean students' learning needs are highly career development-oriented and strongly prefer acquisition of new knowledge and information. Otherwise, U.S. instructors thought interaction is an essential part for learners to attain the learning objectives in a web-based distance environment as well as face-to-face classes. And, they concentrate more on activities designed to promote student interaction.

## Recommendation

Although this study is limited to nine professors in the U.S. and Korea, the qualitative interviews can be expanded to a large community of online educator and learner to determine assessment of these experience, perceptions, and attitudes about teaching and designing web-based courses online through a web-based delivery platform.

Knowledge of the distance education, understanding the potential of using a web-based course and various instructional platforms for teaching in cross cultural contexts, and being aware of the responsibility involved in teaching online course can help facilitate a meaningful and positive learning experience for educators and learners in both countries. Future studies are strongly recommended to broaden the understanding of multi-level cultural contexts and their role in web-based education.

## References


Hara, N., & Kling, R. (1999). Students' frustrations with a web-based distance education course. A taboo topic in the discourse. [online]. Available: http://www.slis.indiana.edu/CSI/wp99_01.html

Kanuka, H. (2001). University student perceptions of the use of the web in distance-delivered programs. *The Canadian Journal of Higher Education*, 31(3), 49-72.

Li, J. (2000). What do US and Chinese college students think 'learning' is? Comparing cultural models of learning of American and Chinese, Unpublished manuscript.

Moore, M. (1991). Editorial: Distance education theory. *The American Journal of Distance Education*, 5(3), 1-6.

Rubin, H. J., & Rubin, I. S. (1995) Qualitative Interviewing: The Art of Hearing Data. Thousand Oaks, CA: Sage Publications.

Vonderwell, S. (2003). An examination of asynchronous communication experiences and perspectives of students in an online course: A case study. *Internet and Higher Education*, *6*, 77-90.

Walsh, J., & Reese, B. (1995). Distance learning's growing reach. *T.H.E. Journal*, *22*(11), 58-62.

# Learning Collaboratively or Individually by Constructing Concept Maps on Computers

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**Description**

Using a quasi-experimental design this study investigated the comparative effects of individually-generated and collaboratively-generated computer-based concept mapping on middle school science concept learning. Seventy four students in middle school science classes participated in this controlled study. The findings revealed that individually-generated concept mapping on computers during study time positively influenced science concept learning above and beyond independent study and collaboratively-generated concept mapping on computers. In addition, students had positive attitudes toward concept mapping using Inspiration software. This study contributes to the limited literature and body of knowledge concerning the comparative effectiveness of individually or collaboratively-generated concept mapping on computers.

## Introduction

Visual representation facilitates both recall and comprehension (Cifuentes & Hsieh, 2003a, 2003b; Gobert & Clement, 1999; Hsieh & Cifuentes, 2003). Gobert and Clement (1999) indicated, "conceptual understanding also requires the student to be able to build meaningful and appropriate mental representations, i.e., a mental model, of the system being taught"(p. 40). Concept mapping, a form of visual representation, can be supported by computer software (Chiu, Wu, & Huang, 2000; Fischer, Bruhn, Grasel, & Mandl, 2002). When students have computer skills, they can more easily construct, modify, or maintain their visualizations than they can on paper, and skilled teachers can monitor and evaluate student's understandings effectively (Chiu, Wu, & Huang, 2000). The use of computer-based visualization tools such as Inspiration™, Mind Mapper™, and Microsoft™ Visio enable learners to interrelate the ideas that they are studying in multidimensional networks of concepts, and to label and describe the relationships between those concepts (Jonassen et al, 1998; Jonassen, 2000).

According to Fischer, Bruhn, Grasel, and Mandl, (2002) processes of collaborative knowledge construction can support learners' scientific knowledge construction more effectively than individual knowledge construction. Collaboratively-generated concept maps have power in supporting the process of meaningful knowledge construction. For this reason, a visual representation technique such as concept mapping is often integrated into collaborative learning activities (Chiu, Wu, & Huang, 2000). Using concept maps allows learners to communicate representations of their cognitive structures with other learners (Novak & Gowin, 1996). According to Fischer, Bruhn, Grasel, and Mandl, (2002) processes of collaborative knowledge construction can support learners' scientific knowledge construction more effectively in the environment of collaborative versus individual learning.

In summary, studies have shown that concept mapping positively affects science concept learning. When students have computer skills, computer-generating concept maps positively affect learning. In addition, the literature indicates that collaboratively-generating concept maps on paper or on computers positively affects learning. The literature has yet to report comparative effects of individually-generating concept maps on computers and collaboratively-generating concept maps on computers.

## Methodology

Using a quasi-experimental design, the researcher investigated the comparative effects of individually or collaboratively generating computer-based concept maps on middle school science learning. During training in concept mapping, students went through the process of identifying three types of text structure: sequential, categorical, and comparative structures. Students then applied visual conventions to represent those structures in concept maps. Students received instruction in concept mapping through workshop training, and used their newly acquired concept mapping skills to individually or collaboratively generate computer-based visual representations during study time. The hypotheses were that middle school students who collaboratively or individually generate computer-based concept maps would perform better on a comprehension tests than those who do not generate concept maps, and that middle school students who collaboratively generate computer-based concept maps perform better on a comprehension tests than those who individually generate computer-based concept maps.

**Participants**

Seventy four students in five 8th grade science classes at a middle school in Southeast Texas participated in this study. The ethnic distribution of the classes combined was 62% African American, 34% Hispanic, and 7% white. Ethnicities were equally distributed across the classes. Over 84% of students were economically disadvantaged. All students and classes were assigned to the same teacher. Using mathematics and reading performance scores on the Texas Assessment of Knowledge and Skills to assure equivalence of student achievement across groups, the researchers assigned the teacher's classes to one of the three experimental groups. Those groups were- (a) control (group that were not trained in concept mapping and were told to study using their preferred strategy), (b) students who were trained to individually-generate concept maps, and (c) students who were trained to collaboratively-generate concept maps.

**Design and Procedures**

Classes were assigned to one of three experimental groups: control, individually-generated concept mapping, and collaboratively-generated concept mapping. Students used the computer software program Inspiration™ to develop their concept maps. The dependent variable was a comprehension test score on science concept learning. Every student had a computer account and logon ID for the school computer laboratory. The teacher was able to trace student work and their outcomes on an administrator's server.

Both of the experimental groups that created concept maps on computers had attended three workshops on computer-based concept mapping in which they learned how to visualize science concepts on computers in their computer laboratory before starting to study science concepts. These computer-based concept mapping workshops lasted 50 minutes each of three days. The workshops had the same content and materials for each group. The science content of the workshops did not contain any concepts to be covered during the experimental study time. The control group spent the same amount of time as the experimental groups watching a video about the upcoming science fair as a placebo during workshop training.

The same teacher for all groups implemented instructional procedures. When students from any group asked for help and information, the teacher gave feedback equally to the students. After three days of the workshop training, the control, individual, and collaborative groups were given the same science essays to study for five days. The only difference among groups was that the control group did not create concept maps using computers and the individual group students worked independently to use their learned concept mapping skills to create visual representations that show interrelationships among concepts on computers during their study time. However, the collaborative group students were required to study together within small groups of three using their learned concept mapping skills to create visual representations that showed interrelationships among concepts on computers during their study time. Each of the three group members was assigned to be either the group's leader, reporter, or monitor.

The teacher gave 10 minutes of instruction for each group in five different science units during each of five experimental days. After the teacher's instruction, the students in the control group studied individually to prepare for the comprehension test. The two experimental groups' students created concept maps using computers for 30 minutes and then saved their files on their computer-server and printed out their concept maps to use during study time. After 30 minutes of study, each day for five days, students in each group were given 10 questions from the computer-based comprehension test to measure their understanding of the science concepts in the text that they studied. A learning strategy survey was given to them on the last day to determine their knowledge of content to be tested prior to the study and attitudes toward their experiences during the study.

The comprehension test consisted of 40 items from the Prentice Hall test bank that was provided with the eighth grade text book adopted by the participating school district. Items were criterion referenced to concepts that students studied during their experimental study time.

**Findings**

Using a quasi-experimental design, a one-way analysis of variance (ANOVA) was applied using treatment group as the independent variable and comprehension test scores as the dependent variable. A .05 level was used for determining significance. Levene's Test of Equality of Error Variances was tested and found to be homogenous. Table 1 shows that the two experimental groups' means scores were respectively - individual group (n=31) mean=6.4358 and collaborative group (n=31), mean=5.9613. The mean score for the control group (n=12) was 4.9167.

Table 1 *Means and Standard Deviation on Comprehension Posttest Scores*

| Groups | N | Mean | Standard Deviation |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Control Group | 12 | 4.9167 | 1.77845 |
| Individual Groups | 31 | 6.4358 | 1.23145 |
| Collaborative Groups | 31 | 5.9613 | 1.39668 |
| Total | 74 | 5.9907 | 1.47499 |
| Effect Size (control vs. individual) = 1.009 | | | |
| Effect Size(control vs. collaborative) = 0.658 | | | |

As shown in Table 2, the one-way ANOVA results indicated that a significant group difference existed among the control, individual, and collaborative groups on the mean scores of the comprehension posttest, F =5.118 (p> 0.05 level).

Table 2 *One way ANOVA Summary Table for the Effects of the Types of Treatment and Comprehension Posttest Scores*

| Source | Sum of Square | df | Mean Square | F | Significance |
|---|---|---|---|---|---|
| Group | 20.011 | 2 | 10.006 | 5.118 | .008* |

Tukey HSD post hoc test was performed for group comparisons. The post hoc test result revealed that the individual group was significantly different than the control group. This finding means that the individual group scored significantly higher than did the control group on the comprehension tests and that students who individually generated concept maps out performed students who studied independently without being instructed to generate concept maps. The effect size between the control and individual groups was 1.009. Therefore, our first hypothesis that middle school students who collaboratively or individually generate computer-based concept maps perform better on a comprehension tests than those who do not generate computer-based concept maps is only partially accepted. Students who collaboratively generated concept maps did not score significantly higher than did the control group on the comprehension test. Effect Size between the control and the collaborative group was 0.658.

Also, there was no significant difference between the individual and the collaborative group. Therefore, the second hypothesis that middle school students who collaboratively generate computer-based concept maps perform better on a comprehension tests than those who individually generate computer-based concept maps has been rejected according this Turkey HSD post hoc test results.

Table 3 *Post Hoc Test Table for the Effects of the Types of Treatment and Comprehension Posttest Scores*

| Tukey HSD | (I) Group | (J) Group | Mean Difference | Sig |
|---|---|---|---|---|
| | Control | Individual | 1.5191* | .006* |
| | Control | Collaborative | 1.0446 | .079 |
| | Individual | Collaborative | .4745 | .380 |
| | | | | P =.05 level |

In table 4, the student input on the Survey Result of Learning Strategy shows that attitudes toward concept mapping for science concept learning were positive. Creating concept maps using the computer program, Inspiration, provided students with a useful learning strategy and a positive experience. An interesting finding was that the students in the individual group were more positively engaged in their studying by themselves more than the students in the collaborative group. Only 50% of the collaborative group students thought that working with peers was helpful and useful to study science concept learning. According to this interesting finding, the researcher assumes that students' negative attitudes toward collaboration influenced the results and might explain why the individual group's students performed better than the collaborative group's students on achievement. When students prepared for the test, the control group students just studied the handout and read them, while the two experimental groups' students studied the relationships between bubbles on their concept maps and links that they created during study time. They expressed that creating concept maps and study relationships between bubbles and links were quite helpful, fun and useful for learning science.

Table 4 *Survey Result of Learning Strategy during Study Time*

| | Control Group | Individual Group | Collaborative Group |
|---|---|---|---|
| Feeling about | None | 87% of the students say | 87% of the students say |

| | | | |
|---|---|---|---|
| concept maps | | helpful and fun. Some students think better than worksheet on paper or regular class activity | helpful and fun. Some students think better than worksheet on paper or regular class activity |
| Helping to learn the content | None | 87% of the students think concept maps help with learning the science content. | 97% of the students think concept maps help with learning the science content. |
| Opinion of working with group | None | None | 50% of the students think that working with group is helpful and useful. 40 % students think negative. 10 % No response |
| Opinion of working with individual | None | 70% of the students think that studying by themselves is helpful and useful. 19% students think negative. 11 % No response | None |
| Steps of the preparing the test | Students read the whole handout and some students take notes and underline parts. | Students studied their concept maps and tried to understand relationship among the bubbles | Students studied their concept maps and try to understand relationship among the bubbles |
| Exposure of concept maps before | None | 12% students knew the concept mapping before. | 9% students knew the concept mapping before. |

## Discussion and Conclusions

The findings of this study revealed that individually-generating concept maps during study time positively influenced science concept learning, at least for eighth graders. However, the findings do not support Fischer, et al's (2002) assumption that collaborative knowledge construction is more effective than individual knowledge construction. Even though there was no significant difference between individual and collaborative groups in this group of participants, the researchers who conducted this study do not conclude that one approach is universally superior to another. In this case, the reason that the collaborative group did not score significantly higher than the control group on achievement might have been lack of a disciplined, supportive collaborative working environment and lack of experience with collaborative processes. Students in the collaborative groups spent excessive time competing the keyboard and were generally distracted by their group members. Most of the participants did not have computers at home and learned concept mapping for the first time in the context of this study. In addition, the school district had limited technical facilities. Also, most students had had few opportunities to develop collaborative learning skills in their young school careers. In another school context, where students have technical skills and support, the atmosphere is conducive to collaboration, and students have a history of collaborative experience in school, the finding may be more positive for collaboratively-generated concept-mapping. Researchers might investigate whether individually or collaboratively computer-generated concept maps differentially effect learners with specific characteristics such as those listed above. Given that participants in this study were distracted by members of their group, both the classroom teacher of those students and the researchers think that an investigation comparing collaborative groups versus collaborative pairs is of interest. This study contributes to the limited literature and body of knowledge concerning the effectiveness of individually versus collaboratively-generating concept maps on computers.

## References

Ajose, S.A.(1999). Discussant's comments: On the role of visual representations in the learning of mathmatics. In: Proceedings of the Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education (21st, Cuernavaca, Morelos, Mexico, October 23-26).

Brandt, L., Elen, J., Hellenmans, J., Couwenberg, I., Volckaert, L., & Morisse, H. (2001). The impact of concept mapping and visualization on the learning of secondary school chemistry students. *International Journal of Science Education, 23(12), 1303-1313.*

Chiu, C.H., Wu, W.S., & Huang, C.C. ( 2000). Collaborative concept mapping processes mediated by computer. *Institute of computer and information education, national tainan teachers college, 33(2).*

Cifuentes, L., & Hsieh, Y. C. (2004a). Visualization for construction of meaning during study time: A Qualitative Analysis. *International Journal of Instructional Media, 30*(3).

Cifuentes, L., & Hsieh, Y. C. (2004b). Visualization for construction of meaning during study time: A Quantitative Analysis. *International Journal of Instructional, Media, 30*(4).

Fischer, F., Bruhn, J., Grasel, C., & Mandl, H. (2002). Fostering collaborative knowledge construction with visualization tools. *Institute of Educational Psychology, University of Munich, Leopoldstr. 13, D-80802 Munich, Germany.*

Gobert, J.D., & Clement, J.J. (1999). Effect of student-generated diagrams versus student-generated summaries on conceptual understanding of causal and dynamic knowledge in plate tectonics. *Journal of Research in Science Teaching. 36(1), 39-53.*

Hsieh, Y. C., & Cifuentes, L. (2003). A cross-cultural study of the effect of student-generated visualization on middle-school science concept learning. *Educational Technology Research and Development*. *51*(3), 90-95.

Hsieh, Y.C., & Cifuentes, L. (2004). Student-generated visualization on paper and on computers for science concept learning. Unpublished manuscript.

Jonassen, D.H. (2000). *Computer as mindtools for schools: Engaging critical thinking.* Prentice Hall, Upper Saddle River, New Jersey.

Jonassen , D. H., Carr, C., & .Yueh, H.P. (1998). Computers as Mindtools for Engaging Learners in Critical Thinking. *TechTrends*, 43(2), 24-32.

Mayer, R. (1989). Systematic thinking fostered by illustration in scientific text. *Journal of Educational Psychology, 81, 240-246.*

Mayer, R., & Gallini, J. (1990). When is an illustration worth then thousand words? *Journal of Educational Psychology, 82, 715-726.*

Novak, J.D., & Gowin, D. B. (1996). *Learning how to learn*. Cambridge, England: Cambridge University Press.

# Development of Media Education Curriculum for Enlarging the Digital Prosumers' Performance Area

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**Abstract**

*This is the study of development of media education curriculum in the elementary schools. Supporting the new concept of the digital prosumer's performance, the project-based learning is considered as one of effective instruction theories. Following this idea, this media education curriculum is developed for the 6~9 ages students. This paper also includes the pictures of the program.*

## Introduction

The necessity of media literacy has been discussed since this information-rich society, to keep pace with the knowledge and technological expertise necessary for finding, applying, and evaluating information. Today the research fields for media education are getting voluminous with change the concept for media education environment as to 'digital environment.' This digital environment has three key meanings for media education. First it is easy for students to express the meaning with the various symbol systems. Second the hardware and software, which is to shape the media text, are developing everyday for the efficient use. Last key point is the raising issues of developing theories and the tools- which is to share the digital media text.

This digital environment has brought out the new concept '*the digital prosumer*.' Digital prosumer is referring to the person who accepts media information critically as well as engages actively in production of media information. In other words, '*the digital prosumer*' is the combination of ideas: media text producers and the media text receptors(Lim, 2003). For enlarging the digital prosumer's performance area[18] the media education, certainly, is required with the great support of the digital media environment.

As the concept of digital prosumer and its performance area have just introduced, the concrete instructional strategies for developing the media environment and media curriculum, are not full enough made out. To cover this limitation for developing the media curriculum for enlarging digital prosumer's performance, consequently, this study has taken up the most suitable instructional theory, project-based learning, as just the sub-instructional strategies.

Therefore, the purpose of this study is to develop media education curriculum for enlarging the digital prosumer's performance area. The main design principle is the contents design strategies of media literacy education to cultivate the digital prosumer with the sub-support of project-based learning strategies.

## Theoretical Framework

### Digital Prosumers' Performance Area

Kwon and Sim(2005) suggested the designing strategies of media literacy education to enlarge the digital prosumers' performance area. Kwon and Sim illustrated the three axis related to the digital consumers' performance area. They are 'multiplicity of symbol systems', 'acceptance and production of media text', and 'sharing of media text'.

'Multiplicity of symbol systems' is concerned with how to use diversely the symbol systems. Learners need to know about the effective way of communication by understanding the characteristics of each symbol system. They also need to understand the principals of effective coordination among various symbol systems.

'Acceptance and production of media text' is related to whether learners only accept the information, or whether not only accept the information but also produce the media text using the information they accepted. In relation to acceptance, learners need to actively access the media text, then, accept the media text critically and selectively. In relation to the production of media text, learners need to acquire the two kinds of competencies. One is associated to the data creation, transformation, edition, and publishment of the media text. The other is related to the critical, creative and complex thinking in regarding the media text.

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[18] Detail explanation for the digital prosumer's performance area is introduced in theoretical backgrounds.

'Sharing of media text' is associated with whether learners personally possess their media text or openly share with others. When they share the media text, learners perform the two roles, consumer and producer. Learners as consumers need to critically understand and interpretate toward the producers and the products(The New London Group, 1995). Learners as producers need to have the attitude that adjustably accommodate the consumers opinion. Every learners should be familiar with the tools and spaces for sharing media texts.

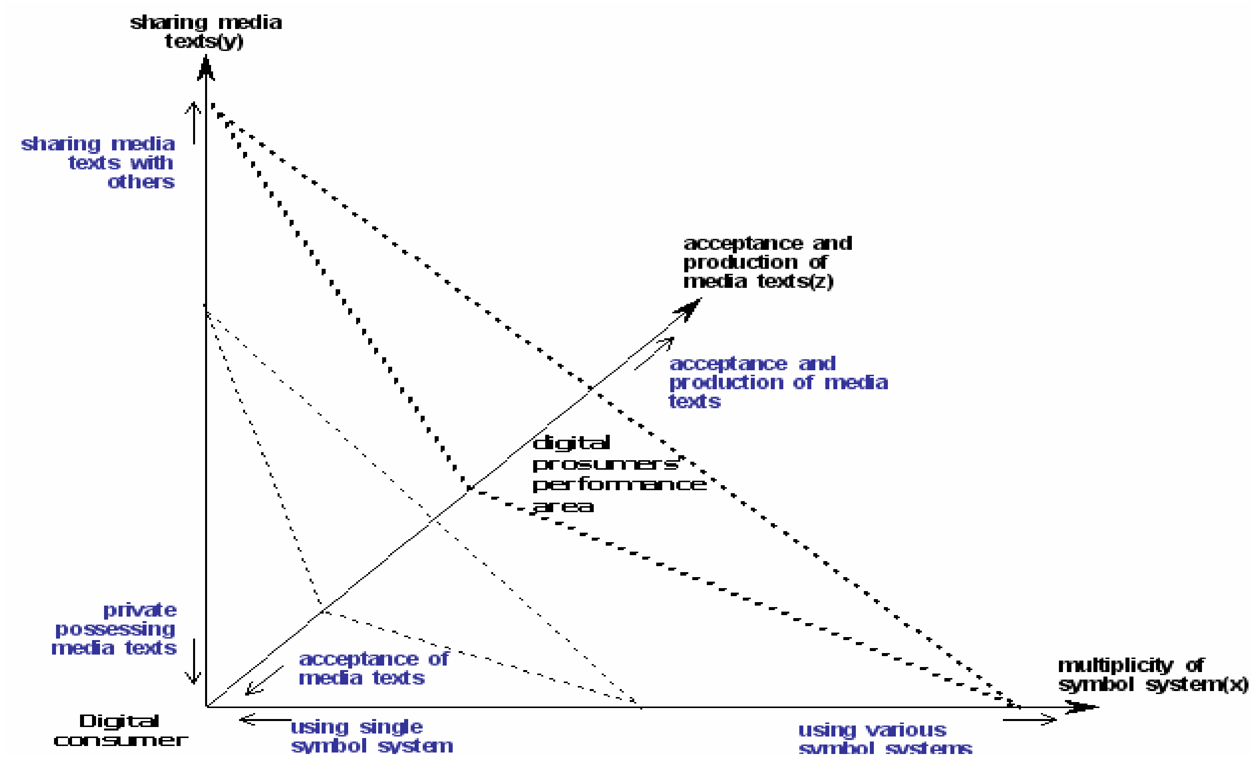


*Figure 1.Tthree axis of the digital consumers' performance area*

**Project-based Learning**

This study applies the project-based learning as the sun instructional strategies. So instead of detail information on the project-based learning, the concept and the instructional method for PBL is shortly presented in this article.

Project-based learning, based on the constructivism, creates opportunities for students to work on problems in the real situation. Teachers bring projects relevant to the real problems, coming out outside the classroom, and help the students to see and understand the connections between classroom activities and the real situation of the work. These projects can also build students abilities to set group goals with collaboration among peers. The interdisciplinary nature of these projects encourages students to widen and explore their personal interests while gaining the knowledge they need in core subjects(Leffy, 1998).

Three main principles for project-based learning are as the following(Penuel et. al, 1999). First key principle is the student's full participation, leading his/her project. Students get the chance for making the decision of all the problems when working the project. And this leads students to get responsibility for their work and their peers. Secondly, students learn how to present all the process of research activities and the final results with effective use of the media literacy. Last principle brings learners to have broader ideas for understanding and developing the curriculum. Both learners and teachers are making the curriculum together, so the curriculum can not be fixed before the class starts.

**Six strategies for PBL are summarized as followings.**

First , scaffolding is used for helping students who lose the ways to work the project. Second, coaching will lead students to finish their job on the level of experts. In other words, the project quality will be advanced up to the project done by experts. Third, ample resources for projects are concretely provided for supporting for all the projects. Forth, each different knowledge representation will contribute to the activities for collecting, selecting, summarizing, and creating knowledge. Fifth, the process of collaboration, and sharing ideas, and feedback will proceed naturally to encourage the communication. Last strategy is providing activity for reflection. This activity will be great help for evaluating the project process and the results, and personal participation.

## Design and Development

This study develops the media literacy curriculum, ‘Building the Garden of Media’ for the 1~3grades. The main design principle is the contents design strategies of media literacy education to cultivate the digital prosumer with the sub-support of project-based learning strategies.

| **Module Flow** | **Module Theme** | **hr.** | **Learning Materials** | | |
|---|---|---|---|---|---|
| | | | **Video** | **Pictures** | **Music** |
| **Prologue** | What is the media? | 1/1 | **O** | **O** | |
| **Media and I** | My face in the pond | 2/4 | | **O** | |
| | Making Media Tree | 2/4 | | **O** | |
| **Making Media** | Making Story of Media Garden | 4/11 | | **O** | |
| | Media Train | 4/11 | **O** | **O** | |
| | Finding the music | 3/11 | **O** | | **O** |
| **Understanding Media** | TV! | 3/6 | **O** | **O** | |
| | Recognizing the Media Garden | 3/6 | | **O** | |
| **Epilogue** | Displaying the final output | 3/3 | | **O** | |

*Table 1. Strategies of media literacy education to enlarge the digital prosumers' performance area*

Table 1 shows the strategies of media literacy curriculum based on the concept of three axes related to digital prosumers' performance area.

| **No.** | **Axis** | **Educational Contents** | **Teaching and Learning Strategies** |
|---|---|---|---|
| **1** | multiplicity of symbol system | ▪ understand the unique characteristics of each symbol system and practice their utilization<br>▪ understand multiplicity of various symbol systems and practice its utilization<br>▪ understand the characteristics of symbol systems used in each media | ▪ guiding for learning activity<br>▪ offering good & bad cases for use of symbol system<br>▪ knowledge on grammar of each symbol system |
| **2** | acceptance and production of media texts | ▪ critical understand and interpretation of media text<br>▪ practice the skills needed for the media text production<br>▪ creative production of the media text | ▪ facilitating practice for critical thinking<br>▪ offering the evaluation criteria for project outcome<br>▪ guiding the process of project activity<br>▪ offering tools for group activity support<br>▪ offering online spaces for group activity |

| | | | |
|---|---|---|---|
| | | | support |
| **3** | sharing media texts | ▪ attitude of consumer who shares media text<br>▪ attitude of producer who shares media text<br>▪ practice the skills needed to use tools and spaces of media text sharing | ▪ suggesting the desirable attitude as consumers/producers<br>▪ offering the tools for sharing media text<br>▪ offering the tools for (a)synchronous discussion<br>▪ offering the tools for reflection<br>▪ guiding how to use the tools and spaces for sharing |

*Table 1. Strategies of media literacy education to enlarge the digital prosumers' performance area*

The following strategies are more precisely for contents design on the basis of project-based learning(Kwon, Seo. Kang, 2002).

| No. | Characteristics | Educational Content | Teaching and Learning Strategies |
|---|---|---|---|
| **1** | Help students who lose the ways to work the project. | Teachers and peers, supporting students to lead the project | Scaffolding |
| **2** | Lead students to finish the project, advancing to the one by experts. | Teachers' advice, , bring synergy effects among peers and the student | Coaching |
| **3** | Full resources for projects, provided for supporting for all the projects | Resources, guiding students to find the project themes in real life situation | Resource support |
| **4** | Each different knowledge representation, contributing to the activities for collecting, selecting, summarizing, and creating knowledge. | Use of multiple media, shaping the learning contents, and materials | Knowledge representation |
| **5** | the process of collaboration, and sharing ideas, and feedback, to encourage the communication. | Interactions, raising through co-working of the project with peers. | Communication and collaboration |
| **6** | Providing activity for reflection helping for evaluating the project process and the results, and personal participation. | ▪Discussions with teacher and the students, and peers, sharing and developing ideas<br>▪Reflect on student-oriented learning process, not teacher-oriented and evaluate it | Reflection |

*Table 2. Strategies of media literacy education based on the project-based learning*

## Results

Media curriculum, 'Building the Garden of Media', has divided its module flow into three, 'Media and I', 'Making Media', and 'Understanding Media.' And the three main parts, including prologue and epilogue, has nine themes. 'Building the Garden of Media' has published into three types: a book for teachers or facilitators, a workbook, and CD including all the learning materials. In CD, pictures, audio materials, and movies are contained. Videotape for movies was provided, either.

'Building the Garden of Media' is developed for the six~nine ages, containing the contents on understanding the media, and its principles for its effective use, and critical analysis skills on media education. This program is to lead students to identify and solve the project problems for themselves – which is the main purpose of the PBL, project-based learning. Besides, the levels of contents are introduced for the differences in cognitive development, and the collaboration work is encouraged with systematic design.

| Module | Module Theme | hr. | Learning Materials |
|---|---|---|---|

| Flow | | | Video | Pictures | Music |
|---|---|---|---|---|---|
| **Prologue** | What is the media? | 1/1 | **O** | **O** | |
| **Media and I** | My face in the pond | 2/4 | | **O** | |
| | Making Media Tree | 2/4 | | **O** | |
| **Making Media** | Making Story of Media Garden | 4/11 | | **O** | |
| | Media Train | 4/11 | **O** | **O** | |
| | Finding the music | 3/11 | **O** | | **O** |
| **Understanding Media** | TV! | 3/6 | **O** | **O** | |
| | Recognizing the Media Garden | 3/6 | | **O** | |
| **Epilogue** | Displaying the final output | 3/3 | | **O** | |

*Table 3. 'Building the Garden of Media' module matrix*

This program has six advantages for effective use for media curriculum.

First, topic 'building the garden of media' leads students be not just the receivers of the media text, but the prosumer in the media environment. Besides, the name 'Building the garden' takes the images of making their own ideas on media for themselves.

Second, students' ages are reckoned when designing the media curriculum. Various learning materials and resources are designed according to the ages, for helping students do the work.

Third, the project is the main activity in this curriculum. Through the project, students get the concept or principles for understanding the media text, and the digital prosumer.

Forth, the program schedule is not strongly fixed. So teachers change the schedule easily, depending on the class situation such as the unexpected periods that learners take to finish one lesson. Additionally, this curriculum can also be actively used in the workshop or seminars.

Fifth, the absolute media preparation is not required in this project. Various methods for active communication is introduced instead of using the cutting edge media.

This curriculum was done through the workshop in June 2001. Following table is the feedback from the interview with teachers after implementing this program[19].

| No. | Three Key Point | Feedback in details |
|---|---|---|
| **1** | Teacher's role | ▪ Making students have interest in lessons when beginning the class(This have brought out the project quality difference)<br>▪ Not goal oriented, but process-oriented class is needed.<br>▪ Leading active need communication and solving the conflicts or fights among students are necessary<br>▪ Patience is required to make students lead the project |
| **2** | Time Schedule | ▪ To keep attention on students' process of learning lessons is required for time schedule change. Usually more time is needed comparing to the time plan in the workshop. |
| **3** | Contents | ▪ This curriculum is absolutely one of alternative solutions for having students with full participation |

[19] In June 2001, a workshop was done for 4days 3nights. Teachers and students in various public schools have participated in here. Interview for evaluating the curriculum was done after the workshop. The table is summarized shortly.

▪ Students' understanding of concepts are not obviously represented easily. But the project process and its output clearly show their understanding of the lessons.

*Table 4. Teacher's Feedback after 'Building the Garden of Media' workshop*

**Conclusion**

This study suggests four new ideas for developing the media education in Korea.

First, both theorists and practitioners should design the effective curriculum of instruction, with organizing various groups of learners and teachers.

Second, , the new paradigm of the instruction in the field of the open media education should be studied using the media tools with the enthusiasm of improving the instruction.

Third, When designing the specific media literacy education program, to enlarge the digital prosumers' performance area, the designer needs to develop the program more elaborately applying the systemic instructional design process after deciding the target audience and the project content.

Fourth, The roles of educational technology needed for future desirable media literacy education is suggested.

# Creating Video Products to Serve Educational and Non-Profit Organizations: A Community-Based Experiential Learning Experience for Students

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**Abstract**

*This paper introduces an interactive video production class. In this class, the learning activities were designed and structured to facilitate student application of classroom learning to a community-based setting. Based on information gathered, the author summarizes and compares students' reflection and learning outcomes in the two semesters. The author also provides suggestions in terms of design and implementation of community-based experiential learning.*

## Introduction

Experiential learning is rooted in doing and experiencing (Hutton, 1989). An interactive video class usually requires student to do a project or several smaller projects to learn camera operation and video editing skills. However, being able to operate a camera and edit video clips does not equal ensuring students to be able to meet the needs that the workforce requires. Projects created by educational technology students are more meaningful when the projects serve educational purposes. For example, an interactive video of an instructor explaining difficult points of a lesson can be very helpful for an online course. For another example, an interactive video of drills and practice for mathematics remediation purposes can be used for as many classes as needed without requiring teachers' extra work hours. These projects serve educational purposes and make students' use of time doing projects more meaningful for the class. Based on its nature, the interactive video class can be designed to facilitate student's application of classroom learning to a community-based setting, so that the projects that students have created can be used by schools or non-profit organizations to help with teaching, research, and service. According to Boydell (1976), experiential learning is synonymous with meaningful-discovery learning. According to Moon (2004, p. 116), "we are not likely to learn from experience unless there is some intention or will to learn." Engaged in the community, through experiential learning, students are expected to be able to learn more meaningfully and their critical thinking, problem solving, technical, and communicational skills that the workforce requires are expected to be enhanced.

The discussion of this paper is based on two semesters' information, one in a 16-week fall semester and one in a five-week summer session.

## Design of the Class Activity

This interactive video class was designed using a community-based experiential learning approach to serve two purposes: 1) to prepare students for working in a real world situation and 2) to create projects that help the community with their teaching, research, and/or services. Students were told to do the project in a group of two to three. Projects needed to meet the needs of the community partners for educational / instructional purposes. The finalized projects needed to include a title, text, graphics, background music, narrative, and special effects where appropriate. Each project should take approximately around 10 minutes to view, focusing on one specific topic.

**Role of students in project development**

1. Contacting a school, a department at the university, or a non-profit organization (using a questionnaire) to find out the need for the project.
2. Defining the project and contacting the community partner to be involved to confirm that the plan was feasible and the activities would be supported.
3. Writing a proposal of the project describing the proposed topic and stating rationale and the confidence to complete the proposed project.
4. Upon the approval of the proposal by the instructor, preparing the production planning document, including goal statement, target audience, communication objectives, content outline, creative treatment for the product (background music, narrative, transitional effects etc.), shot breakdown sheet (shot description and location), script (video and audio for each shot), and projected timeline. The project to be created should meet the community partner's goal and the needs of the target audience.
5. Video shooting, editing, and compressing.
6. Presenting the project in class, debriefing, and peer evaluation.

7. Revising (if needed).
8. Sending the project to the community partner for preview.

**Role of community partner(s) in project development**
1. Receiving students and discussing the project with students to help define a topic.
2. Providing content information for the video product.
3. Scheduling videotaping sessions with students.
4. Reviewing the draft video product and providing feedback.

**Role of the instructor**
- Guiding and supervising students' learning activities
- Ensuring quality of students' projects.

## Student Profile and Work Groups in the Two Semesters

There were five students enrolled in the fall semester, one American and four international students. They formed two groups. Students themselves decided which group to join. After talking to one another, two international students formed one group and the other three formed a second group. The two-student group decided to work with the International Affairs Center and create a project that would introduce every aspect of the university that an international student needed to know before they came to the US. The other group did not have a topic until they went to talk to the community. They finally determined a topic that they thought was meaningful. They decided to work on a project for a senior home.

All five students in the fall class were highly motivated. They scheduled their meetings, discussing their plans, and working long hours together. Their peer evaluation and reflection were very positive (details will be discussed in the "Student peer-evaluation and reflection" section).

In summer, six students were enrolled, two school teachers, one local librarian, one university staff, and two international students. One of the school teachers requested to do an individual project for his school and the university staff member also requested to do an individual project for her own university. The two international students formed one group and the remaining two, the librarian and the other school teacher who was enrolled for teaching license renewal formed another group. The first group was interested in introducing an English language program to international students and the second group was discussing teaching Spanish as the project topic. The two students in the second group had schedule conflicts because the school teacher was living about 70 miles away from the campus. Later, this school teacher dropped the class. As a result, there was only one group project and three were working on their individual projects.

Students in the summer session were very excited about the project at the beginning of the class. However, towards the end of the semester, the three students who were doing individual projects were frustrated. They expressed their wishes that they should have had a team worker. They also said because they did not have a good plan at the beginning, they were not able to fulfill something that they had thought was easy to do.

## Learning Outcomes

Learning outcomes of this class were evaluated in three aspects: the video project, peer-evaluation and reflection, and presentation and professional critique. They are discussed in the following sub-sections.

**Video projects**

The projects that were created by the fall students were of comparatively higher quality concerning both technical skills and the content. The project introducing the university to international students started with welcome remarks from an interim associate director of the International Affairs Center, which was followed by video shots of every detail about living on campus that an international student needed to know. The group interviewed the International Affairs Center to gather all information needed for the project, including official documents, academic life, financial help, living conditions, up to the homecoming and the international festival. The video clips of all information were efficiently and appealingly edited together. The background music was exciting. The narration was spoken using an international student's voice, which made the video even more like home to international students. The video project ended with the interim associate director's welcome remarks together with the contact information. The International Affairs Center was happy with the project.

The second group created a more professionally-looking project. The three students of the group, in their own words, were perfectionists. They did video taping and editing together. For every scene, they videotaped from three different angles, so that they were able to compare the video footages to decide which one was the best for the editing of the project. The purpose of the project is to help senior citizens find a home. The content covered all facilities available for senior citizens, including the library, the bank, the media room, the clinic, the dinning room, the physical fitness facilities, up to various services such as cleaning, transportation, etc. For each section, the video showed viewers what forms needed to be filled out for living in this senior home. The students used a unique technique of transferring static pictures from black and white to sepia and then to color instead of traditional transitional-effects when editing the video clips. The transition from static pictures to dynamic motion made the whole project much more vivid. The background music was soft and graceful. The location of text was also carefully considered. Students were very proud of their project. Although they spent long hours on the project, they thought the project was worth their time because they were rewarded with not just knowledge and skills but also self-satisfaction.

In general, the projects created by the summer students were not as of high quality as those created by the fall students. Both video shots and editing were rougher. The organization of the three individual projects was not as good as the project that was created by the group. Students said that they had expected a better project than what they had. They concluded three major reasons: 1) five weeks' time was too short for doing a project at that scope; 2) during the summer time, it was not as easy for them to get community's cooperation; and 3) they (the three students who did individual projects) should have had a team worker working on the project.

**Student peer-evaluation and reflection**

Every student was required to do self-reflection and students who did a group project were required to write a peer evaluation on the team work. Most members of the three groups, two in fall and one in summer, evaluated their peers' work and attitude highly. They expressed their appreciation for the team work. They pulled their minds together and learned from each other's strength. They said that without their partner(s)' contribution, the project would never be so professional and their work experience would not be so satisfactory. The key words that expressed their appreciation about their partners' contribution include the following:

- "I really enjoyed working on this project with my partner."
- "He had very sharp observation – he pointed out many problems I could have passed while we were editing the video and audio…"
- "I would say we were meant to be a group together because we could fill up the weakness for each other."
- "He is willing to try new things… Because of his willingness of trying new things on our video, we were able to use many different effects on our video."
- "He is also a good team player."
- "I had a very good experience working with my partner and he made a great contribution to this team. I look forward to work[ing] with him again."
- "My partner is an intelligent and hard-working worker. I am so impressed by her creativity. Her idea usually inspired me a lot."
- "She is a dedicated professional that attends each meeting with a spirit of collaboration and cooperation."
- "She is a hard worker, a perfectionist and a very dependable person."
- "She has a great eye for details and uses appropriate technical vocabulary to describe the elements and points of improvement in our project."
- "Her guidance during the shots as well as the interaction with the personnel and residents [in the community] created the atmosphere and the way to success for our project."
- "His technical skills became evident especially during the editing process and in making comments regarding the project."
- "His dedication and dependability were greatly appreciated."
- "During the shots, he conducted himself with the expected professionalism, working collaboratively in a helpful way."
- "He is obviously a dedicated individual."
- "Both my partners are high achievers and perfectionists who push themselves and the team to a better standard than usual."
- "He has a very keen eye for the artistic temperament of a picture, movie or sound and she is very observant about the nuances of a clip while keeping the big picture in focus."
- "Repetitive tasks were speeded up by two or all three persons manning the keyboard and mouse."
- "He and she also improved on each other's ideas, improving the quality of the project and in my opinion surpassing the expectations of quality we had set for ourselves."

- “I believe as teammates we had a very symbiotic relationship and I would work with them again given the opportunity.”
- “He was always willing to try something new even if meant redoing a previous clip.”
- “I appreciated their energy and patience with this project.”
- “Many times we were staying and working on the project until the early hours of a new day. All of us are perfectionists and wanted to create the best project possible.”
- “We knew the parameters and criteria of excellence expected of this project. I believe this was accomplished with their insight, input, and skill.”

One student was not very satisfied with her partner’s performance. She complained about her partner’s lack of computer experience. Her partner was a new international student. This international student said in her peer-evaluation that her partner dominated editing so she did not have much chance of improving her technical skills. However, they completed the project together and both commented that it was a great experience for them to work with their partner in the same group.

Moon (2004, p.164) suggested a list of assessment criteria for reflection on the learning outcomes. According to the nature of our video class, I created the following list based on Moon’s criteria for students’ reflection:

- Appreciation of team work
- Learning to form a system for efficient work
- Enhancement of skills and knowledge /Learning about the equipment and software
- Project management/Planning/Working long hours
- Motivation
- Communicational skills
- Creativity
- Preparation ahead of class
- Learning how organizations work
- Learning about personal work behavior patterns
- Learning to work with feedback from others
- Learning about own career inspiration/Learning to learn from experience
- Learning self-management
- Gaining employability skills/Key skills not easily gained elsewhere in the curriculum
- Development of self-confidence and willingness to take initiative
- Suggestions about future project outcomes

Students’ self-reflection varied in length from half a page to four and a half pages. Not all the students addressed every item on the list. The following table lists the frequency that the students who worked as a group (a total of seven students) addressed for each item.

| **Criteria** | **Frequency** | **Sample Response Coded** |
|---|---|---|
| Appreciation of team work | 27 | We knew the parameters and criteria of excellence expected of this project. I believe this was accomplished with their insight, input, and skill. |
| Learning to form a system for efficient work | 3 | I will never start shooting without a perfect production document again for future project. |
| Enhancement of skills and knowledge /Learning about the equipment and software | 18 | I could try many new tricks and effects controls that I have never used before. |
| Project management/ Planning/ Working long hours | 12 | The instructor wanted us to be perfectly ready with production document before we start any shooting or editing; however, we just started shooting with only simple shooting outline because we thought we could control the story with editing later on. Eventually I could find that she was right and we were totally wrong. |
| Motivation | 3 | It inspired me to make this video better when the faculty in xxx wanted us to make a good video for them, so they could actually use it… |
| Communicational skills | 7 | I hated to ask around at first, but eventually I enjoyed meeting with new people[s]. |

| | | |
|---|---|---|
| Creativity | 7 | I tried to make especially the ending section to look like a professional TV documentary show, with my own creative style. |
| Preparation ahead of class | 4 | The instructor wanted us to be prepared with an idea for the final project of this class. I always wanted to make an educational video for building a computer, so I prepared all the parts of the computer by disjointing my current system. (He changed the topic later) |
| Learning how organizations work | 3 | I thought xxx was a waste of time and money before, but not any more. |
| Learning about personal work behavior patterns | 1 | … I think I was out of focus from what we should do. With the advice of my partner, however, I could finish the project to fit with the purpose of our project. |
| Learning to work with feedback from others | 6 | I showed the finalized video to my old friends who are currently working in a film industry. They suggested modifying the sound volumes and the titles. |
| Learning about own career inspiration/Learning to learn from experience | 3 | The mistakes that I had in this project will not be repeated in my future production jobs, so I think the mistakes were worth enough. |
| Learning self-management | 3 | This class' main project helped me to learn how to manage my time to finish my project in such a short period. |
| Gaining employability skills/Key skills not easily gained elsewhere in the curriculum | 6 | I found that the other classes of my educational technology curriculum do not teach you as much about how to manage your projects. |
| Development of self-confidence and willingness to take initiative | 3 | Since I had the experience and knowledge about Premiere Pro, I was willing to do the editing mainly, and at the same time, teach my partner to use the software so he can assist, and eventually take a part of the editing. |
| Suggestions about future project outcomes | 5 | In the future project, I would just make especially detailed scripts for all the actors in my movie, so I can shoot all the scenes in the way I want. |

Frequency was coded based on how many different items a student mentioned in his/her reflection for each criterion. For example, a student mentioned that he learned 1) improve his technology skills from his friends' feedback, 2) correct his grammatical errors from his partner's feedback, and 3) how important feedback from a third part always could help improve a product, so his reflection on "learning to work with feedback from others" was coded three times. The numbers in the table show us that students had very high appreciation of team work. They also appreciated enhancement of their knowledge and skills. They appreciated the project management skills that they had acquired through doing the project in a community-based environment. Almost all students discussed the above achievements. Not all students discussed other criteria. Only one student mentioned "learning about personal work behavior patterns."

The reflection written by the two students of the group in the summer session was more thorough than the reflections written by the groups in the fall semester. The reason could be that I provided a written reflection guideline for the summer session students while to the fall semester students I only orally explained what they needed to write in the reflection. I decided to provide a written reflection guideline for the summer session students based on my experience with the fall semester students. I believed that the fall semester students' reflection could have been more thorough with a written guideline.

The summer group's reflection focused more on the challenges that they had faced and how they had learned from the challenges while the fall groups' reflection focused more on how much others had contributed and how much they themselves had contributed to the project. The reasons could be summer session students were challenged more than the fall semester students. The summer session students had only five weeks working on their projects and during summer, schools were closed and it was more difficult for students to find community partners. Even when students had a community partner, scheduling was not easy. The fall semester students did not have those challenges.

The summer students who did the individual projects debriefed that they learned technical skills such as video shooting, editing, creating a naming convention for footages for easier searching, etc. They at the same time also stated their frustration. One student expressed her wish. She said only if she could have had a teammate who had a similar skill level in understanding computers and design. She said: "In this class I preferred to work on my own as it was more conducive to my work schedule... I do like to talk through my ideas with other people though." She also said that she had plenty of ideas; however, she was not able to put them down in a cohesive manner. Another student had a very exciting idea for his school. He said that the school authorities were also very excited with his anticipated project. However, he was frustrated when students did not show at his interview that was scheduled according to students' preference. He said: "It is summer time!"

**Presentation and professional critique**

Students were required to do a presentation in the final week. They were also required to do a professional critique on other students' projects. The groups in the fall semester were more "critical." They asked questions when the other group was presenting and offered suggestions about how to improve the quality of the product. Summer students were not that critical. They almost always said "great" to every presentation of the project. One of the reasons could be students in the fall semester worked in more depth on their own projects; therefore, they had more insight about how to improve the quality of a project. Another reason could be students in the summer session went through more challenges, so they valued more on every achievement on the project that their peers made than the quality proper of the project.

## Conclusion

From the above two classes' experience, I would like to conclude that

- Community-based experiential learning challenges and benefits students who do not have work experience more than students who have work experience. According to students' reflection, those who did not have work experience addressed more on their improvement of communication skills, project management, and self-management skills than those who were having a job. They also addressed more on gaining own career inspiration, employability skills, and key skills not easily gained elsewhere in the curriculum.
- Community-based experiential learning is more appropriate to take place in regular semesters. It probably should not be scheduled in a summer session. Summer sessions are usually shorter than regular semesters and in summer, schools and some other organizations are closed. There are not so many opportunities for students to do a community-based project in summer. Even if students get a chance, scheduling of videotaping can be a problem. However, in a more challenging situation, students' reflection went in more depth.
- Successful community-based experiential learning requires team efforts. Projects become much bigger when they are community-based because community-based projects require social negotiations. Students not just learn technology skills but also learn communication and management skills; therefore, they are involved in a multitask environment with community-based experiential learning. Multitask requires more brain; pulling heads together will help solve problems in a better way with less stress.
- Membership of a group needs attention. New comers with no work experience could have certain disadvantages in a group project. If they are not aggressive enough, they could lose some learning opportunities when the project is dominated by some more capable students. Concerning this issue, the instructor needs to enhance monitoring of the group work, for example, having periodical peer-evaluations instead of having only one in the final week. In this way, the problem that needs to be addressed and solved could be identified earlier in the semester.

Designing a community-based experiential learning environment for students is feasible for a video production class. Moon (2004) said that "transfer of experiential learning from an educational context to the situation of its main deployment – such as the work situation – is a major issue." (p.118). Designing experiential learning activities for students needs to put an emphasis on learning in a meaningful environment, in which students will be able to find the theme for the project that can serve a real purpose in the real world. In a community-based experiential learning environment, the shift in emphasis from faculty teaching to student learning requires students to think more, participate more, and take more control of their learning experience (Vega & Tayler, 2005). "By working in groups, students gain additional insights, are exposed to multiple points of view, learn from each other, and learn important interpersonal and group skills" (Paswan, & Gollakota, 2004, p225). Peer evaluation and debriefing encourage students to draw lessons from the process of their learning experience (Walker, 2005).

The limitation of the above conclusion is that the discussion is based on information from only ten students' learning outcomes in two semesters.

## References


Boydell, T. (1976). *Experiential learning*. Manchester: University of Manchester Press.

Hutton, M. (1989). Leaning from action: A conceptual framework. In S. Warner Weil & M. McGill (Eds.), *Making sense of experiential learning* (pp. 50-59). Milton Keynes: SRHE/Open University Press.

Moon, J. A., (2004). *A handbook of reflective and experiential learning: Theory and practice*. London: RoutledgeFalmer.
Paswan, A. K., & Gollakota, K. (2004 Mar/Apr). Dimensions of peer evaluation, overall satisfaction, and overall evaluation: An investigation in a group task environment. *Journal of Education for Business. 79*(4), 225-231.
Vega, Q. C., & Tayler, M. R. (2005 Spring). Incorporating course content while fostering a more learner-centered environment. *College Teaching. 53*(2), 83-86.
Walker, J. (2005 January). Debriefing: Enhancing experiential learning. *Journal of Family and Consumer Science. 97*(1), 73-75.

# Rationale behind the Adoption of Computer-Mediated Communication Channels in an Urban Teachers' Electronic Support System

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**Rationale behind the Adoption of Computer-Mediated Communication Channels in an Urban Teachers' Electronic Support System**

An educational technology expert panel from the U.S. Department of Education (2000) advocated that electronic networks, digital resources, and computer technology can help create stronger connections between preservice teachers, university faculty, and mentor teachers, and thus provide valuable resources as preservice teachers professionally develop through their student teaching and induction phases. Such electronic networks can help create a meaningful learning environment where learning is touted as active, constructive, intentional, authentic, and collaborative (Jonassen, Howland, Moore, & Marra, 2003).

The Teacher Electronic Performance Support System (TEPSS) is a vital part of a PT3 project at a major southeastern university that aims to prepare technologically proficient teachers for diverse urban classrooms. The design of the TEPSS system was based on the concept of EPSS. Traditionally, EPSS have been designed and developed to improve individual work performance on-demand, as envisioned by Gery (1991). Currently, the maturity and diversity of CMC tools enhanced by the exponential growth of computer technology, have made leveraging collaborative efforts to promote individual performance improvement a norm. In accordance with this trend and supporting literature on the value of collaborative efforts in teacher education, the authors have chosen to add CMC as an integral component of TEPSS. This paper provides rationale for the design of CMC tools to be used within TEPSS.

**Computer-Mediated Communication**

CMC is a process by which different parties, situated in particular contexts and separated in space and/or time, create, exchange, and perceive information using networked telecommunications systems (or non-networked computers) that facilitate encoding, transmitting, and decoding messages (December, 1996, 1997; Romiszowski & Mason, 2003). CMC can be synchronous and asynchronous. Some examples of asynchronous CMC tools are e-mail, listservs, newsgroups, bulletin boards, weblogs, and wikis. Some examples of synchronous CMC tools are chat rooms, instant messenger, audio teleconferencing, and video teleconferencing.

CMC has become an important tool in education. It has been accredited useful for fostering learning through reflection, social interaction, engagement, collaboration, high-level thinking, cognitive development, and virtual community building (Bloom, 1981; Bruckman, 1998; Carswell, Thomas, Petre, Price, & Richards, 2000; Fisher, 2002-2003; Graham & Scarborough, 1999; Jones, 1995; Kearsley & Shneiderman, 1998; Muirhead, 2001; Stacey, 1999). Moreover, a paradigm shift in learning theories appears to have taken place in which learning is viewed as being a process involving individual learner's knowledge construction in a collaborative environment (Jonassen, Peck, & Wilson, 1999; Romiszowski & Mason, 2003). Use of CMC effectively supports this idea through the high levels of interaction it provides. In this way, it can enable students to construct their knowledge through active learning and collaboration (Alessi & Trollip, 2001; Carswell et al., 2000; Romiszowski & Mason, 2003). The following sections are results of an analysis that will guide the design of CMC channels in TEPSS.

**CMC Channels in Existing Electronic Support Systems**

CMC tools have been embedded in some existing electronic support systems tailored for teacher professional development. Calandra, Lai, & Sun (2004) reviewed seven such systems, three of which have incorporated CMC into their models. For example, *Integrating New Technologies into the Methods of Education* (InTIME) seamlessly incorporates a WebCT-enabled discussion mechanism into its system structure. InTIME also provide the use of email for students. *Knowledge Loom*, an ongoing virtual learning community, provides several vital discussion mechanisms to boost knowledge creation and sharing. *Teachscape* provides a CMC mechanism where teachers can participate in virtual discussions either among their learning groups or in a public arena. Moreover, in *Learning Inquiry Forum* developed by Indiana University, CMC channels such as email and chat are provided to teachers and students to share, reflect upon, discuss, and improve their teaching and learning in a smaller group setting.

## Theoretical Framework

*Constructionism and Learning*

Constructionism is a theory an expansion of Piaget's "constructivism" and was coined by Seymour Papert. Papert explained constructionism below:

> We understand "constructionism" as including, but going beyond, what Piaget would call "constructivism". The word with the v expresses the theory that knowledge is built by the learner, not supplied by the teacher. The word with the n expresses the further idea that this happens especially felicitously when the learner is engaged in the construction of something external or at least shareable.... (Papert, 1991, p. 518)

People learn best when they actively participate in activities to create something that is meaningful to themselves or to others around them (Papert, 1993; Resnick, 1994). Furthermore, such a process provides a motivating context for students to learn the subject matter and content. For example, when students are engaged "in cycles of designing, evaluating, and redesigning, they also have the opportunity to confront their understanding and misunderstandings of science concepts" (Puntambekar & Kolodner, 2005, p. 185). Constructionism helps to build "a context for learning through community-supported collaborative construction" (Bruckman, 1998, p. 50). This can be done in a self-motivated and a peer-supported manner (Bruckman, 1998). Pinkett (2000) explained this point of view using the social cultural constructionism framework that "addresses the interests of both an individual and a community" (p. 4). According to him, the development of the individuals and of the community "are reciprocally enhanced by independent and shared constructive activity that is resonant with both the social setting that encompasses a community of learners..." (Pinkett, 2000, p. 4). To scaffold the process of learning through construction, different tools and agents should work together to construct a learning environment where it is essential that each tool and agent plays their unique role (Puntambekar & Kolodner, 2005). The reason is that a holistic approach to individual and community engagement with technology can better interest the end-users and meet their needs (Pinkett, 2000).

CMC tools play a central role in TEPSS. CMC is not confined just to the virtual/verbal interactions between and among the learners. It also expands to the interactions between the learners and the interface, the resources, and the learning environment itself. Each of the tools works together as a whole system to affect and effect individual and community learning.

*Collaborative Learning*

Even though research on cooperative learning has been claimed one of the greatest success stories in the history of educational research (Slavin, 1996), collaborative learning presents a more radical departure from cooperative learning. Oxford (1997) and Bruffee (1999) describe the difference between cooperative learning and collaborative learning. Cooperative learning generally refers to a set of principles, structures, and processes associated with a certain task that a teacher carefully defines and monitors. Students in groups or teams take accountability for the completion of the task as a route to cognitive and social development. While collaborative learning enjoys a sociocultural, constructivist philosophical base, collaborative learning is more learner centered and less structured, and is typically applied for adult learners, especially in higher education. Collaborative learning views learning as construction of knowledge within a social context and encourages acculturation of individuals into a learning community. Collaborative learning is touted essential for assisting each student in advancing through his or her own zone of proximal development (Vygotsky, 1962), where "social knowledge – knowledge acquired through social interaction – becomes individual knowledge and individual knowledge grows and becomes more complex" (Gage & Berliner, 1988, p. 126). Gardner's theory of multiple intelligence (1993) also fits well with collaborative learning by emphasizing group work, both as a function of distributed intelligence and as a necessary social skill. According to Gardner, each student varies greatly in his/her strength and aptitude, and each can make a unique and valuable contribution to joint task solutions, which in turn augments the intelligence level of participating individual learners.

Seymour Papert (1980) raised national consciousness about the potential role that computer technology can play in creating alternative educational methods for students. Behind the current promising constructivist paradigm shift in education, technology plays a significant enabler role. Collaborative/conversational is also one of the attributes of meaningful learning envisioned by Jonassen, Howland, Moore, and Marra (2003), where "Humans naturally work in learning and knowledge-building communities, exploring each other's skills and appropriating each other's knowledge" (p. 8). In their model, computer technology functions as a social medium to support learning by collaborating with others, by discussing, arguing, and building consensus among members of a community, and by supporting discourse among knowledge-building communities. Starting from the 1990s, the exponential growth of computer technology and the Internet has made computer-supported collaborative learning, especially online collaborative learning, a robust alternative to traditional teaching and learning, and also made it possible for learners to collaborate even though they cannot meet in person (Alavi, 1994; Alavi & Dufner, 2005; Gilbert & Driscoll, 2002). There are two primary modes of computer-supported collaborative learning: synchronous and asynchronous. Computer-based collaborative learning is categorized by the restriction of boundary to the participants – boundaryless participation formats and boundaried participation formats. Boundaryless participation formats include the communication channels which call for free participation for any interested public learners. While boundaried participation formats are the channels that require restricted membership such as WebCT and listservs.

TEPSS presents an excellent manifestation of how to take advantage of computer-mediated collaborative learning to help professionally and technologically prepare its urban teachers through the use of multiple synchronous and asynchronous communication channels. These channels can provide various levels of coordination and cooperation among the preservice teachers and their mentors. This can boost their ability to reflect on their learning and knowledge construction in cognitive, affective, and behavioral aspects as well as realte the reflection to their existing knowledge base (Kolb, 1984; Tennant & Pogson, 1995). The practice surely satisfies Pea's argument (1994) that, through computer-supported collaborative transformative communication, learning can be fostered which facilitates new ways of thinking and inquiring in education.

*Community of Practice*

Lave and Wenger (1991) first introduced the concept of a communities of practice (CoP), describing it as "... a set of relations among persons, activity and world, over time and in relation with other tangential and overlapping CoPs" (p. 98). The optimal goal of CoPs is to promote community members' knowledge-building and learning in a specific content area where active participation and reification are vital. In CoP, newcomers move from peripheral to full participation in the community as they learn from each other. CoP can promote teachers' professional development (Au, 2002; Barab, MaKinster, Moore, Cunningham, & The ILF Design Team, 2001; Schlager & Fusco, 2004). "Professional development is viewed as a career-long, context-specific, continuous endeavor that is guided by standards, grounded in the teacher's own work, focused on student learning, and tailored to the teacher's stage of career development." (Schlager & Fusco, 2004, p. 125) If a teachers' community is characterized by a focus on student learning, peer collaboration, and reflective dialog, it will provide social and normative supports for teacher participation in their professional development (Schlager & Fusco, 2004).

Learning in a community can take a number of forms. On the basis of CoP (Lave & Wenger, 1991; Wenger, 1998), Riel and Polin (2004) further identified three distinct but overlapping forms of learning communities on the basis of variation within their structure and goals: task-based, practice-based, and knowledge-based learning communities. According to Riel and Polin, "Practice-based learning communities are larger groups with shared goals that offer their members richly contextualized and supported arenas for learning" (p. 20), while "Knowledge-based learning communities often share many of the features of a community of practice but focus on the deliberate and formal production of external knowledge about the practice." (p. 21) and make the overt commitment to record and share knowledge outside of its immediate use or active context.

Practice and research of online learning communities in educational settings are currently robust (Di Petta, 1998; Schlager & Fusco, 2004; Swan & Shea, 2005). *Inquiry Learning Forum* (1999) is an online professional development system designed to support a virtual community of inservice and preservice mathematics and science teachers creating, sharing, and improving inquiry-based pedagogical practices, via multiple communication structures for members to engage dialogue with one another (Barab et al., 2001). *MirandaNet* (2002) is a web site dedicated to providing continuing professional development for worldwide professionals in education, and Cuthell (2002) documented how distributed cognition is achieved in its online community. *Knowledge Loom* (1998) is another perfect example of how online learning communities can be created and maintained around different educational topics to promote teachers' professional development. The study by Nicholson and Bond (2003) found out that, preservice teachers' use of an electronic discussion board became a place for professional support and community, and preservice teachers' reflective thinking developed over time as a result of the discussion board.

The design and positioning of CMC channels within TEPSS facilitates two levels of CoPs – microscopic and macroscopic. Microscopically, preservice teachers can virtually interact, communicate, and collaborate with their cohorts and mentors within a specific content area such as math, language and literacy, and social studies. This strategy can help the cohorts and their mentors focus on the topics directly related to their future teaching content area. Macroscopically, CMC channels also exist where all participants and mentors in TEPSS can freely interact, communicate, and collaborate with anyone, with any topics they are interested in reflecting, exploring, and sharing. Such practice can not only offer the whole online community within TEPSS numerous opportunities for concurrent, purposeful, and sometimes, incidental learning, but also help build on community knowledge base in various areas related to teaching.

## Stakeholder Survey

Eight stakeholders (university faculty from a major southeastern university) were surveyed in order to gain insight into the design of TEPSS CMC. As it was deemed that faculty would serve as opinion leaders and change agents in the adoption and diffusion of TEPSS, high priority was given to their needs.

One faculty member emphasized the importance of increasing communication among their preservice teachers especially while they were entering the field-placement stages, "Given the fact that the schools that we used for field placements are usually very different in terms of students' racial, ethnic, and cultural background. The effective communication among the preservice teachers placed in different schools will not only increase their understanding of technical aspects of teaching, but also facilitate their development of culturally relevant pedagogy." Moreover, as a result of the metropolitan location of the university, all eight surveyed faculty strongly recommended the reinforcement of online communication, as evidenced by their comments such as: "Given the traffic pattern in the city, it is not realistic for students to drive back to campus often to have seminars for face-to-face reflection and exchange"; "Drive time and the large geographic space we have to deal with necessitate significant online communication"; and "Because we are so spread out across the metro area, we need a way to communicate electronically and efficiently."

Survey results also indicated that current CMC channels available to them were unsatisfactory for their teacher preparation courses, "…was adopted all year, but proved to be very rudimentary. Alternative methods such as … were adopted as well, however, it is hard to getting everyone to sign up". Faculty members also expressed the need for extended availability of communication tools. That is, rather than beginning or ending with a given course or program of study, the tools would be available throughout preservice teachers' student teaching and induction phases.

The analysis identified the need for both synchronous and asynchronous CMC channels that could facilitate interactions: a) between mentors (academic and expert teachers) and mentees (preservice teachers), and b) among peers (the preservice teachers). These results were in agreement with a 2000 study on the function of synchronous and asynchronous CMC for ESL students. Sotillo (2000) found that both can be useful for different pedagogical purposes. Rourke and Anderson (2002) also found that asynchronous technologies, such as email, were useful for arranging meetings and sharing provisional documents, while synchronous technologies were more useful for brainstorming and decision-making. Both the synchronous and the asynchronous CMC users commented that it would be more productive for them to work on their study if they had both the synchronous and the asynchronous CMC tools available. This way they were free to choose an appropriate tool depending on the content they were to communicate. Bannan-Ritland also conducted an explanatory synthesis of literature related to CMC, eLearning, and interactivity (2002). Her research corroborates the role of both asynchronous and synchronous communication methods in promoting learning.

## CMC Channels Adopted in TEPSS

Based on a review of literature, and examination of some similar existing systems, and an initial analysis of faculty stakeholders, we have designed a prototype for TEPSS CMC. CMC within TEPSS would be both synchronous (IM) and asynchronous (email, bulletin board, Blog). Our CMC tools would be available to preservice teacher throughout their program of study as well as for the first two years of their actual teaching. By doing so, we hope to provide urban preservice teachers with opportunities to build online communities, to construct their individual and community knowledge base, and to get support from peers and experts throughout their teacher induction experience. TEPSS is currently undergoing a process of design, development, and evaluation. As we now have a general idea of how to effectively integrate CMC tools within the system, we can begin testing them with our end users.

## References

Alavi, M. (1994). Computer-mediated collaborative learning: An empirical evaluation. *MIS Quarterly, 18*(2), 159-174.

Alavi, M., & Dufner, D. (2005). Technology-mediated collaborative learning: A research perspective. In S. R. Hiltz & R. Goldman (Eds.), *Learning together online: Research on asynchronous learning networks*. Mahwah, N.J.: Lawrence Erlbaum Associates.
Alessi, S. M., & Trollip, S. R. (2001). *Multimedia for learning: Methods and development* (3rd ed.). Needham Heights, MA: Allyn and Bacon.
Au, K. H. (2002). Communities of practice: Engagement, imagination, and alignment in research on teacher education. *Journal of Teacher Education, 53*(3), 222-227.
Bannan-Ritland, B. (2002). Computer-mediated communication, elearning, and interactivity. *The Quarterly Review of Distance Education, 3*(2), 161-179.
Barab, S. A., MaKinster, J. G., Moore, J. A., Cunningham, D. J., & The ILF Design Team. (2001). Designing and building an on-line community: The struggle to support sociability in the inquiry learning forum. *Educational Technology Research and Development, 49*(4), 71-96.
Bloom, B. (1981). *A primer for parents, instructos and other educators: All our children learning*. New York: McGraw-Hill.
Bruckman, A. (1998). Community support for constructionist learning. *Journal of Collaborative Computing, 7*, 47-86.
Bruffee, K. A. (1999). *Collaborative learning: Higher education, interdependence, and the authority of knowledge* (2nd ed.). Baltimore: Johns Hopkins University Press.
Calandra, B., Lai, G., & Sun, Y. (2004). *TEPSS: Initial steps in the design of electronic support for novice teachers.* Paper presented at the Association for Educational Communications and Technology, Chicago, IL.
Carswell, L., Thomas, P., Petre, M., Price, B., & Richards, M. (2000). Distance education via the Internet: The student experience. *British Journal of Educational Technology, 31*(1), 29-46.
Cuthell, J. (2002). MirandaNet: A learning community--A community of learners, *Journal of Interactive Learning Research* (Vol. 13, pp. 167-186).
December, J. (1996). *What is computer-mediated communication*. Retrieved Jan. 29, 2005, from http://www.december.com/john/study/cmc/what.html
December, J. (1997). *Notes on defining of computer-mediated communication*. Retrieved Jan. 29, 2005, from http://www.december.com/cmc/mag/1997/jan/december.html
Di Petta, T. (1998). Community on-line: New professional environments for higher education. *New Directions for Teaching and Learning*(76), 53-66.
Fisher, M. (2002-2003). Online collaborative learning: Relating theory to practice. *Journal of Educational Technology Systems, 31*(3), 227-249.
Gage, N. L., & Berliner, D. C. (1988). *Educational psychology* (4th ed.). Boston: Houghton Mifflin.
Gardner, H. (1993). *Frames of mind : The theory of multiple intelligences* (10th anniversary ed.). New York, NY: BasicBooks.
Gery, G. (1991). *Electronic performance supports systems: How and why to remake the workplace through the strategic applications of technology*. Boston, MA: Weingarten Publications.
Gilbert, N. J., & Driscoll, M. P. (2002). Collaborative knowledge building: A case study. *Educational Technology Research and Development, 50*(1), 59-79.
Graham, M., & Scarborough, H. (1999). Computer mediated communication and collaborative learning in an undergraduate distance education environment. *Australian Journal of Educational Technology, 15*(1), 20-46.
Jonassen, D. H., Howland, J., Moore, J., & Marra, R. M. (2003). *Learning to solve problems with technology: A constructivist perspective*. Columbus, Ohio: Merrill Prentice Hall.
Jonassen, D. H., Peck, K. L., & Wilson, B. G. (1999). *Learning with technology: A constructivist Perspective*. New Jersey: Prentice-Hall, Inc.
Jones, S. G. (Ed.). (1995). *CyberSociety: Computer-mediated communication and community*. housand Oaks, CA: Sage.
Kearsley, G., & Shneiderman, B. (1998). Engagement theory. *Educational Technology, 38*(3).
Knowledge Loom. (1998). from http://knowledgeloom.org/index.jsp
Kolb, D. A. (1984). *Experiential learning: Experience the source of learning and development*. Englewood Cliffs, N. J.: Prentice Hall.
Lave, J., & Wenger, E. (1991). *Situated learning. Legitimate peripheral participation*. Cambridge: Cambridge University Press.
Learning Inquiry Forum. (1999). *Learning Inquiry Forum*, from http://ilf.crlt.indiana.edu/
MirandaNet Community. (2002). from http://www.mirandanet.ac.uk/

Muirhead, B. (2001). Enhancing social interaction in computer-mediated distance education. *Educationa at a Distance, 15*(4).
Nicholson, S. A., & Bond, N. (2003). Collaborative reflection and professional community building: An analysis of preservice teachers' use of an electronic discussion board. *Journal of Technology and Teacher Education, 11*(2), 259-279.
Oxford, R. L. (1997). Cooperative learning, collaborative learning, and interaction: Three communicative strands in the language classroom. *The Modern Language Journal, 81*(4), 443-456.
Papert, S. (1980). *Mindstorms : children, computers, and powerful ideas*. New York: Basic Books.
Papert, S. (1991). Situating constructionism. In I. Harel & S. Papert (Eds.), *Constructionism*. Norwood, NJ: Ablex Publishing.
Papert, S. (1993). *Mindstorms: Children, computers, and powerful ideas* (2nd ed.). New York, NY: Basic Books.
Pea, R. D. (1994). Seeing what we build together: Distributed multimedia learning environments for transformative communications. *Journal of Learning Sciences, 3*(3), 283-298.
Pillary, H., Brownlee, J., & Wilss, L. (1999). Cognition and Recreational Computer Games: Implications for Educational Technology. *Journal of Research on Computing in Education, 32*(1), 203-216.
Pinkett, R. (2000). *Bridging the digital divide: Socialcultural constructionism and an asset-based approach to community technology and community building.* Paper presented at the Paper presented at the 81st Annual Meeting of the American Educational Research Association (AERA), New Orleans, LA.
Puntambekar, S., & Kolodner, J. L. (2005). Toward implementing distributed scaffolding: Helping students learn science from design. *Journal of Research in Science Teaching, 42*(2), 185-217.
Resnick, M. (1994). *Turtles, termites, and traffic jams: Explorations in massively parallel microworlds*. Cambridge, MA: MIT Press.
Riel, M., & Polin, L. (2004). Online learning communities: Common ground and critical differences indesigning technical environments. In S. A. Barab, R. Kling & J. H. Gray (Eds.), *Designing for virtual communities in the service of learning*. Cambridge ; New York: Cambridge University Press.
Romiszowski, A., & Mason, R. (2003). Computer-mediated communication. In D. H. Jonassen (Ed.), *Handbook of research on educational communications and technology: A project of the Association for Educational Communications and Technology* (pp. 397-431). New York: Macmillan Library Reference.
Rourke, L., & Anderson, T. (2002). Using web-based, group communication systems to support case study learning at a distance. *International Review of Research in Open and Distance Learning, 3*(2).
Schlager, M. S., & Fusco, J. (2004). Teacher professional development, technology, and communities of practice: Are we putting the cart before the horse? In S. A. Barab, R. Kling & J. H. Gray (Eds.), *Designing for virtual communities in the service of learning*. Cambridge ; New York: Cambridge University Press.
Slavin, R. E. (1996). Research on cooperative learning and achievement: What we know, what we need to know. *Contemporary Educational Psychology, 21*(1), 43-69.
Stacey, E. (1999). *Collaborative learning in an online environment*. Retrieved Jan. 19, 2005, from http://cade.athabascau.ca/vol14.2/stacey.html
Swan, K., & Shea, P. (2005). The development of virtual learning communities. In S. R. Hiltz & R. Goldman (Eds.), *Learning together online: Research on asynchronous learning networks*. Mahwah, N.J.: Lawrence Erlbaum Associates.
Tennant, M., & Pogson, P. (1995). *Learning and change in the adult years : A developmental perspective* (1st ed.). San Francisco, Calif.: Jossey-Bass.
U.S. Department of Education. (2000). *Exemplary and promising educational technology programs*. Retrieved Feburary 5, 2005, 2005, from http://www.ed.gov/pubs/edtechprograms/panelreport.pdf
Vygotsky, L. S. (1962). *Thought and language*. Cambridge,: M.I.T. Press Massachusetts Institute of Technology.
Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge, U.K. ; New York, N.Y.: Cambridge University Press.

# Learning to Collaborate, Collaboratively: An Online Community Building and Knowledge Construction Approach to Teaching Computer Supported Collaborative Work at an Australian University

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## Introduction

Each of the authors has been involved in team teaching a subject called *Computer Supported Collaborative Work (CSCW)* at Charles Sturt University. The subject introduces students to contemporary social and technology issues as participants in online communities. Its enrolment comprises a wide array of undergraduate and postgraduate students, studying both on-campus and via distance education, throughout Australia and overseas, hailing from a diverse range of disciplines. It provides a focus for discussion and application of CSCW in fields such as professional development, information technology, library science, education, teacher librarianship, health care or policing. The four major outcomes of this subject are:

1. to understand the need for a multidisciplinary approach to learning and workflow within online communities;
2. to work effectively within a collaborative community;
3. to understand through negotiation the issues linked to computer supported collaborative work (CSCW); and
4. to demonstrate an understanding of the processes required to design, build, use and evaluate online communities using groupware tools.

Students explore various cognitive frameworks used in CSCW, and learn how to select and tailor a framework appropriate to specific collaborative situations and tasks. They study the principles underpinning the design and building of workgroup specific infrastructures to support successful workflow and human interaction. A mandatory component of the subject requires students to collaborate regularly with others using a variety of software – By integrating literature and other subject content about CSCW, students and instructors employ information environments and groupware tools such as e-mail, forums, Z Object Publishing Environment (Zope), Yahoo! Groups, weblogs (blogs) and MOO to facilitate collaborative learning and knowledge construction, and to capture artefacts resulting from these processes.

In addition, CSCW has a broader, underpinning aim of helping to nurture community-minded individuals, consistent with the views expressed by Peck (1987):

> We human beings have often been referred to as social animals. But we are not yet community creatures. We are impelled to relate with each other for our survival. But we do not yet relate with the inclusivity, realism, self-awareness, vulnerability, commitment, openness, freedom, equality, and love of genuine community. It is clearly no longer enough to be simply social animals, babbling together at cocktail parties and brawling with each other in business and over boundaries. It is our task – our essential, central, crucial task – to transform ourselves from mere social creatures into community creatures. It is the only way that human evolution will be able to proceed. (p. 165)

## Rationale

The subject was first initiated when Eustace and Hay (2000) reflected on their own discourse as University teachers and researchers, in which they and their students were expected to use a myriad of Internet services and tools to communicate and share data. They thought it timely to develop a subject to teach both *about* and *using* such tools to help professional workgroups operate effectively online, based on a community building approach or theme.

Since its genesis, the subject has evolved at the hands of other academics at CSU, including Mark Lee and Geoff Fellows, and through the active participation and contribution of a number of student cohorts. This paper describes how the above objectives were achieved in the subject's Spring (July-November) offering in 2004, in addition to outlining plans for refinement and improvement in future iterations.

## CSCL and online learning communities: A brief literature review

*Collaborative learning (CL)* evolved from the work of Piaget (1926) and Vygotsky (1978). It is based on the social constructivist view that learners learn best through positive, cooperative interactions with one another.

There is certainly no shortage of literature supporting the benefits of collaborative learning in traditional, face-to-face settings. Closely related to this are the positive effects that the social phenomenon of community can have on learning and knowledge construction, as highlighted by the work of Dewey (1929), Vygotsky (1978), Bruner (1986, 1990, 1996), Kafai and Resnick (1996) and Cunningham (1996).

Research into *computer supported collaborative learning (CSCL)* reveals that the benefits of CL can be further enhanced through the employment of appropriate supporting technology (Kaye, 1992; Alavi, 1994; Hiltz, 1995; Veerman & Veldhuis-Diermanse, 2001). Following in this vein, modern information and communications technologies can be put to use in the development of online learning communities (Bonk & Wisher, 2000; Hiltz, 1998; Palloff & Pratt, 1999; Rovai, 2002).

However, the use of a suite of elaborate technological tools or cutting-edge delivery media will do little good to enhance teaching and learning without the presence of well-planned and effective strategies (Clark, 1983). For example, it is a well-known fact that active involvement of the learner dramatically increases the effectiveness of the learning. Strategies must be devised to ensure each learner is engaged and involved, and given the opportunity to process and apply his/her newly acquired knowledge.

It is also a widely accepted view that learners must take ownership and responsibility for their learning. As such, the role of the teacher or lecturer has shifted, in recent decades, to one of a guide, or facilitator. In fact, not only do learners, as newcomers to a community of practice, engage in "legitimate peripheral participation" (Lave & Wenger, 1991) to develop mastery of knowledge and skills through interaction with "old-timers" or experts (such as their instructors, in the case of an academic environment), they also have a responsibility – an obligation – to play a part in the continued evolution and advancement of the community's existing body of knowledge, as they move toward full participation in the socio-cultural practices of this community. The three case studies of telelearning innovation presented by Eustace et al. (2001) and the Teletop development (see Teletop B.V., 2004) by Collis (2002) are amongst the plethora of examples that stand as a testament to the merits of a learning paradigm in which instructors focus their efforts on creating a conducive online environment for students to build content and take responsibility for learning.

The authors have attempted to work towards a re-usable technology model and a set of strategies for facilitating collaborative learning and knowledge construction that takes these factors into consideration, as well as accounting for Salmon's (2004a) five stages of e-Moderating, together with Gunawardena, Lowe & Anderson's (1997) five phases of social construction of knowledge in the online environment (Fig. 1).

## Groupware framework

The CSCW groupware framework is centred around five main tools, as illustrated in Fig. 2.

*The CSU Forums* are asynchronous, Web-based, threaded discussion boards. The system used is one that was developed in-house by the University's Division of Information Technology.

*Z Object Publishing Environment* (Zope) (see Zope Corporation, 2005b) is an object-oriented web application development and publishing system, written in the Python programming language (Fig. 3). It is free and open source, and available for multiple operating systems. Though functionality of the system can be dramatically extended through the use of Python scripts, a number of sophisticated server-side tasks can be accomplished with little or no programming knowledge, thanks to Zope's Document Template Markup Language (DTML). The content on a Zope server can be managed via a web browser or through WebDAV (Whitehead, 2005), the latter of which allows files to be uploaded directly from within supporting software. For example, Microsoft Office documents can be saved on Zope via WebDAV, as if it were simply another folder on the local network.

*Multi-User Dungeon, Object-Oriented (MOO)* was used as the vehicle for delivering synchronous online classes (Fig. 4). Specifically, the enCore system developed by Holmevik & Haynes (2004) was used. A MOO server and object-oriented core database, is a network-accessible, multi-user, programmable, interactive system originally designed for the construction of text-based adventure games, conferencing systems, and other collaborative software. Participants (usually called players) have the appearance of being situated in an artificially-constructed place (social space) that also contains those other players who are connected at the same time. MOO facilitates polysynchronous communications, that is it allows for a hybrid communication model comprising both synchronous and asynchronous elements. For example, players can interact and chat in real-time when they are logged in to the MOO simultaneously. In addition, their actions can impact and have a lasting effect on the state of the objects in the MOO, even after they have logged out – Notes can be left on notice boards and signs erected which will allow messages to be left behind for other players; objects such as furniture and office equipment (eg. whiteboards, slide projectors) can be created, used, moved and otherwise manipulated; etc.

*Yahoo! Groups* (Yahoo! Inc., 2005) is a free, web-based service with which students are able to set up and manage their own discussion groups. Yahoo! Groups works on a "push" based model in which postings to the group are automatically sent to each member's e-mail address, by default. In addition, a rich set of ancillary services are included, such as synchronous chat facilities, file and photo sharing repositories, shared databases and calendars (Fig. 5).

*COREBlog* (*Central Core*, 2004) is a Zope-based, open source web logging (blogging) system. Although originally intended to allow individuals to maintain their own personal journals and make these available for public viewing, blogs have found numerous applications in educational spheres. The easy-to-use nature and informal, journal entry style have lent themselves to ready adoption by instructors, who create blogs for purposes ranging from providing content, commentary and study hints, to disseminating subject-related announcements. Learners, too, benefit from creating their own blogs, be they for use as online learning portfolios and reflective journals, or simply as "soapboxes" for personal self-expression. Shared or group blogs also exist, which can serve as a powerful collaboration and shared publishing tool (Fig. 6).

The abovementioned tools are supplemented with regular e-mail contact between students and instructors, as well as amongst the students themselves. Furthermore, students are encouraged to investigate and explore various alternative tools to add to their groupware "toolkit". In fact, students were required to develop their own, personal taxonomy which to classify and evaluate groupware tools as they encountered them throughout the semester.

## Teaching and learning strategies

Like Waddoups and Howell (2002), the authors believe that the hybridisation of on and off-campus student cohorts is possible, and in many cases, even favourable. In CSCW, the diversity is leveraged to afford students exposure to working in multi-disciplinary teams, with members situated in physically separate locations and disparate time zones. This is, in many ways, an accurate reflection of what is required of today's knowledge workers, who operate in what is truly a global economy dependent on the Internet. In the famous words of Gertrude Stein (1937): "…there's no there, there."

The teaching and learning strategies in CSCW therefore address the challenges of creating social presence, interaction and a "sense of place" (Coate, 1996) in a virtual environment, by using the groupware tools discussed earlier to provide shared and private workspaces for learners.

### Subject content

In Spring 2004, the subject content consisted of five core topics:

1. Underlying principles of an online community: The CSCW framework
2. How to create online communities: Workgroups and collaborative styles
3. CSCW citizenship: Belonging to an online learning community
4. Supportive tools for CSCW
5. Case studies in CSCW

Students were provided with an online schedule of commentary, readings and exercises for each topic on the subject Zope site (*CSCW/online communities groupspace*, 2004). Exercises in the topic schedule were marked with an [OLR] tag to notify students that evidence of completion of the task was to be published on Zope in the student's personal folder, which contributed to his/her own Online Learning Record (Fig. 7).

### Meetings and workshops

Although a resource-based approach was adopted in the presentation of web-based instructional material and other CSCW content to students via Zope, weekly synchronous online meetings were held in Learning Communities MOO (*LC_MOO*, 2004), maintained by the Internet Special Projects Group at CSU. To accommodate both on and off-campus students, three one-hour MOO sessions were run each Thursday, at 11:00am, 2:00pm and 8:00pm Australian Eastern Standard Time (AEST). Students were welcome to participate in any or all of the sessions. The daytime sessions were facilitated by instructors physically present in the University's computer labs; in the case of the evening session, both students and instructors attended MOO tutorials via university or home Internet connections.

A seminar/workshop style was adopted for the MOO sessions in the earlier weeks of the semester. These covered general orientation to the subject and its groupware framework, in particular basic MOO training and familiarisation with Zope. Many online instructors find that interactivity is preferred over the one-way information flow of lectures. As such, in later weeks, MOO time was dedicated to open discussions and debates on topics related to the subject content, including contemporary CSCW and groupware issues.

Logs of all sessions were saved in the form of log objects in the MOO. Since the web-based representations of MOO objects are accessible via URLs (Fig. 8), hyperlinks to the logs and lesson slides (contained slide projector objects) were able to be placed on Zope for easy access.

Learning to use and program a MOO, exploration, R&D and prototype development of worlds and groupware, were also available using a second, "sandbox" MOO called K9MOO (*K9 campus and theme park, 2004*). Both MOOs were available throughout the session for students to hold their own meetings outside of regular class times. Most students were able to build their own personal and group "home" rooms, as well as populating these rooms with their own MOO objects such as log recorders, slide projectors and notice boards, to enhance the collaboration environment. Many took advantage of the programmability of the MOO by scripting their own verbs (methods, or operations) to add to the functionality and interactivity of their objects.

In addition to synchronous online sessions, face-to-face meetings were held for on-campus students. The format of these meetings was largely informal and discussion-based; they simply offered opportunities for those located at the University to convene and discuss/report on their progress in the subject. Short lectures delivered by the instructors on alternate weeks were intended to generate discussion, the notes for which were published on Zope for the benefit of all students.

**Forum-facilitated discussion and additional support**

The subject forum was used by the instructors to post announcements on subject-related matters, and by students to obtain general administrative and technical support. Students were also encouraged to participate in a continual class dialogue via the forums, sharing their reading, experiences, ideas and questions with their classmates. For issues of a more "personal" nature, such as matters relating to a student's own assessment, e-mail was the preferred means of communication.

In addition to the above, e-mail was used for informal interactions between students, particularly in relation to the project work and to support the stages of group formation.

**Pools of Online Dialogue (PODs)**

A key component of the subject was the requirement for students to form and participate in small workgroups called *Pools of Online Dialogue* (PODs). This was to allow them to explore the dynamics of the creation and maintenance of a such a workgroup, and to be part of a supportive group structure that allowed them to explore a deeper understanding of the subject content/readings and collaborative practice in general.

Each student was allocated to a POD group consisting of four members. Differing views exist on how groups should be formed – Some contend that random assignments work best to maximise group heterogeneity (Smith, 1985; Fiechtner & Davis, 1991), while others favour a more deliberate, manual process in the interest of ensuring fairness of group composition (Walvoord, 1986; Connery, 1988). Still others prefer to allow students the flexibility of selecting their own workmates. However, in CSCW, to leverage the diverse characteristics of the individuals in the class, a deliberate attempt was made to achieve a mixture of students studying in different modes and locations in each POD group. This was driven by the desire for students to meet and work with others from backgrounds and interests that could be vastly different to their own. It also served to ensure that the collaborative work was in fact performed online. Many groups also intentionally consisted of members studying different courses (programs) in various faculties of the university, encompassing both undergraduates and postgraduates.

The POD activities began in Week 3 of the session, when students used the subject forum as an initial meeting point to exchange e-mail addresses with their group members. One POD activity was assigned for each of the five main topics in the subject. Activities were posted on Zope by the instructors each fortnight, and was to be completed before the posting of the next activity.

Although each POD group was assigned a number, students were encouraged to select a name for their POD that reflected its identity and purpose. Even-numbered PODs were required to use Yahoo! Groups to complete their POD activities, whilst the odd-numbered PODs used COREBlog. (Each POD was also assigned their own shared workspace on Zope, whose use was optional.) The purpose of this was to afford the students exposure to, as well as encouraging them to reflect on the differences between, contrasting types of tools and how they affect workgroup collaboration. To this end, the fourth activity required each POD group to send a member representative, or "agent", to participate in a group using the other tool. The fifth and final activity saw the agents returning to their original, "home" groups to report on their observations.

Many believe that assessment imposes barriers on effective discussion and the sharing of ideas in an online learning community (eg. Chen, 2004). As it was felt that grading the POD activities might inhibit students' willingness to express ideas openly and freely, the decision was made not to assess these activities directly. Instead, evidence of having completed the POD activities, together with reflective comments on the experiences, were to be incorporated into each student's individual Online Learning Record (OLR), which accounted for a substantial portion of the subject's formal assessment.

In fact, instructors actively participated in PODs only where invited to do so by the members, as "guests". When this was the case, the guests were to be told the purpose of their input a given a briefing of their role. They had to be made familiar with the guidelines regarding group processes, provided with technology support and supplied with feedback on their performance.

**Assessment strategies**

There were four assessment items for this subject. All four items were compulsory, available online and subjected to further analysis and evaluation. These are listed below in order of submission:

1. Project proposal
2. Assignment 1: Online Learning Record (OLR)
3. Assignment 2: Project report
4. Subject evaluation

The two major assignments – the OLR and project report – were formally assessed, and each carried a 50% weighting of the student's final grade. The project proposal and subject evaluation did not carry a weighting but were required for successful completion of the subject.

Students were advised to read through all assessment instructions at the very beginning of the session as involvement in online community building exercises began in the first week of session and was ongoing throughout the semester. They were also required to work out a personal plan in preparation for the completion of weekly readings, written exercises, practical lab activities, and collection of evidence of participation in, and evaluation of, online community activities based on a supplied framework.

**Online Learning Record (OLR)**

The Online Learning Record (OLR), after Syverson (1995), was the vehicle used to support knowledge building and sharing of concepts, artefacts and experiences throughout the CSCW subject. Students could also use the OLR framework as a checklist to monitor their progress in completing core content. They were encouraged to document or diarise their journey throughout the semester by capturing evidence of all activities undertaken, and critically reflecting on their learning. This may have included non-mandatory activities undertaken in their own time, such as wide reading of websites and journal/magazine articles.

Each student was provided with a Zope folder or web space in which to create his/her OLR. The format of the OLR was not stipulated but was left to each student's discretion and creativity – The process culminated in a rich collection of artefacts that may have included responses to the prescribed weekly OLR tasks, blogs containing reflective comments on the POD activities, MOO session logs, project deliverables, annotated bibliographies of CSCW resources, links to relevant websites and copies of e-mail interchanges with instructors and other students, to name but a few.

While the OLR was not formally assessed until the end of session, students were required to develop the framework of their OLR in Week 2 and record progress on a weekly basis from Week 2 through to Week 12 of the session. This required diligence on the part of students to keep their OLRs up to date and not fall behind.

Students' OLRs were graded against a set of assessment criteria, based largely around a weighted five-point Likert scale. An excerpt from the marking sheet used is shown in Appendix A.

**Project proposal and report**

The project was applied in nature and required students to work alone, in pairs, or groups of three to report on, either the design and implementation of a unique online community; or to develop a case study based on the practical application of an online community model and/or groupware to enhance collaborative practice within a workplace, educational or entertainment setting. The assignment submission consisted of a project report (with supporting documentation, artefacts, additional software, etc.), and required the synthesis of ideas and issues relating to course content, as well as the analysis and evaluation existing theories, models and practices relating specifically to their chosen project.

The actual project topic was negotiated on a one-on-one basis with a supervisor. For those having trouble selecting a topic, a list of additional ideas was provided on Zope (Appendix B). The instructors and a number of other academics at the School of Information Studies, CSU agreed to act as "sponsors" for students wishing to undertake these projects.

Prior to commencing the project, students were required to complete a Project Proposal form (Appendix D), which was reviewed by the supervisor and appropriate feedback provided via e-mail. The form was scripted in DTML and deployed on Zope. In many cases this was an iterative process, with students refining and submitting several versions of the proposal until both the student/group and the supervisor were satisfied and ready to move on will the actual project execution. Continuous mentoring and feedback via e-mail continued following the approval of the proposal, throughout the duration of the project. The supervisor was also available at the end of each scheduled MOO session to offer additional assistance.

Students were asked to document the refinement process of their chosen topic and the subsequent development of their project in their OLRs, but were reminded that the OLR itself was to be assessed separately from the project. Students who worked in groups were also required to submit a Division of Work statement so that the contribution of each member could be assessed. The assessment criteria from the marking sheet appears in Appendix C.

### Subject evaluation

The final assessment item was the completion of an online survey form evaluating the content, outcomes, tools and processes used in the delivery of the subject through a series of open-ended questions. Like the project proposal form, the survey form was mounted on Zope. This assessment item was also allocated a 0% weighting, but submission was required for successful completion of the subject. Two copies of student submissions were generated – one stored on the Zope server for analysis, and a second compiled and e-mailed automatically to the instructors and respondent. In addition to eliciting feedback on the tools and strategies used in the subject, the survey also served to prompt students to reflect summatively on their experiences over the semester.

## Analysis of student evaluations

### Methodology

A simple thematic content analysis approach was used to analyse the survey data. For each question, all responses were first read at face value to produce a preliminary (candidate) list of themes or issues. This list was gradually refined as subsequent passes were made through the data, with the content being reviewed in greater detail and common strands factored out. As part of this iterative process, categories were added, deleted, renamed, combined and divided as necessary.

Eventually, each response was categorised according to the themes/issues identified, to reveal those themes/issues that appeared to be the most pertinent, or worthy of mention. It should be noted that the categories were not mutually exclusive; some responses did not fall neatly into a single category, but rather spanned two or more categories. Conversely, other responses did not fit into any of the categories at all and were thus assigned the category “OTH” (Other).

These “distilled” themes/issues were then reported on in the sections that follow, with excerpts/quotes from the actual survey data included to provide richer insight. The spelling, grammatical and punctuation errors in these excerpts/quotes have deliberately not been rectified.

All in all, the aim of the process was to attempt to present a broad, overall or “birds’ eye view” picture of student attitudes and reactions towards the CSCW subject, as seen in the feedback submitted.

### Subject strengths

Table 1 shows the categories that emerged from an analysis of the subject strengths listed by students in response to Question 1 of the survey.

Table 1. *Summary of responses to Q1: “List what you consider to be the three strengths of the subject.” (N=30)*

| Cat. code | Category description | N | % |
|---|---|---|---|
| COM | Community-orientedness, collaboration and friendliness of atmosphere amongst students and between students and teachers | 13 | 43.33 |
| LEA | Learning knowledge and skills related to CSCW, group and groupware tools/technology | 11 | 36.67 |
| PRO | Project | 9 | 30.00 |
| DIV | Diversity of student cohort and POD workgroups | 8 | 26.67 |
| MOO | Online practical sessions (held in MOO) | 8 | 26.67 |
| GRO | Opportunity to work in groups and develop teamwork/collaboration skills | 7 | 23.33 |
| NOV | Novel/unique experience | 6 | 20.00 |
| FLE | Flexible, online nature of subject (ability to work from home, self-paced) | 6 | 20.00 |
| LEC | Helpfulness and enthusiasm of lecturers | 6 | 20.00 |
| DIS | Networking/interacting with other students from the same discipline | 4 | 13.33 |
| OLR | Online Learning Record (OLR) | 4 | 13.33 |
| POD | POD activities | 4 | 13.33 |

| | | | |
|---|---|---|---|
| REL | Relevance and ability to apply learning to work situation | 3 | 10.00 |
| TOO | Effectiveness of groupware suite/tools | 3 | 10.00 |
| IND | Self-directed learning / learning at an individual level | 3 | 10.00 |
| CHA | Challenging (eg. requiring self-motivation) | 2 | 6.67 |
| DED | Inclusivity for distance education students | 2 | 6.67 |
| EXA | No exam | 2 | 6.67 |
| NON | None listed | 0 | 0.00 |

The “COM” category had the largest number of responses associated with it (13 out of 30 students), indicating that these students particularly enjoyed the collaborative, community-oriented nature of the subject, and the high levels of interaction with their instructors and classmates:

“bring students together via a different medium”
“Friendly atmosphere between the students and lecturers.”
“Gobal discussions and view exchange”

It was also apparent that the subject content was well-received by the students, who highly valued learning about the theory and practice of CSCW and groups, while being exposed to some of the many groupware options available and being given the opportunity to learn how to use some of these tools. The project was the specific learning activity that received most mention, with many students appreciating the ability to contextualise their learning and apply it to their current and/or future vocations:

“The ability to base the project work on real work activities - makes it more meaningful and relevant…”
“Doing a project that was directly linked to something I was already involved in.”

Another one of the issues that spoke the loudest in the survey responses was the fact that students highly valued the experience of interacting with others in the diverse cohort and workgroups:

“Not letting students chose their pod groups this was a great chance to meet students in the same situation as yourself. Especially students from abroad.”
“Developing online communities with students from diverse backgrounds.”
“Networking with studints from different cultures and backgrounds”

At the same time, they benefited from interacting with those with similar interests, or from like disciplines.

A number of respondents commented on the novel learning experiences facilitated by the subject, in particular the confluence of the human and technological facets of CSCW and online communities:

“introduction of unique learning opportunities/techniques”
“A bit of mystery as to where the subject was heading and the air of experienmentation”

This included the chance for them to work in teams, and to develop their “soft” skills to this end.

While students particularly enjoyed the collaborative, community-oriented nature of the subject, its flexible, online features were also applauded:

“…the subject can be wholly completed online”
“Learn at your own pace”
“Flexibility with some deadlines/ongoing tasks(CSCW) so can reallocate time where needed.”

Another strength of the subject from the point of view of students was the helpfulness and enthusiasm of the instructors, which helped create a supportive, community-oriented learning environment. This was further underscored by the issue of inclusivity for distance education students.

There were also positive comments about the groupware tools used, including the level of innovation and the variety of technologies explored. MOO, especially, was perceived by many as a strength, in terms of its ability to provide an effective yet enjoyable means of facilitating synchronous collaboration and learning.

Hung & Nichani (2001) propose a constructivist framework that suggests e-learning environments should be situated in both the social community of practice and in the individual minds of learners. For example, one student listed learning how to collaborate using groupware tools and interacting with others from diverse backgrounds as major strengths of the subject, but also pointed out that he benefited from the personal reflection afforded by the OLR:

“You learn to create an online learning record, which in turn is learning at an individual level.”

**Subject weaknesses**

The categories of subject weaknesses identified are presented in Table 2.

Table 2. *Summary of responses to Q2: "List what you consider to be the three weaknesses of the subject." (N=30)*

| Cat. code | Category description | N | % |
|---|---|---|---|
| TEC | Technical issues/difficulties | 11 | 36.67 |
| POD | Difficulty in coordinating POD groups and managing group dynamics/conflict | 10 | 33.33 |
| ACT | Learning activities (eg. number of practical activities and case studies, volume and content of readings) | 8 | 26.67 |
| CLA | Clarity of assessment requirements / activity instructions | 6 | 20.00 |
| INT | Internal lectures (appropriateness, schedule, attendance, content, etc.) | 5* | 16.67 |
| FAC | Lack of face-to-face contact | 4 | 13.33 |
| OTH | Other | 4 | 13.33 |
| TIM | Timing/scheduling issues related to online activities (eg. differences in time zones) | 4 | 13.33 |
| DIV | Diversity of student cohort and POD workgroups | 3 | 10.00 |
| MOO | MOO session organisation (chaotic, too much gossip, participants straying off topic) | 3 | 10.00 |
| ORG | Organisation and structure of subject content | 3 | 10.00 |
| WOR | Workload / time commitment required | 3 | 10.00 |
| FOR | Lack of formative assessment and feedback/advice on project work | 2 | 6.67 |
| NON | None listed | 1 | 3.33 |

* 16 of the 30 respondents were enrolled in the subject in internal (on-campus) mode

The most commonly identified theme in the responses to this question pertained to technical issues/difficulties, such as login problems and issues which arose from the high level of dependence of this subject on the reliability of server and network infrastructure. The user-friendliness of one or more of the groupware tools was criticised in some instances.

The technical problems were closely followed by the difficulty in coordinating and communicating with POD group members. In many cases this seemed to be directly related to scheduling problems, possibly due to differences in time zones. A number of groups were faced with members who failed to make adequate contributions:

"…after the first week we lost two of our POD group members, so their was [there were] only two of us that completed the tasks by task 4, I think it was only me left in the group."

"POD members who do not bother to reply or participate are a big problem."

Although diversity was valued by some as a subject strength, others saw the mixture of students from different disciplines within a single cohort in general, and within their POD groups in particular, as a disadvantage:

"Working with other students from different content/skills(backgrounds) less motivated and less helpful."

"…the cohort was very diverse and were starting from very different knowledge bases and interest - this had some advantages but I think more disadvantages"

It could be argued that many of these issues mirror the demands of computer-mediated communications and collaborative groupwork in the real world, which was one of the original intentions of the subject. In fact, it was hoped that students would document and reflect on these issues in their OLRs, bearing in mind they would not be directly assessed on the effectiveness or activity level of their POD groups themselves. This having been said, more support could be provided to students in the way of strategies for effective scheduling and organisation of online meetings. There may also be a need to provide more motivation and encouragement to what appears to be the minority of students, who failed to actively participate in the POD groups. Like O'Reilly and Newton (2002), the authors believe that imposing requirements through assessment is not the only way to have students perceive importance in online interaction and discussion.

A significant number of responses highlighted the fact that students sometimes found themselves unsure of what exactly was required of them in certain activities and assessment tasks, and in general. This is a reminder of the importance of clear, detailed and unambiguous instructions and guidelines, especially in an online/flexible delivery subject. For on-campus students this can be alleviated to some extent by providing additional classroom-based support, although the ideal level of face-to-face contact for students studying the CSCW subject is unclear. Some students suggested that there was a lack of face-to-face support:

"…I realise this is an online subject but often not all problems can be answered online."

On the other hand, others felt there was little point in holding face-to-face lectures:

"Internal lectures seemed silly for a subject where practicals and content were delivered online."

A number of students listed the workload and time commitment required, in particular the large amount of reading required, as a subject weakness. However, it should be realised that the nature of the subject is such that in order to be successful, students must work consistently throughout the semester. To use a computing analogy, students need to operate in "interactive mode" – Attempting to complete the required tasks just before the assignment due dates, in "batch mode", is simply not feasible! One student admitted:

> "...the weaknesses I found in the subject were more related to my lack of discipline that problems in the actual subject."

**Difficulties faced by students**

The third question in the survey asked students to list the aspects of the subject they found most difficult. The categories that emerged from the responses appear in Table 3.

Table 3. *Summary of responses to Q3: "List what aspects of the subject you consider to be most difficult." (N=30)*

| Cat. code | Category description | N | % |
|---|---|---|---|
| POD | Coordinating POD groups | 11 | 36.67 |
| SCH | Adhering to the subject schedule | 11 | 36.67 |
| TEC | Resolving technical issues/difficulties, including learning/using one or more groupware tools | 8 | 26.67 |
| MOO | Participating in and adjusting to MOO sessions (chaotic, too much gossip, participants straying off topic) | 5 | 16.67 |
| OLR | Maintaining the OLR and completing the [OLR] exercises | 5 | 16.67 |
| REA | Completing the prescribed readings (due to the number, length, academic language and/or format of the readings) | 5 | 16.67 |
| CLA | Understanding the assessment requirements / activity instructions (due to lack of clarity, vagueness and/or missing information) | 4 | 13.33 |
| PRO | Completing the project | 4 | 13.33 |
| OTH | Other | 3 | 10.00 |
| DIV | Working with the diversity of the student cohort and POD workgroups | 2 | 6.67 |
| NON | None listed | 1 | 3.33 |

Once again, the resounding issue in terms of the aspects of the subject students found most difficult, had to do with the organisation of POD groups. Students experienced difficult including initiating and maintaining constant communications with members, scheduling meetings, encouraging participation, eliciting contributions and reaching a consensus on topics of discussion. One student attributed his/her difficulties to:

> "Having to work with people that had completely different goals and responsibilities"

Another student lamented:

> "… Whilst everyone completed their work, we were often a member down when it came to discussing responces."

One student reported that his group managed to overcome the difficulty of ensuring regular contact by exercising good communication skills:

> "…I also found it a bit difficult to catch up with my group members regularly due to the fact that the group ha internal and external students. However, good communication skills that's shown by every member of our group, solve that problem."

Concerns in relation to the size of the workload were also reiterated in this section, with many students finding it difficult to work constantly to stay up to date with the schedule amidst other personal, work and study commitments:

> "I found that checking the forum and my group page on a regular basis was the most difficult thing to do in this subject"
> "The aspects… that i found most difficult were trying to find the time to complete every task on a weekly basis.. All i needed was a big assignment and i fell behind having to catch up all the time"
> "The most difficult thing, was staying in constant communication with my POD group, while trying to study for other subjects and work."

As mentioned earlier, discipline is required on the part of students to be consistent in completing the weekly activities. Moreover, students found it challenging to multitask or simultaneously manage the various strands of activities in the subject. Amongst the difficulties listed were:

> "Juggling the streams of work - POD, OLR, Project whilst learning about MOO and ZOPE."
> "Unable to concentrate on a couple of items moving between POD activities, CSCW tasks, MOOs and project. Trying to familiarise oneself with learning new computer skills and also compete tasks that require reading…"

Although the opportunity for real-time interaction in the MOO was previously identified as one of the subject's strengths, one student described her experience "mooing with over 20 students" as "chaotic learning". This had a lot to do with the overwhelming attendance in the evening session, particularly in the later weeks of the semester, which a large proportion of the on-campus cohort began attending from home or the University's on-campus residences instead of, or in addition to, the daytime sessions.

**Suggested improvements**

Table 4 summarises the responses to Question 4, "List what improvements could be made to the subject."

Table 4. *Summary of responses to Q4: "List what improvements could be made to the subject." (N=30)*

| Cat. code | Category description | N | % |
|---|---|---|---|
| OTH | Other | 7 | 23.33 |
| MOO | MOO sessions – Make changes to the number of scheduled MOO sessions, change the topics covered in MOO sessions, better organisation and more order/control in MOO sessions | 6 | 20.00 |
| ORG | Improve organisation and structure of subject content and resources | 6 | 20.00 |
| POD | Make changes to POD group setup and administration (group size, group composition, closer monitoring/intervention by instructors) | 5 | 16.67 |
| TOO | Changes to the groupware framework/tools | 5 | 16.67 |
| NON | None listed | 4 | 13.33 |
| OLR | Make changes to and/or update the content and/or focus of the [OLR] exercises | 3 | 10.00 |
| TEC | Cater better for technical knowledge/skills gaps | 3 | 10.00 |
| WOR | Reduce the workload size of the subject | 3 | 10.00 |
| ASS | Provide more assistance and feedback with assessment work | 2 | 6.67 |
| CLA | Provide clearer instructions/guidelines and criteria for activities and/or assessments | 2 | 6.67 |
| PRA | Increase the number of hands-on practicals | 2 | 6.67 |
| REA | Make changes to the prescribed readings (number, length and content) | 2 | 6.67 |

As can be seen from Table 4, a large number of responses to this question were unable to be classified into any of the identified categories and were therefore placed in the category labelled "OTH" (Other). However, a noteworthy number of students made suggestions related to the scheduled MOO sessions Many students highly valued this component of the subject, but expressed the need for more order to these sessions.

In this and preceding questions, there were complaints about the time and effort required to rationalise the subject content and assessment requirements and organise them into a more manageable construction. This added an unnecessary overhead, particularly at the beginning of the semester. Many expressed a need to improve the organisation and structure of the content and resources, and take steps to ensure the consistency completeness and accuracy of information. A degree of frustration was evident in some students' responses:

> "...Pertinent pieces of information were left off so that you spent hours doing trial and error to achieve what could have been done in the first half hour if the instructions were correct…Old information on webspace that was incongruent with what we had to work with in a practical session."
>
> "…I think I didn't have sufficient time at beginning of course to extensively read before realising POD groups were going to demand considerable time allocation."

A number of students mentioned specific ways in which some of these concerns could be addressed to improve the subject. Amongst these were recreating the (Zope) webspace so that it is in line with professional learning areas, and developing a more informative and comprehensive subject outline to provide a learning "roadmap" and an overview of the various resources.

The difficulty in organising POD groups arose again, with students calling for closer monitoring of POD groups and lecturer intervention to facilitate the initial group setup. Some students also stated they would like to see more technical assistance provided, particularly for the benefit of those from a non-Information Technology background. For example, additional tuition or simpler, step-by-step instructions could have been provided for the more complex tasks, such as Zope management and MOO building/ programming. One student said he/she would like to see the use of less technical language in the documentation.

Reductions to workload and volume of prescribed readings were amongst the improvements suggested:

> "OLR topic work needs to be reduced whilst the project is on – its a big work load…I am still catching up."
>
> "Need to rationalise course by deciding which computer skills/tools…to develop and what is to be learned."
>
> "…it took quite some effort and time to get through all the readings, and it got a little repetative towards the end of the subject"

**Further comments**

It made little sense to quantitatively analyse the responses to the final question in the survey, "Further comments to add?" due to the extremely broad scope of this question. Many responses received here suggested a sense of accomplishment and fulfilment by students in having completed the subject and achieving the intended learning outcomes:

> "...it was satisfying to complete the major project and my olr. Pod and olr activities provided sound challenges"
>
> "Overall a nicely structured subject, with good teaching strategies, By studying this subject i clearly understood the principles of CSCW, and how it can be applied in real time situations."
>
> "…I enjoyed completing each OLR and POD tasks. In the beginning it took some time for contacting each group members for completion of tasks, but at the end we all understood each other very well and contributed our efforts. Thus this subject indeed teaches us how to work in a group and also introduces us with new ways of communication…"

The unique learning opportunities and techniques of the subject received strong compliments again:

"I did really enjoy this subject and learnt alot. It intorduce me to a whole new learning experience through online collaboration."

"…you don't even feel like you are completing a subject…"

"I took on this subject mainly out of interest – it sounded fascinating and it truly has been. Not only is it a new way of communicating and working, but the subject is presented like no other…I have thoroughly enjoyed my time here."

Specifically, the more technically oriented students benefited from the socio-cultural emphasis, and the opportunity to hone their interpersonal and other non-technical skills. One student found the subject:

"…really enjoyable and completely left field from anything else I have done."

Last but not least, the role of socialisation and friendship building in the success of the subject was given mention in a number of instances:

"This is one subject that really allows students to come out of the class rooms and complete the subject with other fellow students in a more friendly way."

"I have learnt a lot from this subject and also made a lot of new friends which is very important. Collaboration and communication is what this subject, is all about, after all!"

## Further work

The students of CSCW play an important role in the knowledge generation for the rest of the class as well as for and future cohorts. They therefore have a direct influence on the evolution of the subject and its content and are encouraged to play an active role to this end. For example, the artefacts published by them on Zope remain available to students who will study the subject in the future; the objects they have created in the MOO persist after they have completed the subject.

The authors plan to further refine the groupware framework by experimenting with and evaluating other tools and technologies. For example, a number of alternatives exist to cater for the subject's content management (*Content Management System*, 2005) needs; even Zope 3 (Zope Corporation, 2005a), is somewhat different from the version used in the subject. Plone (Plone Foundation, 2005) is a powerful, user-friendly open source Content Management System based on Zope.

The authors are also investigating the integration of *Wiki* into to further encourage collaborative knowledge generation and sharing, by allowing students to annotate and contribute to the web-based lecture materials and online subject content. Collaborative writing software may be introduced to assist groups of students working on their project reports. Finally, the authors are exploring the dissemination of text and audio content through the use of *Really Simple Syndication (RSS)*. Most blogging systems, as well as Yahoo! Groups, are capable of generating RSS feeds to syndicate XML data to subscribers. RSS 2.0 with enclosures allows for the syndication of audio content, a technology known as *podcasting*. It will hoped that the use of RSS and podcasting will make mobile learning (m-Learning) possible by catering for the delivery of instructor as well as student-generated content in the form of small, "bite sized" learning moments viewable on handheld devices such as portable music players, mobile phones and personal digital assistants (PDAs). For example, on-campus lessons and face-to-face discussions may be captured in MP3 format and podcast for the benefit of all students. Students will be given the opportunity to engage in collaborative activities using their personal mobile devices.

Furthermore, the authors will investigate the possible application of the online learning community building framework proposed by Brook and Oliver (2003) in future offerings of the subject.

## Conclusion

The authors believe that the CSCW groupware framework, as well as the teaching, learning and assessment strategies, can be replicated or adapted for most computer education scenarios that will benefit from an online community building and knowledge construction approach. They may have broader implications such as contributing to best practice in this area.

Both the authors' own observations and the student feedback received supply convincing evidence that the subject and its organisation were well received by students. A detailed analysis of forum and MOO log data will be carried out in order to determine the degree to which the role of instructors as active participants played an integral part in building group harmony and confidence. In addition, the authors plan to study the importance and nature of mentoring relationships in the building of an online learning community. It is envisaged that this will entail discourse analysis of e-mail, MOO, forum and POD group data.

According to Delahoussaye (2001, cited in Differding, n.d.) online education is "an isolating and lonely experience". However, as one distance education student aptly observed:

"Studying via DE can either be an isolating experience or a real online community connection."

The framework and strategies employed in CSCW go a long way towards building an inclusive learning environment that causes students – both on-campus and distance education – to collaborate and connect, and encourages them to evolve from social animals into true community creatures.

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**References**

Alavi, M. (1994). Computer-mediated collaborative learning: An empirical evaluation. *MIS Quarterly, 18*(2), 159-174.

Bonk, C.J. & Wisher, R.A. (2000). *Applying collaborative and e-learning tools to military distance learning: A research framework.* United States Army Research Institute for the Behavioral and Social Sciences. Retrieved March 15, 2005, from http://www.publicationshare.com/docs/Dist.Learn(Wisher).pdf

Brook, C. and Oliver, R. (2003). Online learning communities: Investigating a design framework. *Australian Journal of Educational Technology, 19*(2), 139-160. Retrieved March 15, 2005, from http://www.ascilite.org.au/ajet/ajet19/brook.html

Bruner, J. (1986). *Actual minds, possible worlds*. Cambridge, MA: Harvard University Press.

Bruner, J. (1990). *Acts of meaning*. Cambridge, MA: Harvard University Press.

Bruner, J. (1996). *The culture of education.* Cambridge, MA: Harvard University Press.

*Central Core* (2004). Retrieved March 15, 2005, from http://coreblog.org

Chen, Y.-C. (2004). Building an online learning community. In *Proceedings of the Association for Educational Communications and Technology 2004 International Convention*. Bloomington, IN: Association for Educational Communications and Technology.

Clark, R.E. (1983). Reconsidering research on learning from media. *Review of Educational Research, 43*(4), 445-459.

Coate, J. (1993). Cyberspace innkeeping: Building online community. Retrieved March 15, 2005, from http://gopher.well.sf.ca.us:70/0/Community/innkeeping

Collis, B. (2002). The Teletop initiative: New learning, new technology. *Journal of Industrial and Commercial Training, 34* (6), 218-223.

Connery, B.A. (1988). Group work and collaborative writing. *Teaching at Davis, 14*(1), 2-4.

*Content Management System* (2005). Retrieved October 11, 2005 from http://en.wikipedia.org/wiki/Content_management_system

Cunningham, D. J. (1996). Time after time. In W. Spinks (Ed.), *Semiotics 95* (pp. 263-269). New York: Lang Publishing.

*CSCW/online communities groupspace*. (2004). Retrieved March 15, 2005, from http://ispg.csu.edu.au/subjects/cscw/

Dewey, J. (1929). *The sources of a science of education*. New York: Liveright.

Differding, G.A. (n.d.). Preparing students to join the online learning community. In B. Hoffman (Ed.), *The encyclopedia of educational technology*. Retrieved March 15, 2005, from http://coe.sdsu.edu/eet/Articles/stuprep/start.htm

Eustace, K. & Hay, L. (2000). A community and knowledge building model in computer education. In A.E. Ellis (Ed.), *Proceedings of the Australasian Conference on Computing Education* (pp. 95-102). New York: ACM Press.

Eustace, K., Henri, J., Meloche, J., Henri, F., Munro, R. & Weber, W. (2001). Experimentation in telelearning environments: 3 case studies. In D. Watson & J. Anderson (Eds.), *Networking the Learner: Computers in Education: Proceedings of the Seventh IFIP World Conference on Computers in Education* (pp. 963-966). Dordrecht, Netherlands: Kluwer.

Fiechtner, S.B. & Davis, E.A. (1991). Why some groups fail: A survey of students' experiences with learning groups. *The Organizational Behavior Teaching Review, 9*(4), 75-88.

Gunawardena, C.N., Lowe, C.A. & Anderson, T. (1997). Analysis of a global online debate and the development of an interaction analysis model for examining social construction of knowledge in computer conferencing. *Journal of Educational Computing Research, 17*(4), 397-431.

Holmevik, J.R. & Haynes, C. (2004). *enCore Open Source MOO Project*. Retrieved March 15, 2005, from http://lingua.utdallas.edu/encore/.

Hiltz, S.R. (1995). *The virtual classroom: Learning without limits via computer networks*. Norwood, NJ: Ablex.

Hiltz, S.R. (1998). Collaborative learning in asynchronous learning environments: Building learning communities. In H.A. Maurer & R.G. Olson (Eds.), *Proceedings of WebNet 98 – World Conference on the WWW, Internet and Intranet*. Charlottesville, VA: Association for the Advancement of Computing in Education.

Hung, D. & Nichani, M. (2001). Constructivism and e-Learning: Balancing between the individual and social levels of cognition. *Educational Technology, 41*(2), 40-44.
Kafai, Y. & Resnick, M. (1996). *Constructionism in practice*. Mahwah, NJ: Lawrence Erlbaum.
*K9 campus and theme park*. (2004). Retrieved March 15, 2005, from http://ispg.csu.edu.au:7680/
Kaye, A. (1992). Learning together apart. In A. Kaye (Ed.), *Collaborative learning through computer conferencing* (pp. 1-24). Berlin: Springer-Verlag.
Lave, J. & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, UK: Cambridge University Press.
*LC_MOO*. (2004). Retrieved March 15, 2005, from http://ispg.csu.edu.au:7680/
O'Reilly, M. & Newton, D. (2002). Interaction online: Above and beyond requirements of assessment. *Australian Journal of Educational Technology, 18*(1), 57-70.
Palloff, R. & Pratt, K. (1999). *Building learning communities in cyberspace*. San Francisco: Josey-Bass.
Peck, M.S. (1998). *The different drum*. (2nd ed.). New York: Touchstone.
Piaget, J. (1926). *The language and thought of a child*. London: Routledge & Kegan Paul.
Plone Foundation (2005). *Plone: A user-friendly and powerful open source Content Management System*. Retrieved October 11, 2005 from http://plone.org
Rovai, A. (2002). Development of an instrument to measure classroom community. *The Internet and Higher Education, 5*, 197-211.
Salmon, G. (2004a). *E-Moderating, the key to teaching and learning online*. (2nd ed.). London: Routledge.
Salmon, G. (2004b). The 5 stage model. Retrieved March 15, 2005, from http://www.atimod.com/e-moderating/5stage.shtml
Smith, K.A. (1985). Cooperative learning groups. In S.F. Schmoberg (Ed.), *Strategies for active teaching and learning in university classrooms* (pp. 18-26). Minneapolis: University of Minnesota Press.
Stein, G. (1937). *Everybody's autobiography*. New York: Random House.
Syverson, M.A. (1995). *Learning Record Online*. Retrieved March 15, 2005, from http://www.cwrl.utexas.edu/~syverson/olr
Teletop B.V. (2004). *Teletop – enabled learning*. Retrieved March 15, 2005, from http://www.teletop.nl
Vygotsky, L.S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
Veerman, A. & Veldhuis-Diermanse, E. (2001). Collaborative learning through computer-mediated communication in academic education. In P. Dillenbourg, A. Eurelings & K. Hakkarainen (Eds.), *European perspectives on computer-supported collaborative learning: Proceedings of the First European Conference on Computer-Supported Collaborative Learning* (pp. 625–632). Maastricht, Netherlands: Maastricht University.
Waddoups, G.L. & Howell, S.L. (2002). Bringing online learning to campus: The hybridization of teaching and learning at Brigham Young University. *International Review of Research in Open and Distance Learning, 2*(2). Retrieved March 15, 2005, from http://www.irrodl.org/content/v2.2/waddoups.pdf
Walvoord, B.F. (1986). *Helping students write well: A guide for teachers in all disciplines*. (2nd ed.) New York: Modern Language Association.
Whitehead, J. (2005). *WebDAV Resources*. Retrieved October 10, 2005, from http://webdav.org
Yahoo! Inc. (2005). *Yahoo! Groups*. Retrieved March 15, 2005, from http://groups.yahoo.com
Zope Corporation. (2005a). *Zope 3*. Retrieved October 10, 2005, from http://www.zope.org/Products/Zope3/
Zope Corporation. (2005b). *Zope.org*. Retrieved March 15, 2005, from http:///www.zope.org

**Appendix A:** Assessment criteria / marking sheet for OLR

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
|---|---|---|---|---|---|---|---|
| | | | | | | | **Readings and exercises** |
| | | | | | | | 1. Level of conceptual understanding |
| | | | | | | | 2. Use and evaluation of CSCW tools |
| | | | | | | | 3. Object oriented design and programming |
| | | | | | | | 4. Evidence of effort and improvement in skills |
| | | | | | | | **Collaborative practice** |
| | | | | | | | 5. Knowledge sharing and action |
| | | | | | | | 6. Contribution to community building |
| | | | | | | | 7. Management of workflow |
| | | | | | | | **Presentation** |
| | | | | | | | 8. Original ideas, comments and artefacts |
| | | | | | | | 9. Evidence of reflective practice |
| | | | | | | | 10. Structure, style, logical flow and referencing |
| | | | | | | | **Your final score out of 50 points** |

**Appendix B:** List of “sponsored” project topics

1. Multimedia interface upgrade for LC_MOO and K9MOO
Re-development of graphics and other multimedia elements which form the interface for LC_MOO (http://ispg.csu.edu.au:8800) as well as K9MOO (http://ispg.csu.edu.au:9000), including MUD maps for both environments. Sponsors are Mark Lee and Ken Eustace.

2. Q&A project
Building a question and answer Web site for first year IT undergraduates, using a collection of newspaper articles in XML format. Sponsors are Geoff Fellows and Ken Eustace.

3. Archiving policy
An investigation into the policy of archiving data and back-up procedures over time in an organisation eg a school, business or government department. The sponsor is Prof. Ross Harvey.

4. Wiki as a collaborative learning tool
Wiki is a relatively new technology, used to facilitate collaborative web authoring. The most well-known Wiki implementation is Wikipedia (http://en.wikipedia.org). This project will involve an exploration of the use of Wiki as a collaborative learning tool in higher education. This involves some technical implementation as well as research. Sponsor is Mark Lee.

5. 3D MOO development
Design and development of a 3D MOO using ActiveWorlds (http://www.activeworlds.com) to support collaborative work in a particular field such as business or education. Sponsor is Mark Lee.

6. Open source groupware tools
An investigation of one or more open source groupware tools and/or the development of a framework using these tools, to support a particular type of workgroup or community. Sponsor is Mark Lee.

**Appendix C:** Assessment criteria / marking sheet for CSCW project report

| 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|
| | | | | | **Multidisciplinary approach and problem domain** |
| | | | | | 1. Purpose, plan & timeline are consistent with outcomes |
| | | | | | 2. Use & evaluation of CSCW tools |
| | | | | | 3. Analysis & evaluation of related theories, models & practices |
| | | | | | 4. Evidence of application/synthesis of CSCW principles into project |
| | | | | | **Collaborative practice and workflow** |
| | | | | | 5. Evidence of individual contribution to the report |
| | | | | | 6. Evidence of individual contribution to community building |
| | | | | | 7. Observed management or communication with others |
| | | | | | **Presentation** |
| | | | | | 8. Original ideas, results/findings/recommendations & conclusions |
| | | | | | 9. Quality of the product, study or outcomes |
| | | | | | 10. Structure, style, content, logical flow & referencing |
| | | | | | **Your final score out of 50 points** |

**Appendix D:** CSCW project proposal form items

1. Proposed title of project:
State a proposed title for your project, subject to change following consultation with your lecturer.

2. Group size:
How many students in your group? MAX size = 3

3. Group name:
What name would your group like to be identified as (leave blank if you will be working alone)?

4. Group members:
Provide the details of each member in your group. You are also required to nominate ONE member as the team leader, who will be responsible for liaising directly with the lecturer.

5. Groupware tool(s):
List the groupware tools you plan to use and/or explore as part of your project - e.g. MOO, Zope, COREBlog, Yahoo! Groups, BSCW, CoBrow,...

6. Ethics in my/our research:
Include a brief discussion of the ethical issues related to your research (e.g. privacy) and how you plan on addressing these issues (approx. 100 words).

7. Project description:
Include a brief description of your project including client or sponsor, collaborative needs, problems or concerns to be addressed (approx. 150 words).

8. Expected outcomes of project:
List the main outcomes or goals of your project.

9. Project plan:
List the major steps required to complete this project with resources required (include human resources here) along with a projected timeline.

10. Submitted by:
Provide the name of the member submitting this proposal on behalf of the group.

Figure 1. *Stages/phases in online community building/growth and knowledge construction. Adapted from Salmon (2004b) and Gunawardena, Lowe & Anderson (1997)*

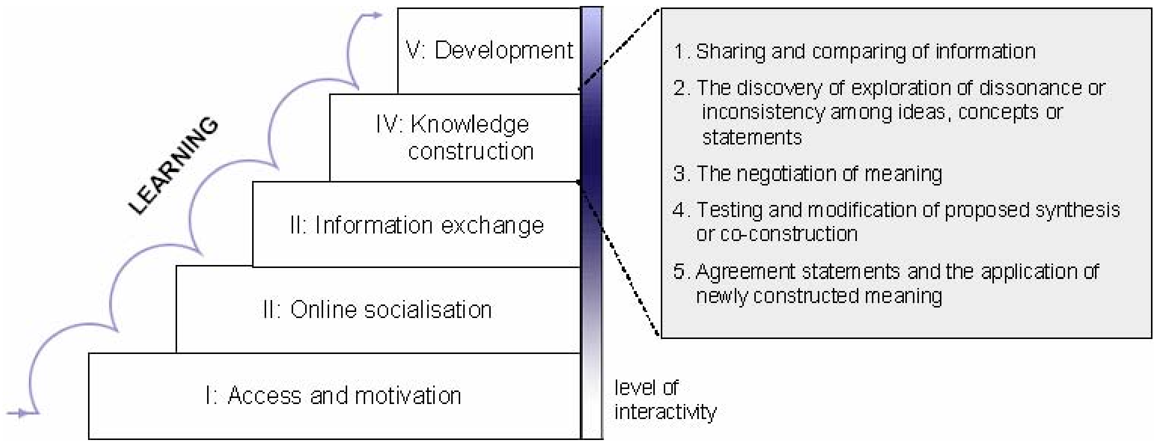



Figure 2. *CSCW groupware framework*

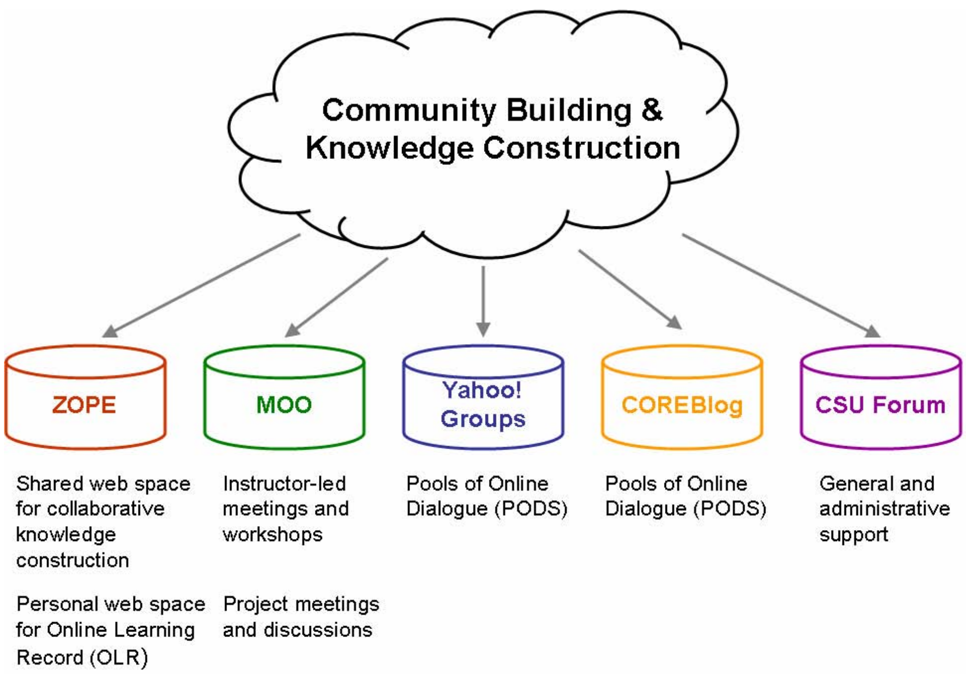


Figure 3. *The top-level folder (home page) of the CSCW Zope site*

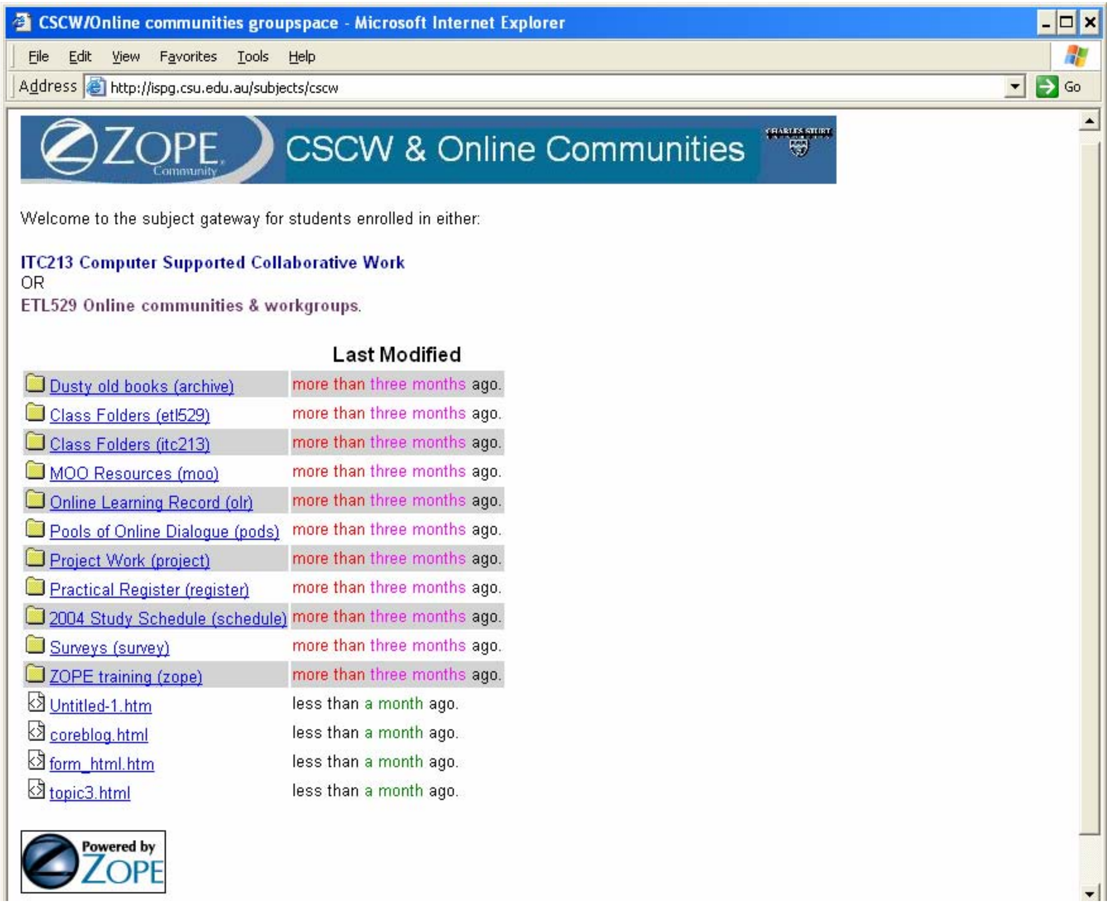


Figure 4. *The Bulga Ferngully room in LC_MOO, where the CSCW meetings and workshops were held*

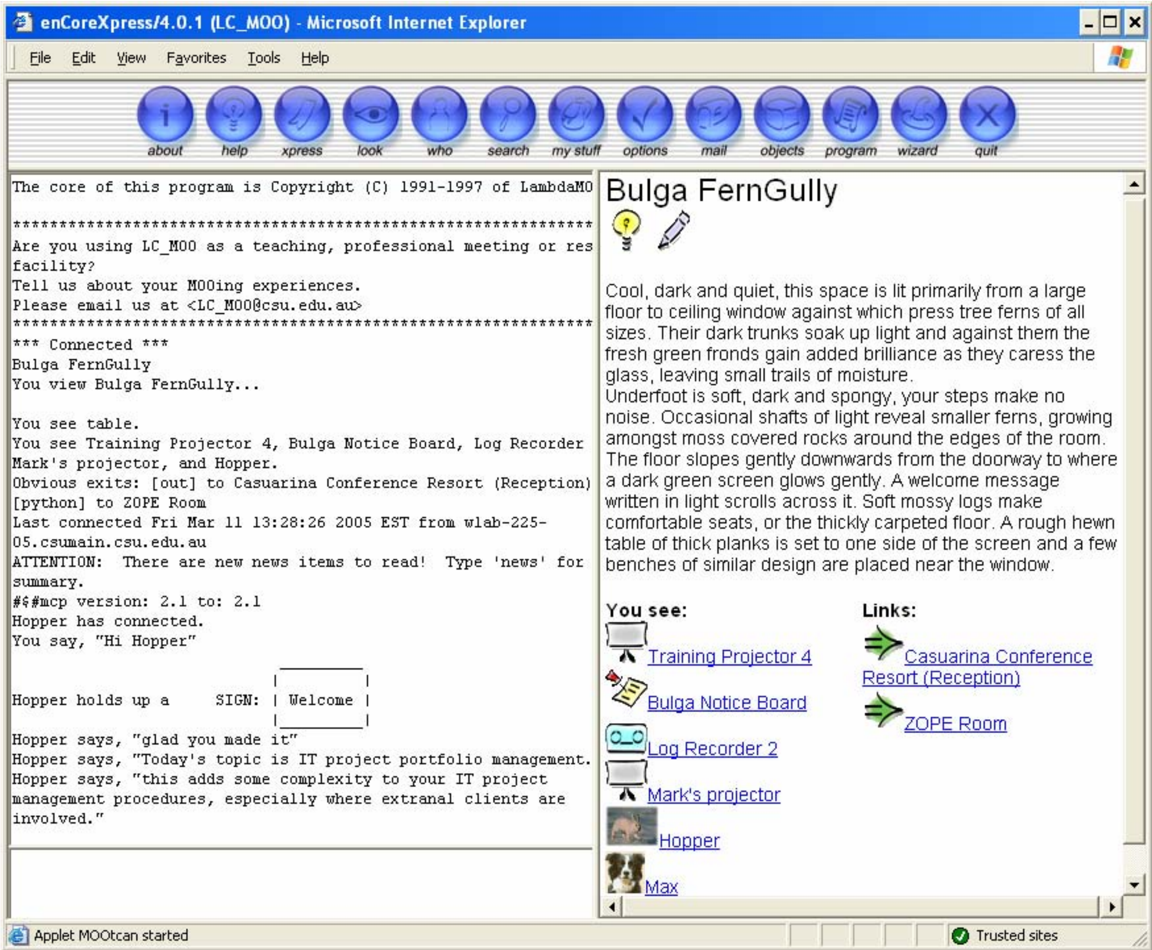


Figure 5. *Yahoo! Groups*

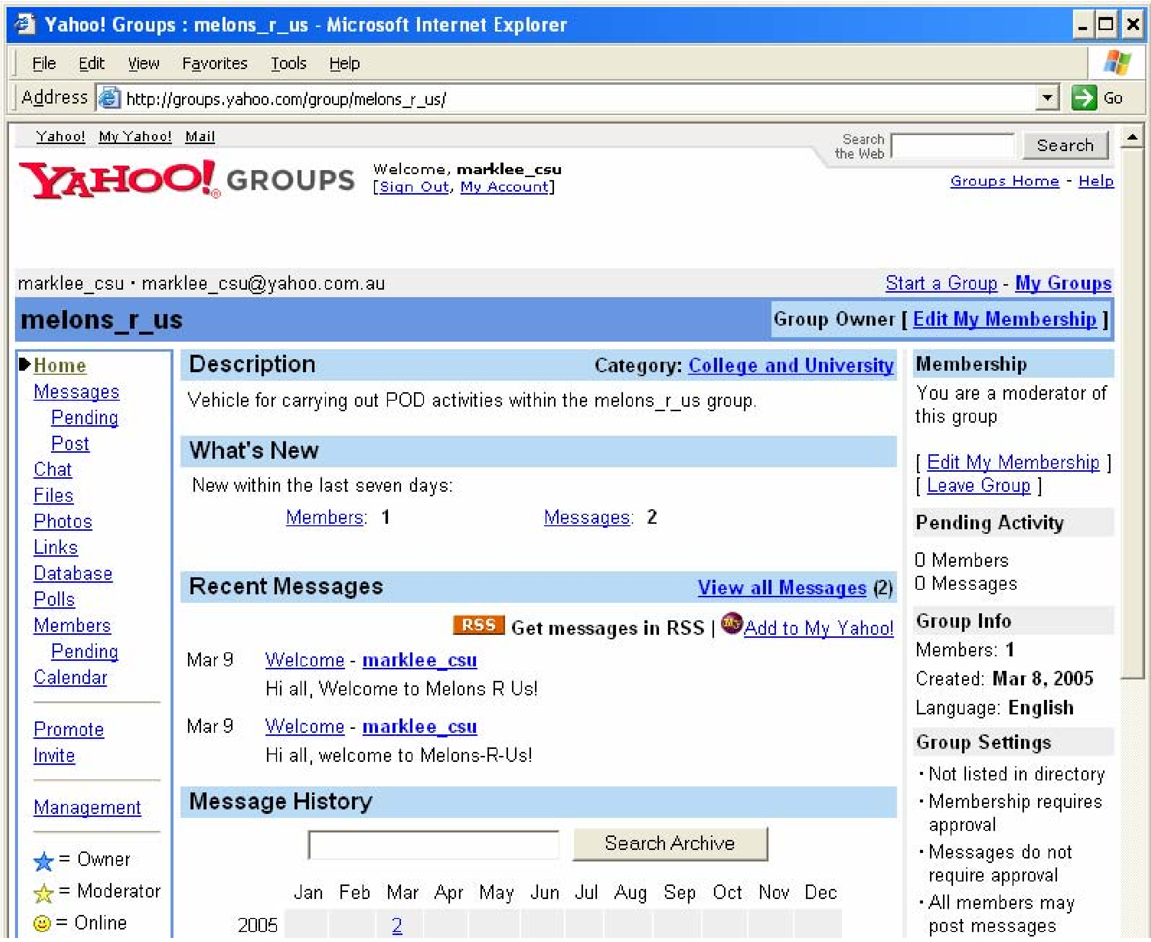


Figure 6. *Group blog established using COREBlog*

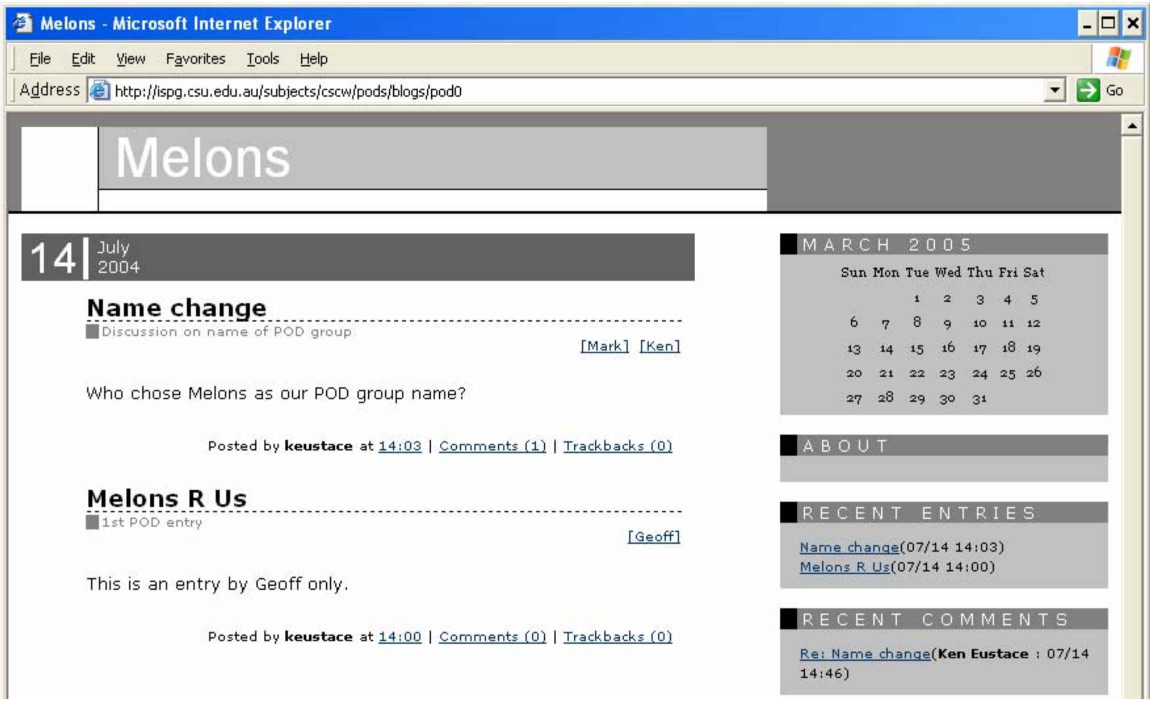


Figure 7. *A typical [OLR] entry that appeared within the CSCW topic schedule on Zope*

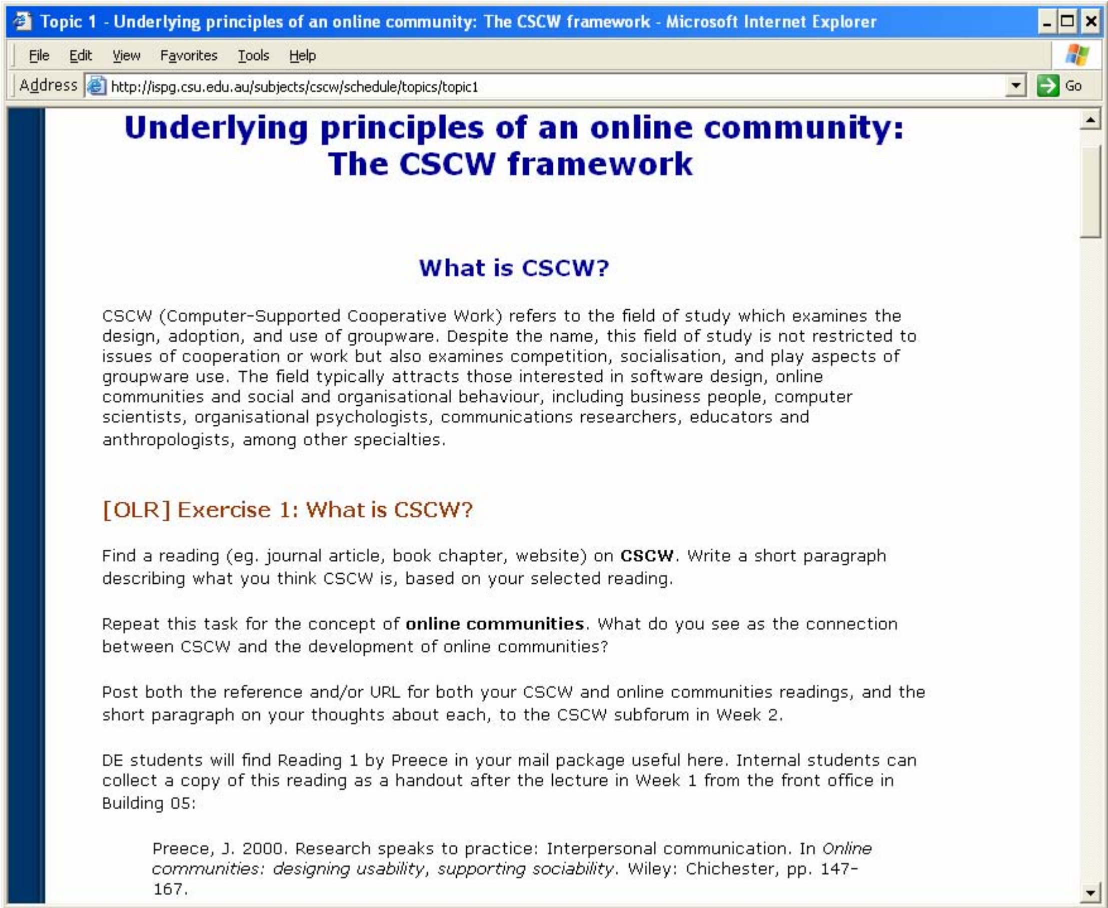
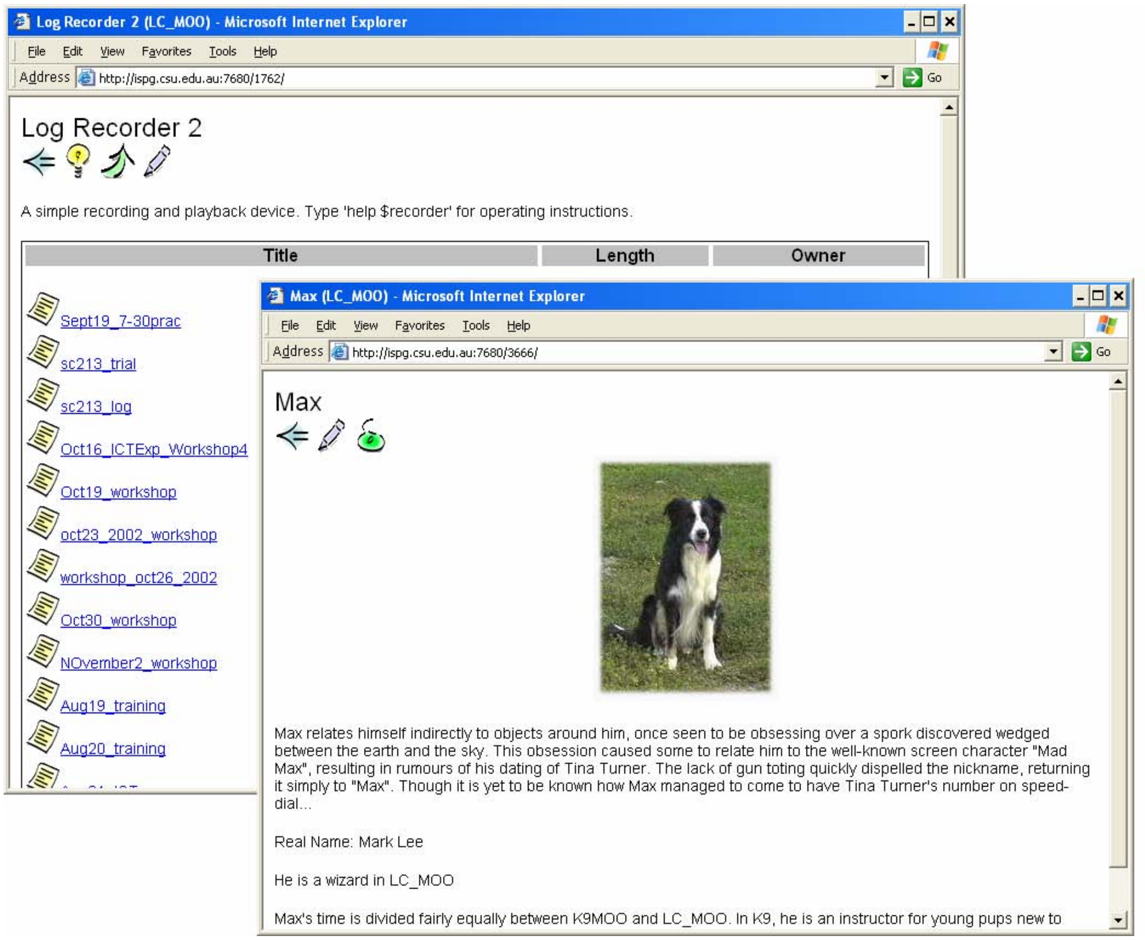


Figure 8. *A log recorder object (behind) player object (in front) - MOO objects can be viewed directly in a browser by specifying the relevant object number in the URL*



# The Design and Development of "PBL for ESL": Exploring the Possibilities of Problem-Based Learning in the K-12 English as a Second Language Classroom

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**Abstract**

*This study describes a middle-school English as a Second Language (ESL) teacher's experiences with a problem-based learning (PBL) approach. Multiple data were used to identify how a PBL approach was realized in the ESL classroom and how the teacher managed this unfamiliar PBL learning environment. The collected data included video footage of PBL inquiry activities, classroom observations, and interviews with the teacher and the students. The study supports technology-enhanced PBL as a beneficial teaching approach for ESL learners for authentic language use, chances to improve communicative competence, and increased motivation and self-confidence as a leaner.*

## Theoretical Framework

Problem-based learning (PBL) approaches, originally developed in medical education, have been adopted in many areas to provide students with meaningful learning experiences. Barrows & Tamblyn (1980) defined PBL as "the learning that results from the process of working toward the understanding or resolution of a problem" (p.1). PBL is also defined as a teaching/learning approach that relies on ill-structured problem to provide opportunities for student learning (Ertmer, Lehman, Park, & Grove, 2003). According to Evenson and Hmelo (2000), PBL often has two key features; first, an ill-structured problem used to prompt students' inquiry, and second, student-centered learning in which a teacher takes on a facilitator's role while learners take ownership of their learning. Common phases that PBL typically follows can be categorized as problem formulation, data collection, brainstorming solutions, evaluating and selecting solutions, implementing the solutions, and assessment (Seifert & Simmons, as cited in Scott & Brush, 1998).

A number of studies have examined the benefits and the advantages that PBL provides for language learning. Abdullah (1998) explained that the PBL inquiry process places students in situations that require authentic use of language. For instance, activities that engage language learners in communication tasks, such as interviewing others or being part of a team, required them to communicate with each other and deliver the message. As Krashen (1985) suggested, language input must be comprehended in order to facilitate language acquisition. Students working in cooperative groups need to make themselves understood, so they would naturally adjust their input to make it comprehensible (Kagan, 1985). Forrester and Chau's article (1999) on PBL lessons implemented in the Hong Kong Institute of Education explained how the problems in PBL effectively gave leeway to students to negotiate meaning and to adjust their language input to make themselves understood. In order to solve the problems given, students had to collect data from various sources, communicate with each other to select important data, and make a persuasive presentation about their solutions to the problem.

Krashen (1985) also suggested that to facilitate language learning, students need to be engaged in meaningful interaction so that they are "concerned not with the form of their utterances but with the messages they are conveying and understanding" (p. 40). McKinnon & Rigby's (n.d.) study suggested that in constructivist learning environments, language became the instrument with which the students complete the activities. Hence, students' attention shifted away from using accurate forms of the language to meaning of the message they were delivering. Although their study addressed constructivist learning environments, PBL learning environments often include most of the fundamental constructivist conditions they referred to, such as collaborative team work, authentic environments, learners' ownership in learning, and the development of problem-solving and other interpersonal skills (McKinnon & Rigby, n.d.).

Another advantage that PBL provides for language learning is in improving communicative competence. Kagan (1995) claimed that memorization of vocabulary lists does not increase *communicative competence*, the ability to use the language correctly and appropriately in the language community (Swain, 1985), because "learning about a language is quite different from acquiring the language" (p. 2)." He then explained that the cooperative group provides opportunities to produce functional and communicative language output that is critical for language acquisition. According to Abdullah (1998), PBL helps language learners develop their understanding of the conventions of language use by engaging in the kinds of language activity found in real life and not by learning list of rules. McKinnon and Rigby's (n.d.) study with project-based learning suggested that cooperative group work and problem-solving activities would successfully function as a bridge between using English in class and using English in real life situations.

Inherently increased motivation in the PBL learning process may be another significant advantage that PBL offers to language learners. As Hmelo-Silver (2004) explained, enhancing student motivation is believed to be a major advantage that PBL provides. In the PBL learning process, students are intrinsically motivated since they work on a task of their own interests and value what they are learning (Hmelo-Silver, 2004). Intrinsic motivation that actively engages students may have a strong impact especially on ESL students who may have experienced more failure than success in learning situations (Solomon, 2003). ESL students are often categorized as at-risk students in schools who have issues of identity, classroom environment, and effective instruction (Bass, 1991). According to Cerezo (2003), several elements in the PBL process, such as teamwork, problem-solving activities, a focus on continuous progress, seemed to be effective strategies to prevent at-risk students from dropping out of school.

In an attempt to present the potential of PBL for ESL learners and to provide a guiding model for ESL educators, this paper will describe a middle school English as a Second Language (ESL) teacher's experiences with a PBL approach. The study will introduce how a PBL lesson unit was adopted and applied by a middle school ESL teacher in teaching her ESL students. What she perceived as benefits from the PBL unit will be also discussed along with the challenges she experienced during the process. Finally, the study will also explain how her perception toward teaching and learning has changed through the experiences with the PBL unit. Accordingly, the research questions of this case study include the followings:

1. How was a PBL approach adopted and applied in a middle-school ESL learning environment?
2. What benefits and challenges did a middle-school ESL teacher and students perceive during the implementation of a PBL unit?
3. How has that teacher's perception of teaching and learning in PBL changed after the unit?

## Method

### Participants and Setting

Participants of the PBL unit were three 7th grade and four 8th grade ESL students enrolled in a rural Middle-East middle school. The teacher was in her seventh year of ESL teaching and had previously taught a variety of grades. All students were from Mexico and spoke Spanish as their first language. There were three female students and four male. Most of the students were described by the teacher as having a relatively high English conversation skill but low reading and writing skills. The teacher and the students were equipped with individual lab tops and a wireless internet connection.

### Research Design and Role of Researcher

The research followed a qualitative inquiry framework and involved description, explanation, and judgment in describing an ESL teacher's experiences with PBL. Multiple data are used to identify how a PBL approach was realized in a middle school ESL classroom and how the ESL teacher managed this unfamiliar PBL learning environment. The collected data included video footage of PBL inquiry activities, classroom observations during the PBL learning unit, and interviews with the teacher and the students.

During the PBL lesson unit, the researcher assisted the teacher in using computer technology in various occasions and also provided technology workshops to the students when needed. The researcher videotaped the classroom ten times throughout the unit and observed eight times at various stages, such as planning, collecting data, developing, and making a final presentation. The observations were made with an observation form developed to capture teachers' practices related to implementing a PBL unit. Interviews were also conducted with the teacher three times (pre-, mid-, and post-unit) and with the students after the completion of the unit.

### Data Sources

*Video footage.* For the purpose of examining how PBL could be adopted and applied in an ESL learning situation, the PBL unit implemented in the middle school ESL classroom was videotaped throughout the process. The video footage was utilized in developing a web site (URL: http://www.pblforesl.com) whose purpose was to present the potential of PBL for ESL learners and to provide a guiding model for ESL teachers to implement a PBL lesson/unit in their classrooms. The site includes video footage of the classroom activities, examples of student work, interviews with the teacher and the students, and other lesson resources. The video footage served as the basis in examining how the PBL approach was realized in the ESL classroom.

*Observations*. The classroom was observed once a week, a total of eight times, at the various stages of the PBL lesson unit. The observation was made to record how the teacher managed the PBL process, such as interactions with students and classroom management skills including the facilitation of students' group work. The observations also aimed to provide information on the challenges that the teacher experienced during the PBL process.

For classroom observation, a checklist was developed to capture teachers' PBL practices based on literature reviews and previous observations of other PBL classrooms. The checklist is categorized by pedagogical approaches, technology use for higher-order thinking, planning & organizing techniques, classroom management skills, collaboration, and professional development (Appendix A).

*Interviews.* The teacher was interviewed three times, at the beginning, in the middle of the PBL unit, and after the completion of the unit. The interviews were conducted to provide in-depth information on her experiences of the teacher with a PBL process. The pre-unit interview included questions on her expectations and goals for the lesson unit (Appendix B), and the mid- and post-unit interviews solicited information on what she perceived that the students gained from the unit and what challenges she experienced (Appendix C). The mid- and post-unit interviews also included questions on how she dealt with student guiding and how her perception toward PBL has changed through these experiences. Interview questions for students included what they liked or disliked about the PBL unit and whether they perceived the PBL unit helped them learn English better (Appendix D).

## Results

*Research Question 1, How was a PBL approach adopted and applied in a middle-school ESL learning environment?*

The PBL lesson unit in a middle school ESL classroom was implemented from November 2004 to May 2005 with a guiding question of how the barriers between the immigrants and the community could be overcome in a Middle-East rural area. In an attempt to employ a problem-based learning approach in the classroom, the ESL teacher sought support from technology support staff, technology resources, faculty members and research assistant from a partnership university. She designed and developed a unit which was organized around the question, "What do we want to share and teach others about Hispanics in our town?". Previous to the unit, she carefully planned an overall schedule of the unit. She prepared outside resources that could be utilized in the process (i.e., a trigger video, guest speakers, meeting with other school students, etc.), classroom facilitation methods (i.e., an individual binder with a list of resources, a weekly project journal, etc.), and assessment tools (i.e., self-assessment rubric, peer-evaluation rubric, final project rubric).

A video on the immigration in the United States effectively served as a trigger for the unit. With the issues brought up by the video, the teacher introduced problems the students had to solve: the difficulties that non-English speaking workers encounter in a rural working place and how to resolve the difficulties. Considering students' background as Mexican immigrants and the situations most of their parents were in, the problems of non-English speaking workers expected to bring intrinsic interest and motivation from the students and actively engage them in the unit. The teacher then explained the overall procedure and assessment tools of the unit, such as a rubric for a final product, project journal, and self- and peer-evaluation. Such assessment tools were utilized to keep students on task and also to provide more opportunities to use English in the process.

After the introduction of the problem, the students were grouped together based on their decision. The teacher allowed the students to choose their own group in an attempt to provide more freedom in the process and thus to motivate them to actively participate in the activities. Three students were grouped to take charge of collecting data, while two other students were given responsibility in writing articles and publishing them. Two remaining students were also given a role of assistants. Each different role was assigned to facilitate the group activities and discussion. However, after group activities, students were gathered to share ideas and make an important decision together.

Students began to investigate the issues of immigrants through the Internet search provided by the teacher. After spending some time to collect data, they were gathered together to discuss the data they collected and make a decision on what they would like to do about the problems. After discussing the problems and data collected, the students decided to develop a movie that would describe the difficulty of non-English speaking workers. The teacher and the students determined that a movie on the difficulty of non-English immigrant workers would help the community gain an understanding of new immigrants and thus increase common experiences and understanding needed to overcome a barrier between the immigrants and the community.

To provide real-world perspectives on the issues, an employee who had experiences of working with immigrant workers was invited as a guest speaker. Before the guest speaker session, the students were given time to develop questions for the speaker and practiced the questions. With the teacher facilitating the discussion, students asked their questions to the quest speaker. In addition, a professor who taught Spanish in a community college was also invited to provide multiple perspectives on the problems. Following the same procedure, the students developed questions, practiced their questions, and asked their questions to the guest speaker.

Based on the data collected from various sources, such as the Internet, guest speakers, and discussions, the students began to write a movie script. Writing a script took much time since students all needed to agree on main characters and the storyline. Having an individual lap-top was beneficial in this stage since they all could develop ideas whenever they wanted and shared them in the classroom. With the script written by and agreed by all of the students, they began filming a movie, using a digital camera, with support and help from the researcher and students of a local high school film class. As a final stage, they presented their movie with the community members, including teachers and students of the school, local business employees, and their family members.

In the meantime, in order to have more opportunities to read and write in English, the students published a newspaper three times, including articles they wrote. The articles discussed the problems of immigrants and their opinions regarding such problems. A number of English native students and teachers along with other ESL students outside the classroom also participated in writing their opinions on the issues. Writing articles and publishing a newspaper were expected to provide opportunities in improving not only English reading and writing skills but also communication skills to share their ideas with others.

Seifert & Simmons (1997) explained that common phases that PBL typically follows are problem formulation, data collection, brainstorming solutions, evaluating and selecting solutions, implementing the solutions, and assessment (as cited in Scott & Brush, 1998). Although the PBL unit implemented in the ESL classroom did not exactly follow the six general stages of PBL, the overall procedure of the PBL unit can be explained following the six stages:

1. Problem formation
    1) Video on 'immigration' of the United States
    2) Introduction to the problem: issues and problems that non-English speaking workers face in a rural Indiana and ways to overcome the barrier between the community and the workers.
2. Data collection
    1) Information search through the Internet on immigrants in Indiana and in the community
    2) Discussion with a guest speaker, an employee who had experiences of working with non-English speaking workers, and the community members, such as a non-English speaking worker and a Spanish professor
3. Brainstorming solutions
    1) Writing a project journal along with self- and peer –evaluation
    2) Writing articles about issues related to non-English speaking immigrants in the community and also in the school
    3) Discussion in group and as a whole class
4. Evaluating and selecting solutions
    1) Publishing newspapers for other students in the school to read the articles they wrote about the issues
    2) Discussion in group and as a whole class
5. Implementing the solution
    1) Writing a movie script that describes complex issues facing non-English speakers working in rural area
    2) Filming and editing
    3) Developing an informational package to help local companies and agencies better understand non-English speaking workers
    4) Presenting the movie to community members
6. Assessment
    1) Final project rubric and self- and peer- evaluation

Observation checklist revealed that she carefully planned and organized learning resources and activities prior to the classroom, with work sheets or questions to answer. In addition, she often integrated technology components in the process. In the stage of brainstorming, she asked the researcher to utilize *Inspiration* program to help students represent concepts and relationships between their ideas. Students' progress was monitored frequently through a project journal required every other week. She also successfully collaborated with other teachers throughout the process, asking to write articles for a newspaper and sending a newspaper to share with their students.

*Research Question 2, What benefits and challenges did a middle-school teacher and students perceive during the implementation of a PBL unit?*

The pre-unit interview indicated that her goal to accomplish through the PBL unit was to provide the students with as many opportunities as possible to read, write, speak and listen in English. In the post-unit interview, she stated that she believed that her goals for the unit have met, considering a number of opportunities the students had in the PBL unit in reading, writing, speaking, and communicating in English. Throughout the unit, the ESL students wrote a project journal once a week and communicated with outside the classroom speakers with the questions they developed. While writing articles for the newspaper, they also communicated with other students and teachers asking for their opinions. Writing a movie script and filming it with a high-school film crew also engaged students in a number of activities in using English.

In the post-unit interview, she expressed her satisfaction and excitement on her PBL unit, stating that “Kids are speaking and communicating more than I’ve ever imagined.” She also expressed her strong satisfaction with a PBL teaching and learning approach and stated that she believed students have gained a lot of things from the PBL experiences:

> “They are still learning speaking, speaking, listening, reading, and writing. But to them, it doesn’t seem like learning, but they are. Instead of reading from the text and answering questions, they are talking about things that concern them in their community and in their life. And they are working for solutions or suggestions to solve those. In doing that, they are using English, reading, writing, comprehending… and they are saying back. All the facets of language, they are using them.”

In the post-unit interview, she also remarked that the positive feedback that she and her students have been getting from the school and from the community was one of benefits that students gained from the unit. A number of teachers in the school used the newspapers published by the ESL students as a reading material in their classroom. Such activities naturally generated opportunities for the ESL students to discuss the issues with other teachers and other students in the school. She believed that her PBL unit positively affected on the motivation and self-confidence of her students, who were often silenced in the mainstream classroom.

The mid- and post-unit interviews indicated some of the challenges she encountered during the implementation of the PBL unit. She stated that the most difficult thing she experienced was a time management to finish learning activities on time and maintain the time schedule with other requirements from the school. Along with the PBL unit, the students were expected to receive help and support to successfully follow mainstream classes from the ESL teacher. Therefore, in several occasions, the teacher had to re-schedule her plan for the PBL unit in order to deal with other problems that the students brought from other classes. In addition, she explained that often students’ activities took more time than she expected, because of their low level English reading and writing skills. She also had to deal with regular school issues like students’ absence and administrative works related to the management of ESL program in the school.

To solicit explicit information on the challenges she encountered, the researcher provided a number of challenges to the teacher and asked her to rank them accordingly. The challenges included a lack of knowledge and skills, feedback and expectation, reward and incentive, motivation, resources, and school culture. She ranked a lack of systematic support and preparation time as a first barrier and a lack of feedback and expectation as a second barrier. She selected a lack of motivation as a third barrier because of the burden of overwhelming works that accompanied the PBL unit. She explained that although it was exciting and motivating to see her students doing what concerned them in their life and voicing their opinions in the school, at the same time, the workload was very burdensome for her. A lack of reward and incentive and a lack of knowledge and skills followed respectively.

When asked difficulties she had at different stages of PBL, she responded that developing a movie was the most difficult part because of scheduling the students and other support groups’ time. Filming the movie brought up other issues like having the students stay after school, arranging transportation for the students, getting permission to go to a different place, etc. Some of the difficulties she experienced in brainstorming and collecting data included preparing different examples at various English levels in order to help the students at various English levels understand the message. However, she stated that she didn’t feel it difficult to facilitate students’ group work because they chose what group they wanted to be in and they all worked well together. She believed a self-decision of a group contributed to their involvement and engagement in the group work. She explained the easy of facilitating students’ group work also came from knowing the students well. For example, she knew that one student often had a strong opinion, so she assigned the student to write articles by herself while accomplishing a collective goal for her group to publish a newspaper.

All the students participated in the PBL unit responded very positively regarding their experiences with the PBL. All answered that they enjoyed the process, some explaining their satisfaction due to group work and use of technology and others due to things they did outside the textbooks. However, some of them also expressed their dissatisfaction with heavy workload and longer time of the PBL unit, saying "It's taking too much time, and I'd like to move onto a different topic." For the question on whether it helped their English skills, most of them agreed that it helped them practice English. two of them weren't sure about whether the PBL process explicitly helped them in learning English.

*Research Question 3, How has that teacher's perception of teaching and learning in PBL changed after the unit?*

Video footage and observations in the classroom revealed that she had a strong belief in student-centered learning. Students were often given responsibility in learning activities, such as selecting their own groups, deciding on what to do with the problem. For instance, the students interacted with guest speakers mostly by themselves, asking questions and responding to the speaker's question. In addition, the teacher often tried to motivate and empower the students by reminding them of the importance of what they were doing.

Regarding her perception change toward teaching and learning through PBL, she responded very positively about the impact of her PBL in the post-unit interview.

> "I experienced the power [of PBL]. A lot of teachers don't realize it. You have to see what kids could learn. Many of my students are coming back with a whole page of descriptive writing. They were barely writing a couple of sentences when this unit began. It [PBL] is just a wonderful teaching and learning tool, getting them out of the book."

## Discussion

Data collected through video footage, observations, and interviews revealed how a problem-based learning approach was adopted and applied in a middle-school ESL learning environment. A middle-school ESL teacher perceived that a PBL unit was successfully adopted and applied in ESL learning environments, actively engaging students in the learning activities and positively affecting their motivation and self-confidence. Video footage and observation data also indicated that a successful implementation of a PBL may require a number of instructional strategies, such as careful planning and preparation of learning resources and activities, use of technology, and frequent monitoring of students progress.

Interestingly, the teacher did not perceive students' low level of English skills as the serious challenges for PBL. Suggestions made by the teacher may provide important insight of what is needed to implement PBL with ESL students. She recommended balancing the information into the level of English that kids are at: "If they are beginner English level, it will have to be really scaled down to their language ability." She also suggested preparing a lot of practical examples of various levels of English so that students at different level could all understand what they were expected of.

However, some difficulties were also experienced by the teacher in the process. The most difficult challenge the teacher experienced was a time management between PBL activities and other school requirements, such as administrative works, homework from other classrooms. In addition, in spite of motivating factors of PBL, the teacher explained that the workload to prepare PBL learning activities was heavy. As Perkins (1991) points out, the cognitive demands that place on teacher and learners tend to increase in [constructivist] instruction (as cited in Driscoll, 2000, p. 381). Unfortunately, these increased cognitive demands may prevent a teacher from applying a constructive instruction, such as PBL. As Krajcik, Blumenfeld, Marx, and Soloway (1994) suggested, if any innovation, such as PBL approaches, is to be adopted successfully, teachers may need additional help to overcome the difficulties, such as heavy workload or longer preparation time.

The researcher hopes that the through this paper that described an ESL teacher's experiences with PBL, ESL administrators and educators may gain some insight into how this problem-based learning can be adopted and applied in ESL learning situations. More importantly, it is also hoped that through this paper, ESL educators would find it motivating and exciting to attempt problem-based learning approaches in their classroom. Further dialogue on implementing this student-centered, inquiry-based problem-based learning approach in ESL learning environments would benefit many ESL educators, providing promising ways to effectively teach ESL learners.

## References

Abdullah, M. H. (1998). Problem-based learning in language instruction: A constructivist model. *ERIC Clearinghouse on Reading English and Communication Bloomington IN*. Retrieved on December 14, 2004, from http://www.ericdigests.org/1999-2/problem.htm

Bass, A. (1991). Promising strategies for at-risk youth. *ERIC Clearinghouse on Educational Management Eugene OR*. Retrieved on March 14, 2004, from http://www.ericdigests.org/pre-9219/risk.htm
Barrows H. S., & Tamblyn R. M. (1980) *Problem-based learning: An approach to medical education*. New York: Springer.
Brinkerhoff, J. & Glazewski, K. (2004). Support of expert and novice teachers within a technology enhanced problem-based learning unit: A case study. *International Journal of Learning Technology*, 1(2). 219 – 230.
Cerezo, N. (2003). Problem-based learning in the middle school: A research case study of the perceptions of at-risk females. *Research in Middle Level Education*, 27(1). Retrieved on April 2, 2005, from http://www.nmsa.org/research/rmle/winter_03/27_1_article_4.htm
Driscoll, M. (2000). Psychology of learning for instruction (2nd ed.). Needham Height, MA: Allyn & Bacon.
Egbert, J. (2002). A Project for everyone; English language learners and technology in content-area classrooms. *Learning & Leading with Technology*, 29(8), 36-41.
Ellis, R., Basturkmen, H., & Loewen, S. (2001). Preemptive focus on form in the ESL classroom. *TESOL Quarterly*, 35(3), 407-432.
Ertmer, P. A., Lehman, J., Park, S. H., Cramer, J., & Grove, K. (2003). Barriers to teachers' adoption and use of technology in problem-based learning. *Proceedings of Association for the Advancement of Computing in Education (AACE) Society for Information Technology and Teacher Education (SITE) International Conference*, 1761-1766.
Evensen, D., & Hmelo, C. (2000). *Problem-based learning: A research perspective on learning interactions*. Mahwah, NJ: Lawrence Erlbaum.
Forrester, V. & Chau, J. (1999) Current developments in problem-based learning within the Hong Kong Institute of Education. *Implementing Problem Based Learning Project: Proceedings of the First Asia Pacific Conference on Problem Based Learning* (pp. 201-208). Retrieved November 18, 2004, from http://teaching.polyu.edu.hk/datafiles/R100.pdf.
Glazewski, K. The impact of scaffolding and student ability in a hypermedia, problem-based learning unit.
Jonassen, D. H., & Howland, J. (1999). *Learning to solve problems with technology: A constructivist perspective* (2nd ed.). Upper Saddle River, NJ: Merrill Prentice Hall.
Kagan, S. (1995). We can talk: Cooperative learning in the elementary ESL Classroom. ERIC *Clearninghouse on Languages and Linguistics Washington DC*. Retrieved November 15, 2004, from http://www.ericdigests.org/1996-1/talk.htm
Krajcik, J. S., Blumenfeld, P. C., Marx, R. W., & Soloway, E. (1994). A collaborative model for helping middle grade science teachers learn project-based instruction. *The Elementary School Journal*, 94, 483-497.
Krashen, S. (1985). *The input hypothesis: Issues and implications*. New York: Longman.
Hmelo-Silver, C. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review*, 16(3), 235-266.
Hanafin, M., Land, S., Oilver, K. (1999). Opening learning environments: Foundations, methods, and models. In C. M. Reigeluth (Ed.). *Instructional Design Theories and* Models (pp. 115-140), Mahwah, NJ: Lawrence Erlbaum Associates.
McDonough, S. (2001). Way beyond drill and practice: Foreign language lab activities in support of constructivist learning. *International Journal of Instructional Media*, 28(1), 75-80. Retrieved October 20, 2004, from OmniFile FullText database.
McKinnon, M. & Rigby, N. (n.d.). Task-based learning. *Onestop Magazine*. Retrieved November 1, 2004, from http://www.onestopenglish.com
Moss, D. & Duzer, C. (1998). Project-based learning for adult English language learners. *National Center for ESL Literacy Education*. Retrieved November 1, 2004, from http://www.cal.org/ncle/digests/ProjBase.htm
Newby, T., Lehman, J., Russell, J., & Stepich, D. (2000). *Instructional technology for teaching and learning: Designing instruction, integrating computers, and using media* (2nd ed.). Upper Saddle River, NJ: Pearson Education.
Park, S. H., Lee, M., Blackman, J., Ertmer, P., Simons, K., & Belland, B. (2005). Examining barriers middle school teachers encountered in the technology-enhanced problem-based learning. *Proceedings of Society for Information Technology and Teacher Education Conference.*
Savery, J. & Duffy, T. (1995). Problem-based learning: An instructional model and its constructivist framework. In R. Fogarty (Ed.), *Problem-based learning: A collection of articles* (pp. 300-316). Arlington Heights, IL: SkyLight Training and Pub.

Saye, J. & Brush, T. (2002). Scaffolding critical reasoning about history and social issues in multimedia-supported learning environments. *Educational Technology Research and Development*, 50(3). 77-96.

Solomon, G. (2003). Project-based learning: A primer. *Technology & Learning*. 23(6), 20-27. Retrieved November 2, 2004, from EBSCohost database.

Scott, B. & Brush, T. (1998). Teaching instructional technology: A problem-based learning approach. *Canadian Journal of Educational Communication*, 27(1), 1-18.

Swain, M. (1985). Communicative competence: Some roles of comprehensible input and comprehensible output in its development. In S. Gass & C. Madden (Eds.), *Input in Second Language Acquisition*. Rowley, Mass.: Newbury House.

Torp, L., & Sage, S. (2002). *Problems as possibilities: Problem-based learning for K-16 education* (2nd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.

Wedman, J. F. & Graham, S. W. (2004). Welcome to the performance pyramid. Columbia, MO. Retrieved Sep 9, 2004 from http://tiger.coe.missouri.edu/~pyramid

# A Theoretical Framework for Evaluating Online Learning Environments

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**Abstract**

*With the combination of innovative technological developments and evolving notions about learning, the interactive and collaborative learning is gradually emphasized in online learning environments. However, current evaluation approaches are not appropriate to evaluate socio-cultural aspects of online learning environments. This paper details a theoretical framework for evaluating online learning environments, especially interaction among learners, tools, and outcomes, based on activity theory. Implications of the framework for future research are also presented.*

Learning is considered as an active process for constructing knowledge. Guiding and supporting learners for their construction of their understanding has been emphasized in learning environments as well as instruction (Wilson, 1996; Bonk & Cunningham, 1998). Since the early 1990s, designing meaningful learning environments has been one of the most attractive issues to many of instructional designers in the field of instructional technology. Some of the examples are Web-Based learning environments, constructivist learning environments, student-centered learning environments, open-ended learning environments, technology-mediated learning environments, and online learning environments.

A learning environment is a place where learners can access resources and construct meaningful knowledge with teachers' guidance; thus, learning is intentionally fostered and supported in a learning environment (Khan, 1997). The development of Web-based technologies has enabled people to create effective learning environments via the Web. Thus, online learning environments use the Web as a supplement to face-to-face instruction, a mixed mode with face-to-face instruction, or exclusively Web-based instruction without face-to-face components (Mishra, 2002). Online learning environments can provide learners with such advantages as flexibility in time and place and easy access to learning materials. Online learning environments in many cases are based on constructivist, learner-centered principles, and learners are expected to share their perspectives and to collaboratively construct the knowledge within a group of learners (Gunawardena, Carabajal, & Lowe, 2001). Because interactive and collaborative learning has proved to be effective to generate meaningful learning activities (Jonassen & Rohrer-Murphy, 1999), they have been gradually gaining attention in online learning environments.

Evaluating online learning environments has become more important as interests and applications of online learning increase. Just as "the situated character of learning was complex and students had to maneuver within a complex system" (Havnes, 2004, p.174), evaluation of students' learning outcomes and instruction should analyze the complex system or the learning environment. Learning cannot be properly assessed solely on the analysis of individual students' interpretation of instruction; rather, evaluation approaches should include how learners construct knowledge, how and what teachers teach, and how other factors influence their learning in online learning environments (Havens, 2004). A variety of evaluation models and approaches have been developed to examine interaction, usability, cognitive processes, different ways of learning assistance, and educational software. However, evaluation approaches used to evaluate the effectiveness of learning in classrooms are insufficient to evaluate dynamic and complex online learning environments (Gunawardena et al., 2001). Thus, a genuine need has emerged to develop a new evaluation approach appropriate for online learning environments.

The purpose of this paper is to build a framework for evaluating online learning environments using activity theory as a lens, thereby contributing to designing more authentic online learning environments. Activity theory is used to provide an analytical lens through which to view and analyze learners' activities and interaction in online learning environments. The framework is not prescriptive, meaning that it would not tell people what to do in a specific circumstance; rather, it analyzes aspects of online learning environments in order for evaluators to better understand online learning environments (Robson, 2000). Online learning developers can modify the framework to fit in a particular evaluation project. Further, the framework can be served as a rubric that people can reference when designing online learning environments.

This paper briefly describes socio-cultural aspects of online learning environments. Also, activity theory and a framework for evaluation using activity theory are presented. Implications of the framework for future research conclude this paper.

## Socio-Cultural Aspects of Online Learning Environments

Although the transition of knowledge from teachers to students used to be considered a good way to instill students with facts and information, it is now regarded as impossible for teachers to feed knowledge to students in the era of information. Rather, learning is viewed as a process for constructing knowledge, and the teachers' role has changed to guides or facilitators. According to Mayer (1999), there are three views of learning and instruction: learning as response acquisition, learning as knowledge acquisition, and learning as knowledge construction. The third view, learning as knowledge construction, means highlighting "the interaction of persons and situations in the acquisition and refinement of skills and knowledge" (Schunk, 2004, p. 287), at least from a constructivism perspective.

Based on Marx's philosophy, Vygotsky was one of modern pioneers in socio-cultural psychology. Vygotsky emphasizes the social environment as a facilitator of learning, where cultural and historical aspects meditate between mind and consciousness (Lerman, 2001; Schunk, 2004). Vygotsky focuses on the interaction of interpersonal, cultural-historical, and individual factors (Schunk, 2004) as the key to human learning and development. His theory maintains that learning and development cannot be understood or explained without the interaction within the culture. Furthermore, Vygotsky presents the concept of a zone of proximal development (ZPD) to describe the whole process of learning, explaining the relationship between the individual subject and his or her environments. According to Engeström (1987), the ZPD is "the distance between the present everyday actions of the individuals and the historically new form of the societal activity that can be collectively generated" (p. 174). The main idea of the ZPD is that humans collectively learn through social interaction in a social and cultural environment (Barab, Evans, & Baek, 1996). Because "the ways of organizing the world that are created by culture, within a social and historical context, become internalized by the person through symbolic matter" (Lerman, 2001, p. 103), people internalize the culture of the environment during the learning process through interaction.

Unlike the view of traditional psychology regarding learning as the individual's cognitive reconstruction (Lerman, 2001), socio-cultural roots of psychology argue that it is more appropriate to say that learners construct their knowledge through interaction with their environments than learn something isolated from others. Thus, the focus is on a learning context rather than on individuals. Green and Gredler (2002) note that because social constructivists view "the classroom as a community charged with the task of developing knowledge" (p. 57), knowledge cannot be separable from activities in the classroom. Likewise, constructivist online learning environments are designed for students to construct their knowledge through interaction with other entities, thus learning cannot be appropriately explained without viewing the whole learning environments. Bonk and Cunningham (1998) regard learning as fundamentally social and argue that it is derived from authentic interaction with others in a community. Accordingly, learning is naturally and meaningfully influenced by social interaction in the socio-cultural contexts in which students are involved (Bonk & Cunningham, 1998; Jonassen, 1999; Havens, 2004). Jonassen (1999) identifies several components of constructivist learning environments including problem-based and case-based learning, learning resources, cognitive tools, conversation and collaboration tools, and social and contextual support based on Vygotsky's socio-cultural theory.

## Activity Theory as a Framework for Evaluating Online Learning Environments

Activity theory is an international and multidisciplinary framework for studying different forms of human praxis that interlinks individual and social levels (Kuutti, 1996). It has originated from classical German philosophy, the works of Marx and Engels and the Soviet Russian cultural-historical psychologists such as Vygotsky, Leont'ev, and Luria (Engeström, 1999). In socio-cultural tradition, "the focus is on mechanisms that make people act in similar ways within in a given context" (Havnes, 2004, p. 162). Investigating learning outcomes can tell us whether or not instruction is successful. However, it cannot provide us with the reason why people succeed or fail to learn in a given context. To view and analyze learners' activities or learning in online learning environments, we need to thoroughly look at the learning environments. Activity theory has been found to provide a holistic framework through which to design, analyze and evaluate online learning environments (Jonassen & Rohrer-Murphy, 1999; Hew & Cheung, 2003; Barab, Schatz, & Scheckler, 2004; Haven, 2004). For the reason, activity theory is used to establish a framework to analyze online learning environments.

### Activity Theory as an Analytical Lens

Activity theory maintains that all human activities are mediated by a third artifact labeled tool or instrument. The central notion of activity theory was well represented in the Vygotsky's triangular model of subject, object, and tool (Vygotsky, 1978). According to Vygotsky, people are not directly interacting with the environment. Instead of accepting the simple behavioral stimulus and response relationship, he came up with the idea of cultural mediation of actions (Engeström, 2001). The environment interacts with human beings through its mediating artifact, or tool. Because “artifacts are the product of human history and culturally specific” (Lerman, 2001, p. 95), the cultural and historical aspects of the environment are likely to influence human interaction and ultimately human development and learning.

Following Vygotsky’s theory and work, Leont’ev developed a framework for the theory of activity that “situates behaviour within social context, via three levels of description: activity system, action, and operation” (Tolmie & Boyle, 2000, p. 125). The activity system comprising a subject, an object, and meditating tools provides a lens to analyze group and individual behaviors. A subject pursues an object by using tools reflecting the culture. At the highest level is activity, which “reaches beyond the individual and is part of a wider, social context” (Havens, 2004, p. 163). Actions refer to individual and usually conscious behaviors directed at specific goals. With individual knowledge and skills, subjects take actions to move forward to the overall object. Actions comprise several associated operations. Operations are the most basic and simplest level of human activity. We tend to behave without any conscious intention. Writing a paper is a good example as an activity. Then, reading reference books and articles, outlining the paper, and writing a paragraph are some of actions toward the goal. The operation would be typing a word, drawing a concept map before outlining.

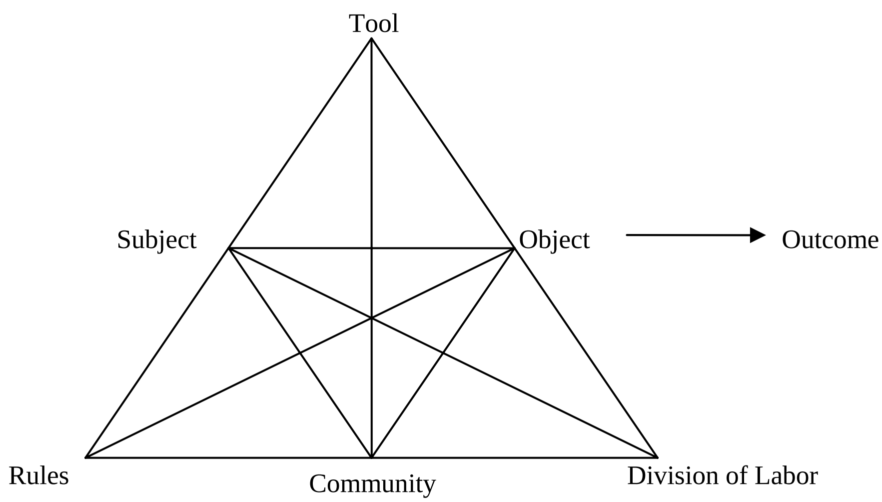


*Figure 1.* An activity system (Engeström, 1987).

Adopting Leont’ev’s work, Engeström (1987) expanded Vygotsky’s triangular model and completed the activity system (see Figure 1). In this model, he acknowledged the contextualized nature of activity by adding rules, community, and division of labor (Barab et al., 1996). For example, taking a basic introductory Hyper Text Markup Language (HTML) course constitutes an activity system. The course is an exclusively online learning environment without face-to-face instruction. The overall objective of the course is to apply the knowledge and skills of HTML in developing Web-based educational courseware (object). The teacher (subject) uses WebCT (tool) to deliver pre-recorded lectures (tool), to provide the students (subject) with a platform where they can interact. There are students in the class, other experts of HTML on the Web (community), and several course requirements (rule). The teacher wants the student to work in groups to produce an educational courseware (division of labor). The teacher in the course assigns weekly tasks to each student for helping them move toward the course object. Some of the assignments are inserting images and texts, creating links, formatting HTML pages, and creating and modifying tables. To achieve the overall object, or to create Web-based educational courseware, the learners should complete the weekly assignments (actions). Each action is a unique task directed at the course object and comprises several operations. Creating and modifying tables requires the learners to manipulate columns, rows, borders, colors, etc. (operations) with provided resources, communication and collaboration tools, and others.

To evaluate the effectiveness of the course described above, evaluators should look at all the components that form the activity system or the learning environment and how they interact with others within the system. The fact that each component of online learning environments interacts with others brings about the complexity of evaluation of it. It has been known that activity theory understands this complexity (Russell, 2002). The complexity of the interrelationship has called for a new framework to work with. Next, a framework for evaluating online learning environments is more elaborated based on activity theory. Each component in the activity system is described and how they interact with others.

**Components of Activity System for Evaluation**

Six components are identified as an action system for evaluation: subject, object, tool, rules, community, and division of labor.

*Subject.* A subject refers to an individual or groups of people who are engaged in an activity. In online learning environments, students are the subjects. Since each of the subjects participates in many other activity systems (e.g., school, home, work, etc.), it is critical to recognize where they come from (Russell, 2002). Students' prior knowledge and experiences, learning styles, motivation, and attitudes can influence learning and performance in online learning environments.

*Object.* An object refers to a concrete goal that an activity is moving toward; that is, the object indicates an overall direction of that activity or a shared purpose and it is culturally and historically formed (Russell, 2002). In online learning environments, this might be the objectives of a course. The shared object is critical in that students can act toward the goal and give meaning to actions related to the activity.

*Tool.* Tools are perceived as mediating artifacts between subject and object. They include both psychological tools such as language, signs and symbols, and material tools like pencils and paper (Barab et al., 1996). In online learning environments, different communication technologies can be mediating tools, such as discussion board, chatting room, email, etc. It seems natural that using different delivery tools will bring about different outcomes. The tools that people use and the variety of ways they use the tools have changed over time as other activity systems produce new tools and new ways to use them (Russell, 2002). For example, the development of technologies enables us to use the Web as a learning environment.

*Rules.* Rules refer to norms, routines, and conventions of behaviors. The rules mediate between subject and community and also shape the interactions of subject and tools with the object (Russell, 2002).Rules in online learning environments are different for those of traditional classroom environments.

*Community.* According to Russell (2002), the subject is a community or a part of a larger community and the community "conditions all the other elements of the system" (p. 70). In online learning environments, they often form a learning community.

*Division of Labor.* Activity system has a division of labor. A division of labor refers to organization of processes related to the goal. In the process, subjects play different roles in the activity. In traditional face-to-face classroom environments, the labor is divided into a teacher and students (Russell, 2002). However, in online learning environments, the labor can be divided in many different forms. In many cases, teachers' roles have changed to facilitators and students form a group and collaborate among themselves to achieve the overall goal. Furthermore, considering the complexity resulting from the interrelationship among the components, the following sub-triangles from the activity system are useful.

*Triad of subject-tool-object.* Tools mediate between subject and object. This triad looks at how effectively tools help the subjects get to the goal. What tools are used and how are they used to deliver the course contents? Do they cover all knowledge and skills necessary for the subjects to obtain the goal? If the tools are not easy to follow, then opportunities for performing the object well may be diminished.

*Triad of subject-rules-community.* Rules mediate between subject and community. The triad describes how the subjects interact with others in the learning community. How do subjects understand the interaction rules of the community? This is particularly difficult in online learning environments where there is no face-to-face communication to clarify and negotiate the rules (Russell, 2002).

*Triad of subject-tool-community.* Tools mediate between subject and community. If insufficient communication and collaboration tools are used, creating a community and keeping the community moving toward the goal may be challenging.

*Triad of subject-division of labor-community.* A division of labor mediates between subject and community. What roles are implied to students in the community? How do these roles contribute to the community? If students' roles in the community are not clearly identified, opportunities for collaborating are likely to be diminished.

*Triad of subject-community-object.* In this triad, a community mediates between subject and object. Do the subjects feel a part of the community to accomplish the goal together? If the object is highly individualized, then opportunities for collaborating are likely to be diminished.

*Triad of object-division of labor-community.* A division of labor mediates between object and community. The triad focuses on how roles of the community contribute to accomplishing the goal of the activity. If the instruction is designed for individual work, opportunities for collaboration may be reduced.

*Triad of object-tool-community.* Tools mediate between object and community. What tools are used for subjects to collaborate and cooperate with other community members in order to accomplish the goal? If tools are not sufficient to communicate and collaborate with others, many in the community may fail to learn.

*Triad of object-rules-community.* Rules mediate between object and community. If there is no explicit rule for working together in online learning environments, collaboration in the community is unlikely to occur.

## Implications for Future Research

As the development of technologies progresses, people want benefits from online learning environments (Bonk, 2002). The number of students taking online courses has been rapidly increasing in recent years. Given the growing number of learners, there are many concerns with how to create online learning environments supporting constructivists' view of learning. As the interests in online learning environments from constructivists' viewpoints have increased, we challenge how to evaluate the learning environments as a whole. In this paper, an evaluation framework using activity theory is presented. Activity theory has been proved to be a useful, practical, and analytical lens to view human activities or learning in online learning environments. The components of the activity system are described and some possible evaluation questions are also presented.

The activity theoretical framework enables us to look at the entire learning environment, describe how every operation and action is directed to the goal, and how they interact with others. An area of future research would be to explore why substantial number of students decides not to continue to take online courses and how some survive online learning environments. Robson (2000) shows that discontinuation in online learning environments are considerable. Because most evaluation models for online learning do not consider these discontinuing students (Robson, 2000), it is difficult to investigate the reason why they decide to discontinue taking an online course. Analyzing the elements of online learning environments using the framework presented in this paper can give us a better idea of how to design effective learning contexts where students actively construct their knowledge through interaction with others and resources. Furthermore, because the evaluation of learning environments tends to be summative as well as formative evaluation, this framework can be used as a guideline for instructional designers to reference when they design online learning environments. Also, it could provide pedagogical guidance for teachers' individual instruction activities.

## References


Barab, S. A., Evans, M. A., & Baek, E-O. (1996). Activity theory as a lens for characterizing the participatory unit. In D. H. Jonnassen (Ed.), *Handbook of research for educational communications and technology* (pp. 199-214). NY: Macmillan Library Reference.

Barab, S. A., Schatz, S., & Scheckler, R. (2004). Using activity theory to conceptualize online community and using online community to conceptualize activity theory. *Mind, Culture, and Activity*, 11(1), 25-47.

Bonk, C. J. (2002). Online training in an online world. *Education at a Distance*, 16(3). Retrieved November 18, 2004, from http://www.usdla.org/html/journal/MAR02_Issue/article02.html

Bonk, C. J., & Cunningham, D. J. (1998). Searching for learner-centered, constructivist, and sociocultural components of collaborative educational learning tools. In C. J. Bonk & K. S. King (Eds.), *Electronic Collaborators* (pp.25-50). Mahwah, NJ: Lawrence Erlbaum Associates.

Engeström, Y. (1987). *Learning by expanding: An activity-theoretical approach to developmental research*. Helsinki, Finland: Orienta-Konsultit.

Engeström, Y. (1999). Activity theory and individual and social transformation. In Y. Engeström, R. Miettinen, & R-L. Punamäki (Eds.), *Perspectives on activity theory* (pp. 19-38). Cambridge University Press.

Engeström, Y. (2001). Expansive learning at work: Toward an activity theoretical reconceptualization. *Journal of Education and Work*, 14(1), 133-156.

Green, S. K., & Gredler, M. E. (2002). A review and analysis of constructivism for school-based practice. *School Psychology Review*, 31(1), 53-70.

Gunawardena, C., Carabajal, K., & Lowe, C. A. (2001). *Critical analysis of models and methods used to evaluate online learning networks*. ERIC Document Reproduction Service No. ED456159.

Havnes, A. (2004). Examination and learning: An activity-theoretical analysis of the relationship between assessment and educational practice. *Assessment & Evaluation in Higher Education*, 29(2), 159-176.

Hew, K. F., & Cheung, W. S. (2003). Models to evaluate online learning communities of asynchronous discussion forums. *Australian Journal of Educational Technology*, 19(2), 241-259.

Jonassen, D. H. (1999). Designing constructivist learning environments. In C. M. Reigeluth (Ed.), *Instructional design theories and models: A new paradigm of instructional theory* (pp. 215-239). Mahwah, NJ: Lawrence Erlbaum Associates.

Jonassen, D. H., & Rohrer-Murphy, L. (1999). Activity theory as a framework for designing constructivist learning environments. Educational Technology Research and Development, 47(1), 61-79.
Khan, B. H. (1997). Web-based instruction (WBI): What is it and why is it? In B. H. Khan (Ed.), Web-Based Instruction (pp. 5-18). Englewood Cliffs, NJ: Educational Technology Publications.
Kuutti, K. (1996). Activity theory as a potential framework for human-computer interaction research. In B. A. Nardi (Ed.), Context and consciousness: Activity theory and human-computer interaction. Cambridge, MA: MIT Press.
Lerman, S. (2001). Cultural discursive psychology: A sociocultural approach to studying the teaching and learning of mathematics. Educational Studies in Mathematics, 46, 87-113.
Mayer, R. E. (1999). Designing instructional for constructivist learning. In C. M. Reigeluth (Ed.), Instructional design theories and models: A new paradigm of instructional theory (pp. 143-159). Mahwah, NJ: Lawrence Erlbaum Associates.
Mishra, S. (2002). A design framework for online learning environments. British Journal of Educational Technology, 33(4), 493-496.
Robson, J. (2000). A framework for evaluation: Including the student who discontinues. Retrieved October 14, 2004, from http://ausweb.scu.edu.au/aw02/papers/refereed/robson2/paper.html
Russell, D. R. (2002). Looking beyond the interface: Activity theory and distributed learning. In M. R. Lea, & K. Nicoll (Eds.), Distributed learning: Social and cultural approaches to practice. NY: RoutledgeFalmer.
Schunk, D. H. (2004). Learning theories: An educational perspective. NJ: Pearson Education, Inc.
Tolmie, A., & Boyle, J. (2000). Factors influencing the success of computer-mediated communication (CMC) environments in university teaching: A review and case study. Computers & Education, 34, 119-140.
Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.
Wilson, B. G. (1996). What is a constructivist learning environment? In B. G. Wilson (Ed.), Constructivist learning environments (pp. 3-8). Englewood Cliffs, NJ: Educational Technology Publications.

# Effective Use of Collaborative Technologies for Virtual Teaming

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**Abstract**

*The study focuses to investigate the use of technologies for supporting virtual teams. Since fast-emerging distance educational fields have adopted a collaboration approach for learning purpose, better understanding the nature of virtual teaming activities is required. With consideration of the fact that virtual teaming activities assist students to build collective knowledge and skills, the study conceptually connects three different virtual team modes with a category of appropriate interactive technologies. Also, this study briefly addresses the current use of interactive technologies in virtual teaming activities. The study suggested the appropriate integration of different technologies for optimal virtual teaming activities.*

## Introduction

Teamwork is one of the most widely used instructional activities in traditional classrooms as well as online learning environments. Many studies point out that teamwork activities provide pedagogically rich context to assist students in building meaningful knowledge in online environments (Carabajal, LaPointe, & Gunawardena, 2003; Lee, Bonk, Magjuka, Su, & Liu, in press; Palloff & Pratt, 2005). In this sense, the use of teamwork activities in online environments has gained more competitive advantages compared to other instructional activities.

When teamwork is introduced in online environments (it can be called 'virtual teams'), the context for virtual teaming activities becomes different from that of traditional classroom teamwork. Virtual team members are dispersed in physically and culturally different environments. Any idea exchanges and decision making within the teams via technologies requires more time, effort, and detailed guidelines than would be required for regular classroom teamwork.

Technology explosion within virtual team members is one of the major concerns that has seldom been considered in classroom teamwork situations. Technologies for virtual teams function as communicational channels, instructional medium, and mutual product tools. Team members adjust themselves to get accustomed to the usage of technological tools for enriched team operation, as well as effective ways of how to learn together.

The success of virtual teams depends on the appropriate integration of technologies with pedagogical activities. What virtual team members pursue determines the modes of virtual teams and the use of technologies, and they eventually bring an impact on the virtual team's process and performance. However, the increased use of virtual teaming activities has not been accompanied by research efforts to better understand interactive technologies to support different modes of virtual teams in online environments. Thus, this study covers two research interests: first, the literature review conceptually connects three different virtual team modes with a category of appropriate interactive technologies. Secondly, this study briefly addresses the current use of interactive technologies in virtual teaming activities. An understanding of different interactive technologies under different modes of virtual teams will be of fundamental interests for instructional designers and practitioners.

## Different modes of virtual teams, different technologies

### Three different modes of virtual teams

Virtual teams can be defined as "a group of people with complementary competencies executing simultaneous, collaborative work process through electronic media without regard to geographic location" (Chinowsky & Rojas, 2003, pp.98). Teamwork for educational purpose requires a group of students to pursue a common learning goal through completing certain tasks. Virtual teams have different operation mechanisms or ways of interactions than traditional classroom teams. Usually classroom teamwork is carried out by individual students who are physically in the same place. Meanwhile, virtual team members reside in different places and seek to accomplish interdependent tasks throughout by interactive technologies.

The essential nature of virtual teams is the growth. Virtual teams start "gathering together online" at the beginning, and gradually develop themselves to the maturity level of "learning online collaboratively". The stage at which virtual teams operate shapes team behaviors and performance in the end. Under the modified viewpoint of Himmelman (2004)'s developmental continuum, virtual team can be distinguished into three modes based on what they pursue as a team and how they behave: communication cooperation, and collaboration.

Communicational virtual teams[20] are basic forms of team at the early stage of team development. Exchanging information and changing work activities for mutual benefits are key concerns to team members (Himmelman, 2004). Sending and receiving messages, and transmitting information among team members via technologies, are ordinary behaviors. No additional data processing or manipulation beyond communicational needs are transmitted or interpreted (Chinowsky & Rojas, 2003). Consequently, the use of technological tools in this mode is limited to message delivery.

Effective communications are the fundamental bases to make teamwork environments friendly, especially when they do not meet face-to-face. However, it is not enough to simply accomplish team goals. Once communicational behaviors contribute to coordinate good relationships among members, virtual teams evolve into a cooperation mode. Cooperative virtual teams "exchange information, alter activities, and share resources, for mutual benefit and the achievement of a common purpose" (Himmelman, 2004, p. 2). In a cooperative virtual team mode, team members divide labor and take responsibilities for a portion of the mutual tasks (Lehtinen, Hakkarainen, Lipponen, Rahikainen, & Muukkonen, n.d.).

On the other hand, collaborative virtual teams involve mutual engagement in a coordinated effort to solve problems together (Roschelle & Teasley, 1995). In other words, they focus on enhancing the capacity of another individual or organization for team benefit, and on achieving a common purpose (Himmelman, 2004). Collaboration seeks team members to experience meaningful learning throughout the whole process of producing team products.

As Himmleman (2004) suggested, the different modes of teamwork can work better under specific circumstances depending on what common tasks and what barriers they are facing. However, considering the features of online environments, what technologies are being used and how technologies can support teams in different modes should be taken into consideration.

**Interactive technologies for virtual teams**

Students select technological tools when their tool functions are understandable. Students use technological tools better when the use of technological tools is pedagogically well designed. Pedagogical design of technology use means that online instructors and educational practitioners carefully integrate the use of technological tools into instructional activities. Proper technology integration supports building meaningful learning experiences without meeting face-to-face. In addition, Chinowsky and Rojas (2003) stressed that the roles of technologies in virtual teaming activities go beyond electronic communications, transferring information, and the products of team projects. In a similar sense, Salomon, Perkins, and Globerson (1991) mentioned about importance of the use of technologies as cognitive tools. What this means is that students are aware of what technological tools they will use for certain activities, instead of being overwhelmed by technologies themselves. By doing so, the use of technologies as cognitive tools can enhance students' thinking and learning.

Interactive technologies for virtual teamwork should be able to "communicate, collaborate, and interact to share knowledge and information" (Mayben, Nichols, & Wright, 2003; Sole & Applegate, 2000). Currently many current course management systems support virtual teaming activities with advanced technological tools containing a variety of functions. However, the proper application of technological tools into the virtual teaming activities is not fully known. It can be taken for granted that the appropriate use of technologies determines the quality of virtual teamwork process and performance. However, many questions regarding effective use of those technologies remain unsolved. For example, what technological tools can we consider for each of virtual team modes (communication, cooperation, and collaboration)? How can we use the technological tools effectively as cognitive tools?

Mayben, Nichols, and Wright (2003) list a variety of collaborative technologies including email, file transfer protocol, video conferencing, discussion boards, electronic mailing list, instant messaging programs, digital imaging, Web Sites, phone/teleconferencing, and word processing editing tools. Also, the existing studies have mostly used technology classification of synchronous and asynchronous applications (Coleman, 1997; Durate & Snyder, 1999; Reynolds, 1994). However, since this study examines different technologies in different virtual team modes, it utilizes Chinowsky and Rojas (2003)'s spectrum of electronic interaction technologies. This classification

[20] Himmelman (2004) in his developmental continuum for change strategies points out "collaboration is in a relation to three other strategies for working together: networking, coordination, and cooperation (p. 1)." Instead, this study combines "networking" and "coordination" under the name of "communication" in order to clearly distinguish it from the other two modes of virtual teams (i.e., cooperation and collaboration).

of technologies is useful to examine the actual technology use in three modes of virtual teams (such as communication, cooperation, and collaboration).

The function of communication technologies is to deliver messages to one team member or the team, and to exchange thoughts under discussions. These messages can be asynchronous or synchronous. Chinowsky and Rojas (2003) point out that phone/teleconferencing, and representative traditional communication channels, can be still used for virtual teaming activities involving communication.

Cooperation technologies feature technical advances over communication technologies. The central focus of cooperation technologies is concerned with asynchronous interactions and information manipulation for team tasks. Project Web sites and discussion forums fall into the category of cooperation technologies. Virtual team members access the teamwork space, exchange communications, and update the project documentations. However, the limitation of cooperation technologies is that they support mostly asynchronous teamwork and do not go beyond the real-time experiences.

On the other hand, collaboration technologies[21] put more focus on real-time functions of the tools. Synchronous communications and data productions are critical if team members need to accomplish mutual team products in a limited time. Two way synchronous tools such as videoconferencing or web conferencing could create similar environments with face-to-face virtual teams. Those tools can support virtual teams' efforts to real-time data manipulation and idea exchanges.

Each interactive technological tool features its own functions and supports virtual teaming activities somehow across the developmental continuum of virtual teams. However, this study points out that there is a limitation of the use of existing technologies to support the team member's effort to collaborate. Importantly, mere operation of virtual teaming activities does not guarantee the effectiveness and efficiency of the teamwork. What is more important is to identify technologies that have the potential to improve the performance of virtual teams.

**How interactive technologies were used for virtual teams?**

This study examined a well known online MBA program as a case study. Course content analyses, faculty interviews, and student surveys were used in order to analyze the use of interactive technologies for virtual teams. Different data sets were cross checked as a means of triangulation method and this study mainly presents a small piece of content analysis and student survey due to the page limitation. The data on the detailed use of interactive technologies that have been utilized for virtual teaming activities were reassembled into the categories of communication, cooperation, and collaboration.

According to the content analysis, twenty-one out of twenty-seven courses used virtual team activities (78 percent). Surveys pointed out students are relatively satisfied with teamwork in online environments. In detail, they responded that online courses provided them with useful tools for collaboration (71.6 percent, M=3.74 SD=1.01). Overall, students agreed that virtual teamwork contributed to build co-knowledge among themselves (M=4.18, SD=.80).

*Use of communication technologies*: According to the content analyses, most virtual teams analyzed in this study frequently used ordinary communicational channels. The eight courses used phones/teleconferencing (30 percent) and twenty-six courses utilized emails (96 percent). It is assumed that virtual team members easily selected those technological tools for communication purpose due to relatively easy access and functional familiarity of the tools.

*Use of cooperation technologies*: The results of course content analyses showed that eight courses (30 percent) used discussion forums for virtual teaming activities. Team file sharing was used in nine courses (33 percent). The cooperation technologies function for asynchronously creating, modifying, storing, retrieving team products. Also, team discussion forums asynchronously used updating ideas among team members.

*Use of collaboration technologies*: The usage level of one-way and two-way synchronous tools such as chat, instant messaging, or video conferencing was reviewed. Five courses reported using chat tools for discussion in virtual teams (19 percent) and one course (4 percent) used LiveMeeting. The official use of video conferencing and instant messages was not shown in the online courses which were analyzed in this study. Providing students with the chances of exchanging ideas synchronously is critical to solicit team members to negotiate and make decisions. The combined use of asynchronous and synchronous tools can help team members better deal with conflicts that usually occurred in the middle of teamwork process due to little presence of team members.

Overall, the review of interactive technologies for virtual teaming activities shows that many of technological tools are embedded in the course management systems were in effective use. In practice, most virtual

[21] Chinowsky and Rojas (2003) classified virtual teaming into interactive technologies of collaboration. However, this study does not see virtual teaming as technological tool itself, but it is an intentional instructional activity.

teams remain in heavy use of both communication and cooperation technologies. The actual use of collaboration technologies recorded as quite low, compared to the other two categories of technologies. It is natural that virtual team members, at the beginning, start to work together in a communication mode and heavily rely on emails and phone talks for facilitating communications. However, communication behaviors and technologies have constraints to support producing team deliverables and do not always improve their higher-order thinking and knowledge-building. Teamwork for learning purposes should go beyond information transmission, labor division, and working independently.

Kirschner and Van Bruggen (2004) stress the point that from a pedagogical point of view, current interactive technologies for teamwork are, generally speaking, designed for mechanical functions of basic communications, or limited use for supporting teaming activities. Similarly, simple implementation of virtual teaming activities does not guarantee the effectiveness and efficiency of the teamwork. It is more important to guide appropriate usage of technological tools to support the whole process of collaborative learning so that it can be eventually leading virtual team members to improve the team performance.

**Summary**

The nature of team tasks and modes of team development determine team behaviors. In particular, what team members are pursuing influences the selection of interactive technologies for virtual teaming activities. Consequently, the use of technologies impacts the quality and depth of virtual teaming process and performance.

In this study, the use of different technologies to support virtual teaming activities was investigated. Kirschner and Van Bruggen (2004) have raised issues that current technologies put more weight on so called “functional collaboration,” not on “conducting learning tasks properly, understanding each other’s work and teamwork process.” What they point out is the use of many technological tools remains facilitating communicational behaviors such as message delivery, but not assisting building collective knowledge.

In practice, this study confirms that virtual teaming activity as an instructional method has been positively used in online learning environments. However, the practices of virtual teaming activities still rely on technologies of communication and cooperation, rather than collaboration technologies. The introduction of technologies in virtual teaming activities itself do not assure meaningful collaborative learning experiences. With consideration of this fact, elaborated design of appropriate technologies into virtual teaming activities are required. While this study focuses the relationship of interactive technological tools with collaborative learning, the focus of next study is expected to develop practical guidelines to use technologies for different stages of the collaborative learning process.

**References**


Carabajal, K., LaPointe, D., & Gunawardena, C. N. (2003). Group development in online learning communities. In M. G. Moore, & W.G. Anderson (Eds.), *Handbook of distance education* (pp. 217- 234). Nahwash, NJ: Lawrence Erlbaum Associates.

Chinowsky, P. & Rojas, E. (2003). Virtual teams: Guide to successful implementation. *Journal of management in engineering, 19*(3). 98-106

Coleman, D. (1997). *Groupware: The changing environment*. In D. Coleman (Ed.), Groupware: Collaborative strategies for corporate LAN's and intranets (pp. 1-37). Upper Saddle River, NJ: Prentice Hall.

Durate, D., & Snyder. N. (1999). *Mastering virtual teams: Strategies, tools and techniques that succeed* San Francisco, CA: Jossey-Bass Inc., Publishers.

Himmelman, A. T. (2004). *Collaboration for a change: Definition, decision-making models, roles, collaboration process guide*. Minneapolis: Himmelman Consulting.

Kirschner, P. & Van Bruggen, J. (2004). Learning and understanding in virtual teams. Cyber Psychology & Behavior, 7(2), 135 -139.

Lee, S., Bonk, C. J., Magjuka, R. J., Su, B., & Liu, X. (in press). Understanding the dimensions of virtual teams. *International Journal of E-learning*.

Lehtinen, E., Hakkarainen, K., Lipponen, L., Rahikainen, M., & Muukkonen, H. (n.d.). *Computers supported collaborative learning: A review*. CL-NET project. Retrieved July 19, 2005 from: www.comlab.hut.fi/opetus/205/etatehtava1.pdf

Mayben, R., Nichols, S., & Wright, V. H. (2003). Distance technologies in collaborative research: Analyzing the successes and barriers. *The Journal of interactive online learning, 2*(2), 1-21.

Palloff, R., & Pratt. K. (2005). *Collaborating online: Learning together in community*. San Francisco, CA: John Wiley & Sons, Inc.

Roschelle, J., & Teasley, S. (1995). The construction of shared knowledge in collaborative problem solving. In C. E. O'Malley (ed.), *Computer supported collaborative learning* (pp.69-97), Berlin: Springer-Verlag.

Salomon, G., Perkins, D. N., & Globerson, T. (1991). Partners in cognition: Extending human intelligence with intelligent technologies. *Educational Researcher, 20*(3), 2-9.

Sole, D. L., & Applegate, L. M. (2000). *Knowledge sharing practices and technology use norms in dispersed development teams*. In Proceedings of 21st international conference on information systems (pp.581-587). Atlanta, GA: Association for information systems.

# Demobank: a method of presenting just-in-time online learning

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**Abstract**

*A demobank is a method of presenting web-based instruction for promoting procedure-based learning. This presentation technique is a well structured collection of web-based animated demonstrations (narrated demonstrations of computer-based procedures). A demobank allows the learner to view animated demonstrations individually or as a series. These demonstrations usually depict a group of computer-based procedures, which if properly constructed can act as a help system or as a "just-in-time" online workshop. Animated demonstrations are increasingly being used by a number of companies to deliver web-based training to their intended audiences, either potential clients or employees. This paper discusses learning given a demobank of animated worked examples and design considerations for this new presentation technique.*

## Animated worked examples?

Many people believe they must first perform a procedure to learn that procedure, sometimes repeatedly. However, one can learn how to perform a procedure just by studying examples (Sweller and Cooper, 1985). Certainly the correct performance of a procedure reinforces learning, but as Sweller and Cooper clearly demonstrate, performance is not truly necessary to learn a procedure. They found that learners that studied worked examples required significantly less time during skill acquisition, and that these learners made significantly fewer errors during problem solving. This paper builds upon Sweller's worked examples studies to produce a just-in-time learning environment which is generalizable to all computer based applications.

For decades researchers have known that graphics are necessary in instruction, because they support verbal communication (Bransford and Johnson, 1972). More recently it has been shown that learners using multimedia significantly out-performed learners using single media instruction (Brünken, Steinbacher, Plass, and Leutner, 2002; Mayer and Moreno, 1998; Mousavi, Low, and Sweller, 1995). Mousavi, Low and Sweller (1995) suggested that the simultaneous use of visual and verbal media effectively increases the learners' working memory capacity. Brünken et al. (2002) suggested that this is because multimedia makes use of the combined resources of both the visual and auditory subsystems of working memory.

Chandler and Sweller (1992) succinctly define worked examples as "a problem statement and the appropriate steps to solution (Chandler and Sweller, 1992, p. 233)." Animated demonstrations clearly fall under this category as they describe a problem and its solution in a series of steps. Because animated demonstrations are goal directed and procedure-based they act as animated worked examples.

Several researchers have studied the instructional effectiveness of animated demonstrations (Palmiter, 1991; Harrison, 1995; Lipps et al., 1998; Waterson & O'Malley, 1993). Like Sweller, these researchers, found that this form of instruction speeded skill acquisition, and that learners were faster and more accurate when learning procedural tasks. Sweller suggests this is because these learners concentrate on relevant problem states and the steps necessary to solve problems (Sweller et al., 1998). In addition performance may be improved because of the multimodal nature of this form of instruction.

Given such a useful form of instruction, how might we improve upon this presentation technique? Sweller suggests instructional designers should design instruction with the human cognitive architecture in mind (Sweller, 1993, 1999). The remainder of this paper explores how Sweller's statement can be applied to the design of a demobank of animated worked examples.

## How learning occurs given animated worked examples

A distinction should be made between procedural and declarative knowledge. Declarative knowledge refers to mental representations of the outside world; whereas procedural knowledge refers to processes that operate on those mental representations (van Merriënboer, 1997). Declarative knowledge is primarily concept or language based whereas procedural knowledge is usually goal directed and aimed at "knowing how." Demobanks may describe declarative information to learners, but are primarily useful for teaching learners procedural knowledge. Given complex cognitive skills require both declarative and procedural knowledge (van Merriënboer, 1997), a demobank becomes an ideal medium for teaching these complicated skill sets.

Sweller and Cooper (1985) suggested worked examples were useful mainly in the initial stages of skill acquisition. Researchers have been describing the phases of skill acquisition for over forty years (Fitts, 1964; Anzai and Simon, 1979; Anderson, 1983). Anderson continued in this tradition when he described cognitive skill acquisition (Anderson, 1982). In Anderson's ACT framework (Anderson, 1976, 1983, 1993) the three stages of skill acquisition are the declarative stage, the knowledge compilation stage, and then finally a procedural stage (Anderson, 1983). Since animated worked examples are most useful early in skill acquisition, this paper will strictly focus on learning during the declarative stage.

During the declarative stage, learners mentally rehearse procedures during a performance (Anderson, 1982). Anderson suggests it is even common to observe learners in this phase verbally rehearsing the steps of a procedure (Anderson, 1983). Performance during this first stage although laborious is often poor and error prone (Shiffrin and Dumais, 1981). This is because learners must first understand under what conditions a particular procedure is used. In addition they may also be considering the current problem state, the end goal and differences between the two (Ward and Sweller, 1990). So it is understandable that novice learners may have some difficulty.

Given Anderson's framework, the steps of a procedure are worked out according to procedure specific production rules. Production rules involve if then statements like the following:

IF the goal is to communicate with someone in another state

THEN dial the telephone.

A grouping of production rules is called a production. Productions are similar to what a behaviorist would have called a stimulus-response pair, but from a cognitive perspective (Anderson, 1983), because it takes into account decision making. So procedural knowledge according to Anderson's framework is initially represented verbally in working memory, and then later during many hours of practice converted into the fluid movements of an expert.

Chi et al. (1981) noticed that experts analyze problems differently than novices. These experts gather information to categorize problems usually according to schema specific rules (Chi et al, 1981). Once a problem is categorized, the expert may use a set of schema specified production rules to solve that particular problem (Chi et al, 1981). Chi and Anderson are working from complementary theory bases. Chi tends to place more emphasis on categorization. In summary, a problem schema is basically a set of production rules that guides a problem solver to first categorize a problem, and then to solve that problem, by following the production rules for that specific problem category.

Without the guidance of a demobank, novice learners may use weak methods like "means ends analysis to try to solve a problem (Owen and Sweller, 1985; Anderson, 1987). Being that a demobank of animated demonstrations is a collection of animated worked examples the literature on learning by studying examples will be described in this next section.

**Studying worked examples versus means-ends analysis**

Owen and Sweller, (1985) found that most novices try to solve problems by attempting to achieve a series of sub goals. This strategy is called "means ends analysis." Their results suggested that this strategy "places a heavy load on cognitive processing capacity (Owen and Sweller, 1985, p.272)." This is perhaps Sweller's first reference to cognitive load. After making this statement John Sweller went on to describe cognitive load theory (Sweller, 1988).

Sweller developed cognitive load theory as a means of explaining the performance of novices during schema acquisition. He proposed that during the initial stages of learning, learners are bombarded by information, which if not properly regulated, can quickly overload a learner's limited "working memory" and thus deteriorate performance (Sweller, 1988). Cognitive load theory contends that if instructional designers limit the amount and complexity of information impacting learners that this will promote more efficient schema acquisition and automation (Sweller, 1988, 1993, 1994).

Means-ends analysis is like trying to get through a maze by going in what seems to be the best direction at the moment. Learners using this strategy often make errors, given the maze analogy they may try the wrong path toward their eventual goal. Many flounder and may find themselves going in circles. Errors like these may cause the learner a great deal of frustration.

The use of worked-examples on the other hand, decreases cognitive load by presenting only enough information to learn how to solve a problem. In terms of the maze metaphor, learning with worked examples provides the learner with guidance that can shorten their route toward learning. In many cases learners learning this way as opposed to learning by traditional problem solving (via means ends analysis) required less time to study the examples and then later less time to solve problems (Sweller and Cooper, 1985). Ward and Sweller (1990) explain means ends analysis this way: "A heavy cognitive load is imposed because of the need to simultaneously consider and make decisions about the current problem state, the goal state, differences between states, and problem solving operators that can be used to reduce such differences (Ward and Sweller, 1990, p.3)."

Learners using means ends analysis, often make errors and waste time trying to solve problems, rather than using that time effectively to learn the underlying problem schema. Later because of these errors those using means ends analysis may have difficulty piecing together the underlying steps of the overall procedure.

Zhu and Simon (1987), later went on to replicate Sweller and Cooper's findings with a group of high schools students that were learning algebra and geometry. They were able to show that learners using worked examples could complete a 3 year curriculum, in only 2 years -- a full year ahead of their peers who had learned through a traditional problem solving curriculum. Zhu and Simon (1987) also found that this group of students scored slightly higher on national achievement tests as compared with their problem solving peers.

The results from these early studies (Sweller and Cooper, 1985; Cooper and Sweller, 1987, Zhu and Simon, 1987) are encouraging, but somewhat counter intuitive; and certainly they are not without their critics (e.g. Gabrys et al., 1993). This is because educators have had "learning by doing" ingrained in educational culture, since the time of Dewey (Kilpatrick, 1918). But Sweller's empirical results still suggest learners using worked examples learn to perform those skills quicker and with fewer errors (Sweller and Cooper, 1985). Why might this be the case?

Chi et al. (1981) compared experts and novices as they solved physics problems. They found that experts solve problems based upon solution mode. Novices on the other hand concentrated on the surface features of the problems. By presenting novices with worked examples instructional designers teach them to be more like experts. That is they are taught to categorize problems according to solution mode. This is as compared to traditional problem solving techniques which expect learners to grasp the means to a solution while being simultaneously burdened with the task of solving the problem. Traditional problem solving adds cognitive load to an already demanding situation.

While studying learners using worked examples, Chi et al. (1989) shed some additional light on the worked example effect. They suggested students learn via self-explanations. This supports Anderson framework of verbal explanation of problems during schema acquisition (1982). Chi et al. (1989) monitored students using think aloud protocols. They found that "poor" students do not generate sufficient self explanations. "Good" students on the other hand monitor their understanding and misunderstanding. In doing so they were better able to locate areas of difficulty and concentrate on those areas. Unfortunately "poor" students were unable to locate problem areas and in turn had difficulty when the time came to perform.

Practice of course is important after initial learning and indeed this is what Zhu and Simon (1987) did in their longitudinal study. They initially taught students using worked examples so that they would learn to categorize problems based upon solution mode. Then once learners could categorize problems effectively they provided them with practice solving problems. This allowed them to automate their skills (Schneider and Shiffrin, 1977; Shiffrin and Schneider, 1977) and promoted what Bloom later described as "automaticity (Bloom, 1986)."

**Implications for demobank design**

The problems an instructional designer can provide via a demo bank are diverse. As mentioned earlier this presentation technique is generalizable to all computer based instruction. An instructional designer must make several important decisions about how to present instruction via this form of instruction. Therefore this section will apply the preceding discussion to the practice of demobank design and provide a set of demobank design guidelines. But first an example will be provided to give some context to these guidelines.

A demobank was developed by the author to produce a series of web-based animated worked examples for university faculty (note figure 1). Our campus PeopleSoft implementation (PantherSoft) became the subject matter for this tutorial. The menu is designed to support the schema behind this software. For each learner action a menu item opens an animated worked example.

The initial implementation of this project became very useful as a tool to teach large numbers of people at their own convenience. Because this multimedia learning environment is posted on the web it is available 24 hours a day 7 days a week. Given that a demobank is posted on the web, learners can make use of it wherever they are as a just-in-time online workshop. In addition it is also available to learners for review, as they solve problems. The PantherSoft tutorial is just one example of a demobank, which can be generalized to form a general classification of tutorials. Several design issues were found to be apparent during the development of the above example. These are documented here and can serve as guidelines for future designers.

First and foremost it is very important for designers to work with experts in order to categorize problems by solution mode. Expert users can suggest how a task can be broken down into constituent sub skills. Given that designers arrange worked examples according to how experts view problems, learners will begin to view the software like experts.

Providing smaller segments will be beneficial to the learner in two ways. First it prevents working memory overload by decreasing the amount of information impacting the learner. In addition it will be easier on the learner's computer because smaller video segments require less bandwidth. Another bandwidth consideration is the use of audio. Audio does require more bandwidth, but resist the temptation to remove the audio from the presentation. As mentioned, earlier multimodal instruction (simultaneous use of visual and verbal media) has been shown to promote learning because it makes more effective use of a learners working memory (Mousavi, Low and Sweller, 1995).

As Gagne (1965) explained many years ago the sequence of instruction is very important. It would be useful to list animated demonstrations in order if possible. Be clear why these procedures matter and explain under what conditions a particular procedure is used and why the order or sequence of tasks is important. Perhaps consult the advice of an expert to get a better understanding of the sequence of tasks.

Remember Chandler and Sweller described a worked example as "a problem statement and the appropriate steps to solution (Chandler and Sweller, 1992, p. 233). Therefore it is important to explain the goal of the problem at hand. This confirms for the learner that they are watching the appropriate presentation. In addition explain the context of the current presentation as it relates to others in the demobank. This will provide the learner with the appropriate context.

Learners may wish to return to your tutorial on another occasion. For this reason it is important to make these demonstrations available as just-in-time instruction. Designers can suggest in the narration that learners review certain segments in the presentation. So suggest repetition and practice. Demobanks are a good way to present procedures to the novice, but without practice they will remain novices. The easiest way to make these demonstrations available as just-in-time instruction is by publishing them as a web site, complete with a menu of tasks based on the problem schema.

The development of animated demonstrations presents a different set of problems from most video production. During most video production, camera operators capture the simultaneous movement and audio of actors. This typically occurs through many takes that can later be seamlessly edited together to produce one continuous stream of video. However this is not as easily accomplished with screen capture software. Even though it is possible to record audio and video simultaneously, this is not suggested. Screen capture software products capture on-screen motion but it is suggested that this is only be integrated with audio segments in post production.

Therefore the most efficient way to produce animated demonstrations is to begin with the narration. Narration begins as a well written script. Spend time carefully considering your instructional message for here is where much of the instruction takes place. Once you have your script ready, have your voice talent practice the script once or twice before recording the narration. Narration can then be recorded as digital audio files in a computer. Several takes may be necessary to record the complete script. This audio file can then be edited to produce one continuous error free file. This narration file can then be played back to cue someone as they capture the video component of demonstration with screen capture software (e.g. Techsmith Camtasia or Macromedia Captivate). This should also be rehearsed several times before making a video capture. Next a developer can synchronize the audio and video tracks to produce a fluid animated demonstration. Finally these movies should be saved as a steaming file format, most developers prefer Macromedia's Flash file format because of its ubiquity and its cross-platform compatibility. These movie files should be displayed on a web page one at a time. In addition each page will contain a schema-based menu system that allows the learner to view files one at a time at their own pace.

## Summary

Sweller suggests instructional designers should design instruction with the human cognitive architecture in mind (Sweller, 1993, 1999). Given schema theory, an ideal demobank would exactly mirror an expert's problem schema. One may think of a demobank of animated worked examples as an externalized problem schema. Given this conception of a schema, presenting a demobank to a novice learner, can be thought of as "schema sharing." This is because this presentation technique allows the designer to group animated examples according an expert schema. Learners can use this built in organization to constructively group procedures into problem categories that can be used to solve problems according to procedures outlined by the animated worked examples. Finally once a schema has been incorporated into the learner's long term memory, perhaps through the performance of the demonstrated procedure, that schema is successfully shared with a learner.

## References

Anderson, J.R. (1976). *Language, Memory and Thought*. Hillsdale, NJ: Erlbaum Associates.
Anderson, J.R. (1995). *Cognitive psychology and its implications*. (4th ed.) New York: W.H. Freeman and Company
Chi, M. T. H., Feltovich, P. , & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive Science*, 5, 121-152

Bartlett, F.C. (1995). *Remembering: An Experimental and Social Study*. Cambridge: Cambridge University Press.(Original work published 1932)

Bobrow, D. G., & Norman, D. A. (1975). Some principles of memory schemata. In D.G. Bobrow & A. M. Collins (Eds.), *Representation and understanding: Studies in cognitive science*. New York : Academic Press

Bransford, J. D., & Johnson, M. K. (1972). Contextual prerequisites for understanding: Some investigations of comprehension and recall. *Journal of Verbal Learning and Verbal Behavior*, 11, 717-726.

Fitts, P. M. (1964). Perceptual-motor skill learning. In A. W. Melton (Eds.), *Categories of human learning*. New York: Academic Press.

Harrison, S. M. (1995). A Comparison of Still, Animated, or Nonillustrated On-Line Help with Written or Spoken Instructions in a Graphical User Interface in Proceedings of CHI 95, Association of Computing Machinery retrieved October 14, 2003 from http://www1.acm.org/sigs/sigchi/chi95/Electronic/documnts/papers/smh_bdy.htm

Kilpatrick, W. H. (1918). The project method. *Teachers College Record*. 19, p 319-335

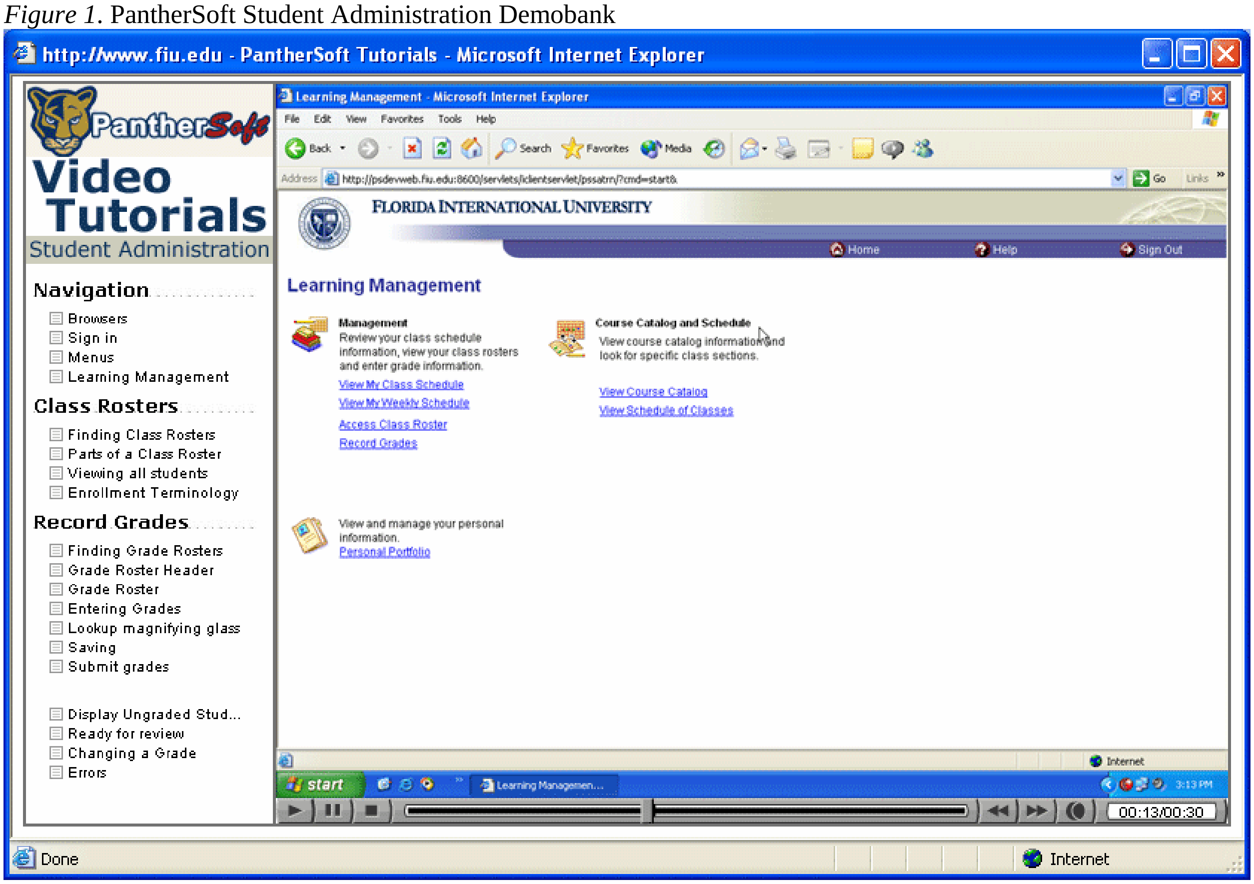
Mayer. R & Moreno R. (1998). A split attention effect in multimedia learning: evidence for dual processing systems in working memory. J*ournal of Educational Psychology*. 90, 2, 312 320.

Neves, D. M., & Anderson, J. R. (1981). Knowledge compilation: Mechanisms for the automatization of cognitive skills. In J. R. Anderson (Ed.), *Cognitive skills and their acquisition*. Hillsdale, NJ: Erlbaum.

Shiffrin, R. M. & Dumais, S. T. (1981). The development of automatism. In Anderson, John (Ed.), *Cognitive Skills and Their Acquisition*, 111-140. Hillsdale, NJ: Erlbaum.

van Merriënboer, J.J.G. (1997). Training complex cognitive skills. A Four Component Instructional Design Model for Technical Training. Educational Technology Publications, Englewood Cliffs, NJ.

*Figure 1*. PantherSoft Student Administration Demobank



# Designing and Evaluating Self-Regulation Instructional Support

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This developmental study documents the systematic design and development of embedded self-regulation (SR) support into existing instruction; this investigation encompassed two common aspects of developmental research, how a model guides the design process and what features facilitate its usability (Driscoll & Dick, 1999). If the SR support activities are systematically designed for replicable instruction, SR support could remove much of the SR planning and resource coordination effort from the learner and instructor and place it on the instructional design. The instructors may be able to incorporate a prescribed set of embedded SR activities instead of an individualized prescription for each learner (Ley & Young, 2001).

This development study investigated how SR may be designed and developed within instruction and the relationship of the process to the efficient, effective and usable instructional support. A review and analysis of SR models initiated the study and addresses model usability and model comparisons, characteristics of Type 2 developmental research (Richey, Klein, & Nelson, 2004), the analytical framework for this study. The theoretical foundation for this developmental study places SR in the context of instructional design and establishes the relevance of instructional SR support, consistent with Type 2 research (Richey, Klein, & Nelson, 2004). The implicit instructional design and development requirements and constraints of each SR model form the basis for comparing alternative model feasibility and usability. Some of these constraints and demands preclude certain instructional design or development conditions and create substantial barriers to others, thus providing a rationale for selecting a model based on usability.

**SR Model Analysis and Selection**

We identified fourteen SR models from published approaches to explaining SR in a learning context. The models include a seminal SR model (Corno & Mandinach, 1983) and thirteen others published between 1995 and 2001. The term model refers to any set of propositions suggested to describe self-regulation processes whether or not the authors identified the propositions as a model. Three content-dependent models were excluded from the analysis (Corno & Randi, 1999; Maitland, 2000; Pressley, El-Dinary, Wharton-McDonald, & Brown, 1998). Two variations of a similar model were analyzed as one (Winne & Hadwin, 1998; Winne, 1997). The ten models (Butler, 1998; Corno & Mandinach, 1983; Ertmer & Newby, 1996; Graham, Harris, Troia, 2000; Ley & Young, 2001; Manning, Glasner, & Smith 1996; McCaslin & Hickey, 1998; McCombs, 2001; Winne & Hadwin, 1998; Zimmerman, 1998b) included in the analysis were both prescriptive and descriptive.

Several models have been developed for specific learning environment conditions or requirements in part because the assumptions of an SR support approach have been tailored to specific learning environment conditions and requirements,. Their specificity potentially inhibits their adaptability to learning environments with different conditions or requirements. For example, SR approaches that complement instructional content models (Butler, 1998; Graham, Harris, & Troia, 1998; Ley & Young, 2001; Manning, Glasner, & Smith, 1996; Winne, 1997) should be more adaptable to a wider range of instructional content than content-dependent SR approaches (e. g., Corno & Randi, 1999) or skill-specific approaches such as reading (Maitland, 2000; Pressley, El-Dinary, Wharton-McDonald, & Brown, 1998).

Instructional content is one of several factors that may preclude some SR support approaches. Some SR support approaches have been developed for specific learner populations and content which also constrains where and how SR support may be provided within instruction. The strategic content learning model (SCL) for basic skills (Butler, 1998) and the SR strategy development model (SRSD) for writing skills (Graham, Harris, & Troia, 1998) address the cognitive and affective needs of learning-disabled students.

Another factor affecting the utility of an SR approach is the role of an instructor or tutor in an SR support approach. Some SR support approaches implicitly assume an instructor physically present in the learning environment and include instructor-led or instructor-guided learning conditions (c.f., Butler, 1998; Corno & Randi 1999; Graham, Harris, & Troia, 2000; Maitland, 2000; Manning, Glasner, & Smith, 1996; McLoughlin, 1996).

Teacher-directed activities offer SR support to compensate for weak self-regulation characterized by insufficient or ineffective learner efforts (Butler, 1998) and may include teacher-modeling of SR (Butler, 1998; Corno & Randi 1999; Maitland, 2000; Manning, Glasner, & Smith, 1996). Assuming an instructor is an integral and necessary part of the SR support imposes a design constraint on the learning context to which the model may be applied. Many of the models reviewed for this study depend upon relatively labor-intensive, skillful teacher-learner interactions to provide individualized SR support; instructors would at a minimum have to be trained or guided to fulfill their role and even then may not have the time to individualize the instruction. On the other hand their very strength for a specific purpose becomes a weakness when seeking to embed instruction in different content/skills, perhaps with minimum instructor effort to manage the SR support.

The purpose of this developmental study was to embed parsimonious SR support requiring minimal preparation and maintenance time and effort and to document that process; the SR model applied to the content should facilitate this goal. Therefore the model selected for embedding instructional SR support (Ley & Young, 2001) was most appropriate for three reasons. First, embedded SR features could be used instead of instructor-individualized SR support; second, the SR principles were readily adaptable to a broad range of content and contexts; third, the model was theoretically and empirically supported. In sum, the model was flexible, data-based, and parsimonious; it was a design model well suited to the investigation. The inherent model adaptability has distinct advantages over SR models constrained by learners, content, or learning context requirements or assumptions.

## POME SR Support Model

The POME model encompasses four principles (POME) that may be flexibly applied to most instructional contexts and learning contents (Ley & Young, 2001). The principles establish four SR support functions characterizing embedded self-regulation support yet they are general enough to be flexibly adaptable to most content or contexts. The POME model must be used with a content design model, e.g., Dick, Carey, & Carey (2001), or to enhance existing instruction. The four SR principles establish instructional conditions or features in four categories: preparing a study environment, organizing study materials, monitoring learning processes, and evaluating learning processes (POME). When applied collectively and systematically to create a comprehensive SR support system, the four design principles guide embedded self-regulation support design for either existing or planned instruction.

Principle 1 (Prepare): Guide learners to prepare and structure an effective learning environment. Instruction should encourage and guide learners to prepare an appropriate learning environment. Successful learners make "efforts to determine or arrange where a task is to be completed" (Trawick & Corno, 1995, p. 62). Structuring the environment relates to a learner's ability to cope effectively with disturbances, a crucial part of SR (Corno, 1994).

Principle 2 (Organize): Organize instruction and activities to facilitate cognitive and metacognitive processes. Organizing is an important component of SR (Hagen & Weinstein, 1995; Zimmerman & Paulsen, 1995). Organizing materials may be broadly defined as transforming and "rearranging instructional materials to improve learning (Zimmerman & Martinez-Pons, 1986, p. 618).

Principle 3 (Monitor): Use instructional goals and feedback to present the learner with monitoring opportunities. "Monitoring is an important component of self-regulated learning" (Zimmerman & Paulsen, 1995, p. 13). Monitoring is the cognitive process that assesses the state of progress relative to goals and generates feedback that can guide further action; it is pivotal in self-regulated learning (Butler & Winne, 1995).

Principle 4 (Evaluate): Provide learners with continuous evaluation information and occasions to self evaluate. Self-evaluation "involves the comparative outcome between some component of performance and the set standard" (Belfiore & Hornyak, 1998, p. 190) or setting standards and using them for self-judgment (Zimmerman, 1998a, p. 78).

Embedding SR may avoid the constraints of instructor-led SR, but would embedded SR prove practical, useful, effective, and sustainable for the instructor and the students? The study answered two research questions about the process of embedding systematically-designed SR support. First, how easily can a designer apply a model for embedded instructional self-regulation (SR) support into existing instruction? Second, are the resulting instructional features, that is, the cues, tools, prompts, and organizers, effective and feasible to implement with instructors and students?

## Method

Data was collected during three phases (design, development, and field test). A description of the SR support features precedes procedure description that details how SR support in the course was designed, integrated and delivered. Once the SR model for the design and the course for the field test was identified, the two designer-researchers met to design the SR support tools in one session. The researcher who would teach the class conducted the expert-review interview to formatively evaluate the materials in an hour meeting. Data on SR support implementation feasibility and effectiveness was collected during the field test.

**Participants**

Participants in the design and development phase included the two experienced, formally trained designers, us; a regular course instructor, an experienced teacher who evaluated and recommended revisions to the documents; the learners during the field test. Both instructors, the regular course instructor and the designer-researcher, had similar supervisor ratings on classroom observations (no-SR, 3. 89; SR, 3. 92 on a scale of 1 – 4, low to high) although the regular course instructor had more years teaching experience.

The learner participants were randomly assigned to alternating sections of the two offered in the same classroom, one at the eight a. m. and the other at nine a. m. The participants were low-achieving college students who failed to meet admission requirements and subsequently assigned to this course. Over 60 students, at least 30 in each section were randomly assigned to one of two sections of a mandatory study skills course at a southern community college. Fifty-one of the participants completed the course, 21 in the no-SR section and 29 from the SR section. The course was mandatory for all but one of the participants because they had an ACT score less than 17; the remaining participant who was not required to enroll in the course and had an ACT score of 21 was dropped from the analysis. Participants in the two sections had comparable ages, ACT scores, and racial composition

**Design-Development of SR Instructional Support**

The design assumed several conditions during the initial planning stages for development of SR instructional support given the context of the design problem. First, the target population, developmental or under-prepared college students, would have SR deficiencies associated with lower-achieving, under-prepared college students (Ley & Young, 1998). Second, the SR instruction would benefit all students, not just low-achievers. Third, the SR strategies had to be largely intuitive and, if possible, inherent to the support structure or form thereby limiting time spent on training or learning to use any SR features other than required by job aids or minimal instructions. Fourth, the strategies would not explicitly teach SR. Fifth, transferring learner SR skills to other learning contexts was not a goal; although the use and modeling of SR support throughout the course by the instructor should motivate students to deploy the strategies in other learning environments, it was neither necessary nor expected. Since the four principles are to be applied synergistically, the researcher-designers included had at least one support feature within the course for each of the four principles. One or more SR features, that is, activities and tools, supported each principle (Appendix A).

Preparation features direct students attention to what and how their study environment affects their learning. Preparing the learning environment was presented with one brief, recurrent activity. The feature included a six-item Environmental Structuring Checklist (ESC; (Appendix B) with three frequency response options, almost always, sometimes, almost never. Students were instructed to mark the option that best described how frequently they studied under six different statements represented four positive and two distracting conditions. For example, students indicated frequency with which they studied under that condition, "avoid noise distractions such as studying while listening to television, music or radio" - almost always, sometimes, almost never. The initial baseline plus three exams were on the first form and last four on a second form. The SR class students recorded a priori study conditions for the first examination and then their subsequent score on the corresponding examination; for the remaining six, they recorded how they studied on the examination day and recorded the score after the exam was returned.

Organizing in this case is reinforcing recognition of the content to be covered by a multiple choice recognition test. To add SR support to existing instruction this SR feature presented a set of notes that included the salient information required for the examinations. The Partial Study Guide (PSG; (Appendix C) organized study materials by presenting chapter content in a list of statements with about 40% of key concepts missing. The student completes the statements by finding the corresponding statement in the text that includes the missing content..
The SR support design included three different monitoring features. The first was a study time log (STL) that listed assignments due dates, test dates and included a monthly calendar for each month in the semester on a different page. The STL included a computer-generated calendar, one month per page with squares for each day large enough to record a beginning and ending study time.

The second monitoring feature, a Progress Report (PR; (Appendix D) listed all examinations and assignments with a place to record the completion date and the number of points earned or score. Learners were responsible for recording their grades from their returned examinations and activities. Completing the PR enabled each student to monitor if and when he or she missed a test thereby tracking their progress through the course. At the same time the instructor inspected the STL, she also reviewed the PR.

The third monitoring feature, an attendance chart, covered a standard size poster board with a grid listing class sessions in columns and student names in rows. Attendance for each session was indicated by a different colored marker or sticker affixed to the cell on the grid for that student and that day. The different colors corresponding to different attendance dates prevented a student from marking himself or herself present in advance.

Participants received a tool that was designed to help them compare their effort to their learning outcomes, that is, their examination score. The Incorrect Response Log (IRL; Appendix E) listed the unit test number, the item number and two blank lines on which the student wrote out the correct answer.

**Content Instruction**

The SR features had to be designed to accommodate the existing content instructions. About 90% of the course content was presented through a textbook, and the course instructor had developed the instructional strategy that depended upon the textbook. The course purpose was to help students acquire the college success skills, e. g., test-taking strategies, time management and organizational skills, note-taking techniques, and activities to heighten motivation and build self-esteem. Developmental students received instruction in a face-to-face study skills course. The existing course instruction covered the textbook content and the usual instructor who had developed the course, had been reinforcing learner self-efficacy intuitively and appropriately during class but did not use any specific self-regulation support. The researcher who would teach the treatment section of the same course recorded how and what the usual instructor did and identified the salient features of the usual instructor's instructional approach during a semester prior to the study. The SR section researcher-instructor imitated the repetitious and easily-replicated instructional style of the usual instructor. The instructor's dominant instructional strategy was to direct students to highlight textbook (Ellis, 1997) as she reviewed the textbook content in chronological sequence during the class.

**Procedures**

Procedures for the design, development, and field test are reported in this section. Although we, the researcher-designers, were familiar with the model, this was initial effort to systematically design instruction with the model. The article (Ley & Young, 2001) describing the model guided the design process; this included generic strategy descriptions, such as, provide a checklist of environmental conditions conducive to studying. Although lacking developed SR support features, the article clearly presented principles and strategy descriptions.

After selecting the model, we identified constraints on the SR features to assure their feasible implementation. The primary constraint was the amount of instructor time required for implementation would have to be minimal. On the other hand, external monitoring similar to the form-checking and self-recording procedure had significantly improved achievement among college statistics students (Lan, 1996). Therefore the design included external monitoring; the instructor reviewed selected SR documents briefly at scheduled intervals throughout the semester. Within three hours of beginning the initial design phase, a list of SR instructional support features, their sequencing and integration within the course, and the instructor's role was completed and a design document produced (Appendix A). After completing the design revisions, the researcher who would teach the SR section developed the five forms and the attendance chart.

The regular instructor participated as an expert reviewer during the development phase; she was charged to identify any inconsistencies with the course content and assure the features were feasible given the learners and the instructional context. One of us who would teach the SR section met with the usual course instructor to solicit feedback about the appropriateness and feasibility SR support materials. During the meeting, the usual course instructor offered a few minor revisions but no substantive revisions to the SR support tools; she quite unexpectedly offered to use the SR support immediately in the forthcoming semester. The researcher clearly and unequivocally reminded the usual instructor that she would be welcome to use all the SR support when study was completed, that is, after the next semester. The usual instructor said she would comply.

Each of the two instructors taught one section of the same course taught on the same days in the same room, back-to-back, and in the morning. One section was taught by the instructor who had developed and usually taught the course; the other section was taught by one of us who had studied the usual instructor's instructional strategy in every for a semester. Random assignment controlled for learner differences and certain instructional conditions were replicated for the SR section to control for important instructional features unrelated to SR.

To control for teaching style, the researcher who taught the SR support section of the course replicated the control instructor's instructional strategy; the instructor reviewed/lectured on the textbook reading assignment and told students what to underline in the textbook. To control for content, both sections had the same syllabus, handouts, projects, and assessment measures. The only instructional difference was that the SR section received instructional SR support.

The SR section of the semester-long study skills course was the field test. The SR section instructor tracked the SR field test process by noting student comments, time allocated for cueing SR behavior, etc. SR features included more than the obvious, print-based tools; in practice it also included oral or print instructional guidance for using the tools, and occasional instructor prompts to complete PSGs, PRs, STLs or ESCs or cues to use the tools, such as reminders to complete the PSG or allocating class-time to complete an IRL.

The SR section instructor required students to purchase a paper folder with center brads for organizing their SR support documents and instructor initially distributed an ESC form to each student during the last class meeting of the first week of the semester. After the students completed the form prior to the first examination, the instructor explained the importance of an appropriate study place and provided examples of appropriate study places, such as the library or a home desk and to remove distractions such as television or radio or pets. Participants returned the ESC during the same session so that the instructor could keep the form. Then after every examination, the instructor returned the form to the students after each examination and asked them to complete the section on how they prepared for the examination. Following the examination, the instructor asked them to review their ESC form and reminded them to consider if their test score reflected their study environment and to consider if they needed to make changes in their environment or should continue studying in the current conditions.

Prior to each class session the instructor posted the attendance chart conveniently visible from anywhere in the class so that as they arrived, students recorded their attendance by initialing the cell for their name and the session date. When the poster was removed, the instructor placed a black "A" for the session for those absent on that particular day, thus preventing students from marking themselves attending a session at a later time. At least once a week near the end of class the instructor called students' attention to the attendance chart and reminded them to pay attention to the number of their absences. The instructor also reminded them that the college attendance policy administratively withdrawing students with too many absences.

Students received the PR and STL in the first two weeks of the semester. The instructor told students to enter their grades on the PR form and file it in their class folder so that the instructor can review it after each examination. The instructor explained that the length of time studying was less important than the quality of the studying and that learners who were aware of how long they studied did better than those who were not aware. Beginning on the 7th class day in the third week, the instructor prompted students to record when they began and finished studying for that day on the STL.

The SR instructor told students to keep the IRL in their class folders and, during the oral examination review, record the correct answers to each item they missed. The SR section had the same 5 multiple-choice Scantron-scored examinations during the semester as the no-SR control section. The no-SR control section instructor returned the tests and reviewed each test, item-by-item, identifying the correct response for each. The SR participants heard the same oral review and completed an SR tool, an Incorrect Response Log (IRL). During some of the reviews, the SR instructor reminded students that the completed IRLs would serve as a study guide for the comprehensive final examination. After returning the exams, the instructor encouraged students while the class was reviewing answers, everyone should complete his or her IRL. The instructor did not directly check the IRL form but did monitor use of the time to complete the form. Students had no substantive questions about how to complete the forms and expressed no difficulty in completing them.

The SR section instructor asked students to complete the SR forms as part of the class and, while never penalizing or reprimanding students who did not complete SR activities, implicitly expected them to do so by checking every student's class folder and his or her PR, STL and IRL records.The instructor would check each person's SR activities as he/she submitted his/her exam and recorded one of three levels SR activity for the set of three documents, (1) progress reports (PR), (2) study time log (STL), and (3) incorrect response log (IRL); the symbols, a - minus if no monitoring for any of the three; ✔ check if partial monitoring, that is any monitoring on any of the three; + plus if completed monitoring on all three. The instructor reviewed but did not record a fourth SR support document, (4) environmental structuring checklist (ESC). The purpose was to assure that most of the class participated as expected and most learners completed most of the tools most of the time; the review was adequate to ensure that almost all students engaged in the SR activities as intended. The PSG was usually included in folders although not specifically reviewed.

## Results

The initial purpose of the study was to answer two questions, the first of which was, can a designer efficiently apply an SR support model into existing instruction? The answer required inspection of design and development records kept by the two designer-researchers one of whom taught the SR section. An analysis of the documentation from each phase, design, development, and field test process and the observations of both designer-researchers at each phase of the process answered the first question. The second question asked if the resulting SR support would be effective.

To determine the efficiency of designing developing, and delivering the SR instructional support, the time and skill required were compared to the quality of the SR features. Therefore efficiency was a function of time and effort for design, development, and delivery for sustaining the essential SR activities, and the quality of the features. The SR model's uncomplicated and limited set of explicit principles and the predetermined instructional strategy for delivering the content established the SR requirements for the pre-existing course. Designing, SR support for an existing course proceeded quickly since the designers had limited but explicit guidelines to facilitate the process. The designers had generic strategy descriptions from the initial article describing the model that made it relatively easy to apply the model; the instructional strategy dictated the content of the tools. The rapid design process yielded features addressing all four SR support principles with five specific tools (PR, IRL, ESC, PSG, and an attendance chart).

Unsurprisingly, applying the SR model required about three hours each for two designers to create the design for the instructional SR support features, write brief instructions and format the support features. Except for the partial student guide development of all other components took about 2 hours since most were one page forms with minimal text. The partial study guide took the most time to develop since each of seven was one to three pages long and transcribed from the course content. The skill, and intellectual effort to deliver SR was minimal, and the time, less than 15 hours for the semester for the cues, prompts, and in-class external monitoring checks.

The expert review of the features conducted with the usual course instructor by one of the researcher-designers took less than one and a half hours including the resulting minor revisions, such as deleting words or moving elements on a form. During the review the researcher who would be the SR section instructor, reminded the usual instructor, eager to use the SR features immediately, that she had to wait until the following semester.

Likewise, the development process required very little time and relatively low technical skills. The PR, IRL, and ESC took no more than about an hour each to develop since they were forms rendered in MS Word. Although the seven PSGs took almost no time to design, developing all seven took about as many hours, most of which was transcribing printed textbook statements to a study guide since the exam content was predicated upon those statements and both were predetermined by the usual instructor who had previously developed the course format and content several semesters before. The applied the model to create an integrated set of SR support tools for an existing course.

The field test supported relatively efficient processes for both the instructor and student. Their time required to sustain the SR activities was optimized because three of the five SR tools, the ESC, PR, and STL were inspected as students submitted their completed examinations. The combined review took about 30 seconds to 2 minutes per student but no additional time for the instructor because it was completed while proctoring the class during the examination. Students spent very little time in class on SR activities and kept four of the five SR tools in a binder, the PSG, IRL, PR, and STL. Students completed the PSG, PR, and STL on their own time and the IRL, ESC, and attendance chart, in class. Most students could completed the IRL during the quiz oral review when the teacher corrected the errors for the class and the amount of effort a student expended to complete an IRL increased proportionally to the number of missed items. The PSG required the most effort of all since every student had to find each statement in the text to complete it in the PSG. Students could complete the ESC, distributed, collected and reviewed on test days, in less than two minutes for each examination.

Descriptive and inferential statistics combined with implementation notes answered the second question about SR support effectiveness. Two conditions violated basic assumptions for parametric statistical analysis: (a) the student's total points earned were not distributed normally in the two sections and, (b) the no-SR section had less than 30 participants by the end of the semester. Descriptive nonparametric statistics were in the direction expected; the SR section had higher 2$^{nd}$ and 3$^{rd}$ quartile scores (802, 978, 1005 Pts) than the no-SR section (890, 927, 956) quartile scores. Likewise, the range for the SR section had a higher minimum and maximum total points, higher mean and lower standard deviation (380 – 1060; $M = 883$; $SD = 182$, $n = 29$) than did the no-SR section (0 – 1045; $M = 848$; $SD = 238$, $n = 21$). Despite mean scores were in expected direction and higher relative range, the rank orders between SR and no-SR sections were not statistically different for a Mann-Whitney U test; 28.1 for SR support ($n = 29$) and 21.8 for no-SR ($n = 21$).

## Discussion

The results of the study reveal that systematically designed SR support is feasible to design, develop, and implement efficiently and can result in positive learning outcomes. The POME principles applied to SR instructional support design led to an integrated set of SR tools and activities. The embedded SR support model strongly guided a very fast design and uncomplicated development process which culminated in a set of embedded strategic SR instructional enhancements. An easily-remembered four-letter acronym, POME, enabled designers to apply the four principles without consulting complex charts or using decision trees. In less than 6 hours for design & formative evaluation; about 11 hours for development; and no more than 2 hours instructor time for the semester, SR support was embedded in an existing college study skills course.

Three features imbue the POME model with useful advantages over many SR approaches. Unlike many of the other approaches, this model promotes empirically-derived strategic SR activities without requiring any specific media, or content to implement the four principles. First, the POME model may be applied to most media including a web delivery. Second, the instructional features suggested by the principles may be delivered through web-based materials and activities with minimum instructor support. A third advantage specific to this context was that embedding instructional SR support based on activities empirically associated with higher achievement encouraged strategic learner self-regulation and avoided labor-intensive instructor-individualization. Because the foundation of this model is based upon investigations that addressed multiple SR activities simultaneously, the model addresses the activities from these multiple-activity studies which are more strongly associated with higher achievement than most SR activities. Therefore this is one model that attempts to provide strategic support and thereby put the learner's instructional effort on activities which evidence suggests may contribute the most to positive learning.

**References**


Belfiore, P. J., & Hornyak, R. S. (1998). Operant theory and application to self-monitoring in adolescents. In D. H. Schunk & B. J. Zimmerman, (Eds.) *Self-regulated learning; from teaching to self-reflective practice* (pp. 184-202). New York: The Guilford Press.

Brown, C., Hedberg, J., & Harper, B. (1994). Metacognition as a basis for learning support software. *Performance Improvement Quarterly*, *7*(2), 3-26.

Butler, D. L. (1998). A strategic content learning approach to promoting self-regulated learning by students with learning disabilities. In D. H. Schunk & B. J. Zimmerman, (Eds.) *Self-regulated learning; from teaching to self-reflective practice* (pp. 160-183). New York: The Guilford Press.

Butler, D., & Winne, P. H. (1995). Feedback and self-regulated learning: A theoretical synthesis. *Review of Educational Research, 65*, 245-282.

Corno, L. (1994). Student volition and education: Outcomes, influences, and practices. In D. H. Schunk & B. J. Zimmerman, (Eds.) *Self-regulation of learning and performance: Issues and educational applications* (pp. 229-254). Hillsdale NJ: Lawrence Erlbaum Associates, Publishers.

Corno, L., & Mandinach, E. B. (1983). The role of cognitive engagement in classroom learning and motivation. *Educational Psychologist*, *18*(2), 88-108.

Corno, L., & Randi, J. (1999). A design theory for classroom instruction in self regulated learning?. In C. M. Reigeluth, (Ed.) in Instructional design theories and models, volume II: A new paradigm of instructional theory (pp. 293-318). Mahwah, NJ: Lawrence Erlbaum Assoc.

Dick, W., Carey, L., & Carey, J. O. (2001). *The systematic design of instruction* (5th ed.) New York: Longman.

Driscoll, M. P., & Dick, W. (1999). New research paradigms in instructional technology: An inquiry. *Educational Technology Research and Development*, *47*(2), 7-18.

Ellis, D. (1997). *Becoming a master student* (8th ed.). Boston: Houghton Mifflin Company.

Ertmer, P. A., & Newby, T. J. (1996). The expert learner: Strategic, self-regulated, and reflective. *Instructional Science, 24*, 1-24.

Graham, S., Harris, K. R., & Troia, G. A. (1998). Writing and self-regulation: Cases from the self-regulated strategy development model. In D. H. Schunk & B. J. Zimmerman, (Eds.) *Self-regulated learning; from teaching to self-reflective practice* (pp. 20-41). New York: The Guilford Press.

Hagen, A. S., & Weinstein, C. E. (1995). Achievement goals, self-regulated learning and the role of classroom context. In P. R. Pintrich, (Ed.) *Understanding self-regulated learning* (pp. 43-56). San Francisco: Jossey Bass.

Ley, K., & Young, D. B. (1998). Self-regulation behaviors in underprepared (developmental) and regular admission college students. *Contemporary Educational Psychology 23*, 42-64.

Ley & Young, (2001). Instructional principles for self-regulation. *Educational Technology Research and Development 49*, 93-105.

Maitland, L. E. (2000). Ideas in practice: Self-regulation and metacognition in the reading lab. *Journal of Developmental Education; 24* (2), 26-36.

Manning, B. H., Glasner,S. E., & Smith, E. R. (1996). The self-regulated learning aspect of metacognition: A component of gifted education. Roeper Review; 18, 217-23.

McCaslin, M., & Hickey, D. T. (2001). Self-regulated learning and academic achievement: A Vygotskian view. In B. Zimmerman and D. Schunk, (Eds.) *Self-regulated learning and academic achievement: Theory, research, and practice (2nd Ed.)* (pp. 227-252). Mahwah, NJ: Erlbaum.

McLoughlin, C. (1996). Higher levels of agency for students: Participation, self-regulation and the learning process. In Abbott, J. and Willcoxson, L. (Eds), *Teaching and Learning Within and Across Disciplines*, p105-109. Proceedings of the 5th Annual Teaching Learning Forum, Murdoch University, February 1996. Perth: Murdoch University. http://cea.curtin.edu.au/tlf/tlf1996/mcloughlin.html

McCombs, B. L. (2001). Self-regulated learning and academic achievement: A phenomenological view. In B. J. Zimmerman & D. H. Schunk, (Eds.) *Self regulated learning and academic achievement: Theoretical perspectives* (pp. 67-124). Mahwah, NJ: Lawrence Erlbaum Publishers.

Pressley, M., El-Dinary, P. B., Wharton-McDonald, R., & Brown, R. (1998). Transactional instruction of comprehension strategies in the elementary grades. In D. H. Schunk & B. J. Zimmerman, (Eds.) *Self-regulated learning; from teaching to self-reflective practice* (pp. 42-56). New York: The Guilford Press.

Richey, R. C., Klein, J. D., & Nelson, W. A. (2004). Developmental research: Studies of instructional design and development. In D.H. Jonassen, (Ed.) *Handbook of Research on Educational Communications and Technology,* (pp. 1099-1130). Mahwah, NJ: Lawrence Erlbaum Publishers.

Trawick, L., & Corno, L. (1995). Expanding the volitional resources of urban community college students. *New Directions for Teaching and Learning*, *63*, 57-70.

Winne, P. H. (1997). Experimenting to bootstrap self-regulated learning. *Journal of Educational Psychology, 89,* 397-410.

Winne, P. H., & Hadwin, A. (1998). Studying as self-regulated learning. In D. J. Hacker, J. Dunlosky, & A. C. Graesser. *Metacognition in educational theory & practice*. (pp. 277-304). Mahweh, NJ: Lawrence Erlbaum.

Young, D. B. & Ley, K. (2003). Self-regulation support provided by developmental educators. *Journal of Developmental Education*, *27*(3), 2-11.

Zimmerman, B. J. (1998a). Academic studying and the development of personal skill: A self-regulatory perspective. *Educational Psychologist, 33* (2-3), 73-86.

Zimmerman, B. J. (1998b). Developing self-fulfilling cycles of academic regulation: An analysis of exemplary instructional models. In D. H. Schunk & B. J. Zimmerman, (Eds.) *Self-regulated learning; from teaching to self-reflective practice* (pp. 1-19). New York: The Guilford Press.

Zimmerman, B. J., & Martinez-Pons, M. (1986). Development of a structured interview for assessing student use of self-regulated learning strategies. *American Educational Research Journal*, *23,* 614-628.

Zimmerman, B. J., & Paulsen, A. S. (1995). Self-monitoring during collegiate studying: An invaluable tool for academic self-regulation. In P. R. Pintrich, (Ed.) *Understanding self-regulated learning* (pp. 13-28). San Francisco: Jossey Bass.

# Exploring Four Dimensions of Online Instructor Roles

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**Abstract**

*The purpose of this study was to understand the practice of online facilitation in a Midwestern university which has already established a highly successful traditional MBA program. This article explored the instructors' perceptions regarding four dimensions of instructor roles using Berge's (1995) classifications: pedagogical, managerial, social, and technical. This article also examined the challenges and issues confronting online instructors when fulfilling these roles. The results suggest that instructors carried out several important roles to varying degrees. The findings reveal a stronger emphasis on the pedagogical roles (e.g. course designer, profession inspirer, feedback giver, and interaction facilitator). A lesser emphasis on social roles represented mixed feelings regarding its importance to the instructors. While students rated the instructors very positively, the results also indicate that instructors still need to have their roles transformed pedagogically, socially, and technologically if they are to establish a more engaging and fruitful environment for online learning.*

## Introduction

One of the key challenges facing online instructors is how to provide clear and visible guidance in a virtual environment. In the traditional classroom, facilitation relies on both verbal and non-verbal cues to initiate understanding of ongoing communication and courses tasks. Communication online, however, relies mainly on written language without paralinguistic cues. Changes in communication patterns require instructors to adapt personal perceptions of their roles in order to adjust to an online learning environment that keeps remotely distributed learners continuously engaged in the learning process (Copplola, Hiltz, & Rotter, 2001). A large body of literature argues that the roles of online instructors may be new and more complicated than in traditional classrooms (Bonk, 2000; Heuer & King, 2004). Meanwhile, the emergence of new technologies makes it increasingly easier to have distant learners involved in two-way communications, thereby enabling self-directed learners to construct meaning both individually and socially (Berge, 2001). The culture of higher education has increasingly moved away from teacher-centered learning towards learner-directed learning, with instructors functioning as facilitators, coaches, consultants, or resource people who provide intellectual guidance in student learning (Berge, 2001; Bonk, wisher, & Lee, 2003).

A comprehensive classification, first proposed by Berge, then expanded by Ashton, Roberts, and Teles (1999), describes the multiple roles of online instructors under four dimensions: (1) pedagogical, (2) social, (3) managerial, and (4) technical. While there is a growing body of literature that emphasizes the importance of instructor roles in distance learning, few empirical studies have examined the issues that instructors face in their new roles. Ashton et al. suggest future research should examine the four dimensions of online instructor roles across different instructors, across different courses, and from the beginning to end of an online course. The results reported in this study extend previous findings regarding the facilitative roles of online instructors by examining pedagogical, social, managerial, and technical roles across instructors in an online program.

The purpose of this research was to examine the most important concerns and issues linked to the four dimensions of online instructor roles in a rapidly-expanding online MBA program. This study will focus on the following research questions:

- What are instructors' perceptions of their roles when teaching online in terms of Berge's classifications?
- What are students' perceptions of four dimensions of instructor roles?

## Theoretical Review

In the present research, Berge's instructor roles - pedagogical, managerial, social, and technical - have been used as a starting point to help organize the literature on the varied duties of the online teacher as well as the key findings of this study.

The pedagogical roles of the online instructor revolve around facilitating educational processes for students' understanding of critical concepts, principles, and skills (Berge, 1995). Such tasks include encouraging students' knowledge sharing and building through interactive discussion, designing a variety of educational experiences, providing feedback, and referring to external resources or experts in the field. Similarly, Salmon (2000) elaborated the important role of facilitators as "weavers" who pull together the participants' contributions in an online conference by weaving statements and relating them to relevant concepts and theories so as to enable the development of ideas through collaborative discourse. High quality instructions require online moderation skills of instructors. Oftentimes a variety of pedagogical roles have to be performed to facilitate higher order thinking skills.

The social function is typically employed to promote a friendly environment and community feel that supports student cognitive learning processes. Such social tasks include developing harmonic human relations, group cohesiveness, and collective identity (Berge, 1995). Online social roles require the instructor to develop "nurturing" skills for creating a context conducive to knowledge construction by encouraging participation, giving ample feedback and reward, attending to individual concerns, and using a friendly, personal tone (Kerr, 1986). It is expected that in a learning community, participants have a strong sense of belonging and are ready and willing to contribute to the knowledge building of a larger community (Wenger, 1991). Though the social roles have been widely cited in literature, studies have indicated that instructors who are new to teaching online may have difficulty getting used to this concept. Conrad's (2004) study noted that the inexperienced online instructors often lacked essential social skills and preferred personalized communication instead of taking leading roles in establishing a wider community.

The managerial roles include the organizational, procedural, and administrative tasks associated with the learning environment (Berge, 1995). The tasks involve coordinating assignments, managing online discussion forums, and handling overall course structure (Ashton et al., 1999). Berge advocates that online instructors take strong leadership in shaping online interaction through setting clear agendas and objectives of online conferences and establishing procedural rules and decision-making norms. Studies support using the course syllabi and time tables to lay out the expectations of learning activities to improve the performance of online discourse (Pincas, 1998) , and setting the expectations for the conditions of communication prior to the beginning of the course to shape the nature and the amount of interaction during the course (Heuer & King, 2004). The evolving nature of the managerial roles has been observed in several studies (Concrad, 2004). The managerial roles may not be directly related to learning, but they are regarded as important roles as they constitute necessary conditions for maintaining a successful online learning environment.

Early studies indicated that technical difficulty was one of the most important reasons that caused students' dissatisfactions with web-based courses (Hara & Kling, 2000). The technical roles of online instructors can make participants comfortable with the system and software program used for online courses. Such tasks include referring students to technical support resources, addressing technical concerns, diagnosing and clarifying problems encountered, and allowing students sufficient time to learn new programs (Ashton et al., 1999). By accomplishing the technical roles successfully, the learners will be able to concentrate on the academic task (Berge, 1995).

## Methodology

The purpose of this study was to understand the nature of instructor roles and the complex issues involved in a distance learning environment. The case study approach is considered appropriate for such exploratory research. Such an approach is also beneficial in providing better understanding of a complex system like the one studied here (Stake, 1994).

The field setting selected was an accredited online MBA program at a top ranked business school in a large Midwestern university. The program was designed for professionals who wish to continue their employment while earning their MBA. The researchers believed that such a rapidly expanding program would best illustrate the complexities and changing nature of instructor roles.

For the purposes of this particular study, twenty-eight faculty members within this program were interviewed. Importantly, the subject areas of the participants related to all the major disciplines offered in this program. Twenty-seven semi-structured questions were asked and the interview was conducted in a one-on-one interview format. The questions asked related to the four dimensions of instructor roles, including issues of course delivery and management, pedagogy and motivation, social interaction, and technical support. Each interview took approximately 45 – 75 minutes.

Strauss and Dorbin's constant comparative method (Meriam, 1998) was used to triangulate the data from different interview transcripts and to identify emerging themes under different dimensions of instructor roles. To ensure the intercoder reliability, two interview transcripts were coded initially and the inter-coder agreement achieved 89 percent. The researchers then continued coding independently and discussed their coding decisions with each other until a common set of codes based on all the transcripts were determined.

Program evaluation survey data related to students' perceptions of the learning online experience was used to assess students' satisfaction with the four dimensions of online instructors' roles mentioned previously. The student survey instrument consisted of 65 questions. The 65 item survey questionnaire contained 5-point scale Likert type questions about their overall student perceptions and attitudes toward learning online. The internal reliability of the survey, Cronbach's alpha, was reported .91.

**Instructors' perceptions on four dimensions of their roles**

In this section, instructors' perceptions of their roles are described in terms of Berge's four dimensions. Under each dimension, the roles were identified by grouping similar themes associated with that title.

**Pedagogical role**

*Course designer*. Many instructors agreed on their "designer" role of repurposing learning materials from the traditional classroom to online courses. Due to the loss of real-time interaction and rich contextual cues that they had experienced in the traditional classroom, it was essential for instructors to provide much more elaborate information in their online courses. As an example of this change, one instructor shared the following:

> … I'll spend five minutes talking about an experience that I had, it's more difficult to do that with our text files, and that's one of the reasons that I started doing these sound clips, was to simulate some of things that I might say in class in addition to, or that would supplement, the slide material. So, enriching the material, the presentation, as much as possible, I think is the most important point.

While selection and design of course material were crucial, many instructors noted that it was equally important to carefully structure and organize the course materials in a way that made students engage in learning through a variety of activities.

Many instructors also alluded to the iterative nature or "trial and error" of online course design by continuously refining and improving the assignments or deliverables or course materials in a way that was both challenging and manageable from instructor's perspective.

Instructor design strategies seemed to benefit a great deal from sharing and discussing their experiences with instructors who taught the same courses. Instructors worked as a team formally or informally to discuss ideas, share materials, and mentor each other. Additionally, they often provided vital support and encouragement for the faculty who were new to teaching online. The interactions of instructors across different disciplines were not as high as within each domain community.

Faculty members in this online MBA program seemed to have identified strongly with such varying roles. This study indicated these online instructors regarded course design as a vital first step to ensure the quality of online learning.

*Profession inspirer*. Helping learners move closer to their professional aspirations is a key goal of professional education. Instructors consistently noted that the nature of online learners, usually plugged into their careers and more practically-oriented than traditional learners, created a further impetus for them to structure the learning tasks around real world experiences. A number of instructors noted that they adjusted their assignments and discussions to connect to students' work experience. One instructor commented on her experiences to initiate a professional dialogue among online learners:

> I'm just a facilitator to draw out the experiences …. So I really spend a lot of time trying to draw from them their experiences and then having other people, you know, pick up on what's said and expand that to their environment and all these things.

This opportunity for applying learning to the real world is even more handy when a number of instructors taught company specific courses such as a Strategic Marketing Management course designed specifically for General Motors Corporation. They noted that online courses have the advantage to take learners back to their work contexts and apply the theories on the specific issues they confronted in a company.

*Feedback giver* Not surprisingly, instructors unanimously agreed on the important role of giving feedback to online learners. The immediacy and quality of feedback as well as the sustainability of instructional feedback on students' engagement was valued by online instructors. Two instructors commented:

> Deliverables, timely feedback, and extensive feedback and forcing them to do something with that feedback [are essential]. If I'm going to go to the trouble to spend 2 hours to write them a memo of feedback I want them to have to take that feedback and use that feedback rather than spend 5 minutes reading over.

The importance of feedback giver role reflected, partly, the instructors' perception of the importance of student-instructor interaction and the need for instructors to contribute their knowledge through ways of giving feedback. On the other hand, instructors also used it as the most important way to pace or control the learning progress of online learners. For example, an instructor commented on how he redesigned the learning tasks so that more interim feedback can be obtained from the instructors:

> We use fewer cases but in greater depth over a longer period of time with interim submissions by the students with interim feedback from the faculty. And all of that is our attempt to compensate for the lack of real time class discussion so, one way to look at it is, we do fewer assignments but another way to look at it is we so amplify the ones that there's more grading and evaluation.

*Interaction Facilitation.* Instructors agreed that online discussion was the key to online interaction. The online discourse promoted a democratic environment as it created a common framework for students to share their learning experiences and professional growth. The instructors agreed that the students needed to take a central role in online discussion while they assumed a "facilitator" or "consultant" role to scaffold the discussion on the road. For example, one instructor commented,

> So that I could find a way where I feel comfortable commenting in the discussion forums as another person but maybe I have to bring a little more expertise or a broader view of how your company relates to other companies. And occasionally students would clearly put me in that role. They'd say you know I had this question about your case. I wonder what the professor thinks about that.

Although many agreed on the role of instructor, the range of facilitations showed a wide spectrum of moderating strategies and frequencies of interactions. On the low end, approximately half of the instructors rarely moderated online discussions. On the high end, a few instructors participated extensively in online discourse through a variety of facilitating techniques including questioning, prompting responses, recognizing, requesting responses, and modeling social presence.

Instructors noted several issues that affected the degree of their presence. For instance, a few instructors expressed concerns about not knowing effective moderating strategies to promote peer interaction. A few instructors were concerned about the time commitment associated with facilitating online discussion. In addition, some instructors were concerned that the authoritarian role of the online instructor might deter a fruitful peer discussion among online learners.

**Managerial role**

*Conference manager.* Ensuring "equity" in online discussion has been one of the most important managerial concerns. Many instructors noted that the negative effect of "time lag" in asynchronous discussion could easily cause "dominancy" issues in discussions because early students can take control of the forum by effusive comments. The following comment demonstrated how an instructor provided guidelines to ensure students' equal opportunities in contributing to the discussion:

> So this year, I said you can only contribute on the first day to two of the cases. You can't contribute to all four. Because there were guys in the previous years that would try to beat everybody to the punch on the cases, and answer every question on every case, and it got some of the others upset, so I said, no, you can only post to two. And, I give them some suggestions on these things. You don't have to answer every question. I'm interested in quality, not quantity. This time, they were much more disciplined.

Another issue related to "time lag" was the reduced responsiveness of online students to peer's comments which resulted in extensive redundant information. To address this issue, some online instructors created specific rules related to not repeating previous comments or ideas. Besides introducing rules of non-repeating, the instructors either introduced more discussion threads at the beginning or introduced new discussion topics in the middle of the discussion to augment the discussion.

Though much effort was made on promote interactive discussion, the results revealed that the instructors still had great difficulty in refining and "weaving" discussion so that conversations progressed from sharing answers to knowledge negotiation and construction (Anderson et al., 2001).

*Organizer and planner*. One important aspect of organizer was to require instructors to be clearer and more organized when giving directions online. Many instructors found that any ambiguity may result in misunderstanding in communication and thus reduce the efficiency of the learning process. An instructor commented:

> I think you have to be clearer online. If you're not clear in the classroom a student is going to ask you a question and it'll get conveyed immediately to everybody … So you've got to be a lot more careful online as to how you answer something or ask something and you've got to be a lot clearer in your direction, clearer in your instruction.

In addition to daily pedagogical concerns, instructors consistently noted the importance of course structure and organization in an online course for planning purposes. The instructors sensed the needs of online learners to be provided with a clear structure and timeline to keep them plugged in learning in the midst of their busy work schedules. For example, one instructor commented:

> In an online environment they've got control of their calendar essentially as to when they do certain things. The splitting up into weekly modules in part was a recognition that we all tend to put things off if we can and so having weekly modules with some sort of a deliverable every week … puts or forces some structure on them so they can't wait until the last couple of weeks and try to do everything at that point in time.

Meanwhile, flexibility should be considered by instructors to accommodate the students' schedules. A number of instructors commented on their changes of the assignment due date from Sunday to Monday which seemed to work much better because many students have to spend a great deal of weekend time to work on the assignments.

**Social role**

*Social rapport builder*. One of the greatest challenges for online learning, as many instructors noted, was the ability to build a personal touch between the instructors and students. The "impersonal nature" of online environment posed a great difficulty for building social rapport. Examples of the lack of personalization can be seen in the comment as following:

> The feedback that we've gotten from the students is that things online feel very impersonal and they never get to know the instructor. And I would agree because I never get to know the students.

Many instructors associated the low social presence in their courses with the limitations of existing technology that was unable to project participants' identity or personality into an online course. To address this issue, the program established a policy to add at least one video introduction of the instructor in each course. This, in part, solved the problems of instructor identity in an online course but, nevertheless, did not help with the social presence or online identities of students. In fact, only two out of 27 instructors, tried to use some simple social ice-breaking activities or introduction forums, which allowed students to become familiar with each other and their personal stories. In addition, only 3 of them used virtual office hours.

With regard to instructor's role in building a sense of community in an online course, many admitted that they did not feel a sense of community in their course nor did they take any measures to purposively build a collective identity in an online course. For instance, one instructor stated:

> So I really encouraged the students to contact me in any way that they felt comfortable. I sort of gave them many options. But as far as creating a sense of we're all here at this moment, I did not.

However, instead of taking an active role in establishing an online class community, the instructors agreed on their role in establishing online teams and encouraging group knowledge sharing to accomplish a shared learning goal. Nonetheless, whether the relationship among a group can be projected as a sense of belonging to a class community remained an open question. When asked whether there was a sense of community in his course, an instructor indicated:

> Well, I think it's important …The teams provide an opportunity to do that, whether or not it has to move to the class level, I'm not so sure. It probably is useful, but I'm just trying to think about why that would help beyond.

Several instructors mentioned that the time expense associated with playing the social role in an online course might be detrimental to their pedagogical role play.

In summary, the instructors had mixed feelings regarding the importance of the social role in this online MBA program. In general, these instructors were not yet convinced of the relevance and viability of the social role for student learning. Various technological limitations and concerns about time further detracted from any efforts in building a sense of community.

**Technical role**

*Technical coordinator.* Instructors recognized that their technical role required them to refer students to technical support resources or communicating technical issues to support staff. This role was also partly defined by the technical support structure of the program. Each course was supported by a course designer who helped with the operation of the course. Because the course management system in general functioned effectively, sometimes the issue was not really technical but the inappropriate creation of the settings by the instructors or students' insufficient understanding of the mechanics of the tools. Oftentimes, the commercial simulation programs used in the online MBA courses had technical issues that the instructors had to send or forward to technical support staff.

*Media designer/developer.* About half of the instructors reported uses of multi-media elements in their courses. However, the instructors reacted differently about their roles in using different forms of multimedia in their online courses. Several instructors who had experiences in using video tapes in the traditional classroom felt comfortable in converting their video into digital format. However, a few instructors who had developed video clips from scratch were unsure about whether the anticipated education benefit was worth the extra development effort. A number of instructors mentioned the needs to identify or develop tools that could improve the efficiency of assessment and giving feedback to online students. A few instructors in this program had collaborated with the technical developers on developing innovative teaching tools through contributing their design ideas.

**Technology integrator**

One of the most highly mentioned issues related to the instructors' frustration with the inefficiency of online chat room tools. From the start, almost every instructor tried to use chat rooms for online discussions or virtual office hours. However, a majority of them finally discontinued using it as a discussion tool for learning. Among many reasons, the concerns about technological limitations, typing skills, and the difficulty in scheduling a time for class to meet online were expressed frequently.

Many instructors held positive attitudes toward using the emerging collaborative technologies such as web-based video conferencing and NetMeeting, which could overcome the weakness of text chat tools and further improve the efficiency and effectiveness of online learning. With those tools, it was expected that it could help establish a better professional intimacy, realism, and real-world flavor for online students. However, when adopting more visually rich and interactive tools, accessibility and bandwidth were two key issues or concerns of all the instructors. Examples of those issues can be seen in the following comment:

> I think the idea of doing, there's a lot you could do but the constraint is the computers at the other end are not what they need to be. I'd love to get on a web cam and have a chat room with a web cam where they could get on and see me but most of them can't do that because they don't have the software or the hardware to do it.

The role of "technology integrator" of online instructors represented an increased awareness and effort of highly interactive pedagogical tools. However, the issues involved with technology integration affected the technological roles of online instructors. As a result, the overall level of technology use was still relatively low. Email, asynchronous discussion, and announcement online were the most frequently employed communication tools, whereas more sophisticated interactive tools, e.g. online synchronous collaborative tools, multimedia lectures, etc., were in relatively low use.

**Students' perceptions of four dimensions of instructor roles**

The selected items from program evaluation survey reflected students' satisfactions of four dimensions of instructor roles.

**Pedagogical role**

According to the student survey, overall, the students had positive experiences with instructor's pedagogical facilitation in this program, and were highly satisfied with the impact of instructor guidance on their learning experiences. Nearly 80 percent of the students agreed that the instructors used a variety of instructional techniques to foster students' critical and reflective thinking. About 90 percent of the students agreed that online learning activities fostered their understanding of key concepts. Nearly 85 percent of the students agreed that the instructors play a role of "facilitator" rather then a "lecturer." More than 75 percent of the students replied that the way the instructors facilitated the class discussion fostered their learning. However, about 20 percent of them were not so sure about the effectiveness of the instructors' facilitation in discussion forums .

**Social role**

The results suggested that the level of social presence in this program was relatively low. In effect, the students were not engaged in a fully socially supportive online learning environment. While approximately 60 percent of the students never felt lonely while taking the classes, about 25 percent did, in fact, feel isolated. In addition, 49 percent could not saliently feel the emotions or feelings of other students in their online courses. Similarly, only 28 percent students felt that they knew their instructors and other students well. Although the students felt a low level of social presence in online courses, nearly 90 percent indicated they felt they were part of a learning community when they took online courses. These findings indicated that other factors, such as the one week in-residence required by the program to develop group cohesiveness helped foster a sense of community in online courses in this program.

**Managerial role**

The students overall, reacted positively about the organization of course materials and were able to efficiently find learning resources in an online course. About 85 percent of online students agreed that online instructors provided clear instructions. Nearly 95 percent of the students agreed that the online courses were well organized. With the effort of online instructors in promoting equity in online participation, nearly nine in ten students felt comfortable participating in online discussion with others.

**Technical role**

The students overall had positive experiences with technical tools used in online courses and rated highly the overall program technical support. Slightly more than 85 percent of the students agreed that the tools and technologies used in online courses were helpful for deep learning. However, it should be noted that about 11 percent of the students did not agree that technologies were effectively used in online courses.

The overall satisfaction of learners in this program was extremely high. Students in this study had significantly benefited from taking courses in this online MBA program and were able to utilize the knowledge learned from online courses.

## Discussion

Although the themes presented may not represent all the roles the instructors engaged in, they represented the most important concerns expressed by online instructors in this program. The findings confirmed Berge's assertions that instructors perform different roles in different degrees when teaching online. Many roles identified in this paper are similar to what have been identified in previous research. At the same time, there are some emerging new roles, such as "profession inspirer", that have not been discussed in literature. Based on the findings from this study, a summary of the perceived priority of different roles by online instructors is displayed in Figure 1 (3=High priority, 2=Medium priority, 1=Low priority).

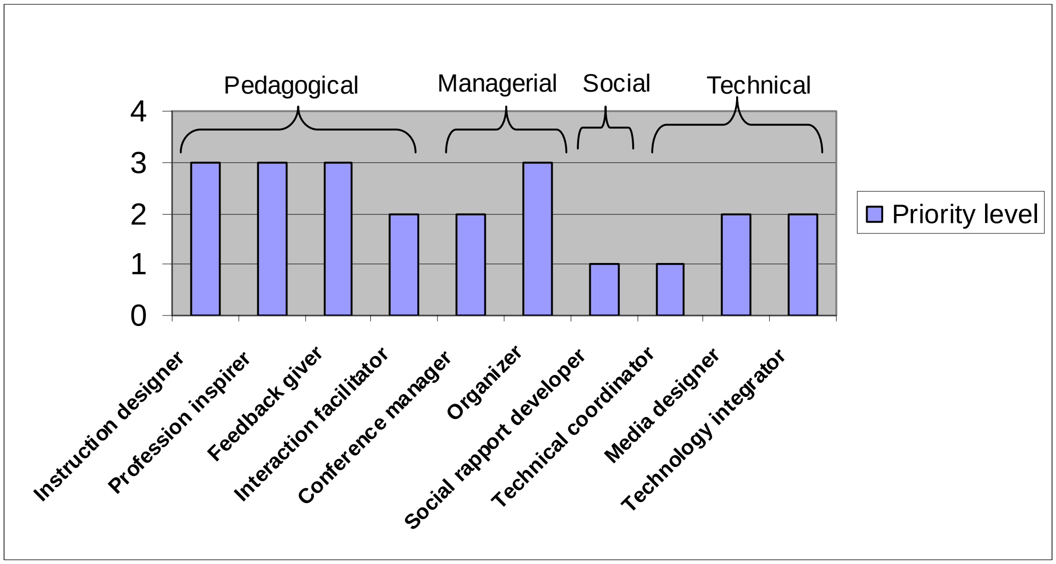


Figure 1. Perceived priority of different roles (High priority=3, Medium priority=2, Low priority=1)

Overall, there is a much stronger emphasis on the pedagogical roles within four dimensions. The effectiveness of instructor's pedagogical roles was confirmed by the students' survey. The strong emphasis on the pedagogical roles reflected four important concerns of the pedagogical roles: (1) course design, (2) promoting professional aspirations, (3) providing timely and quality feedback and (4) facilitating discussion. By emphasizing those tasks, the instructors promote three key types of interactions online: student-content, student-student, and student-teacher.

It is worth noting that a strong emphasis on the "designer role" reflects an important a policy concern in this online MBA program; namely, the importance of ensuring that the learning experience of students in the online environment is roughly equivalent to what students experience in the traditional classroom environment. Based on the results of this study, it is clear that traditional course materials provide a solid knowledge foundation for online courses to build on (Salmon & Giles, 1997). However, it was also observed that mimicking the classroom experience will preserve the status quo, while limiting the exploration of more innovative learning strategies that can better engage online learners. This status quo was evident in that many instructors lacked innovative uses of pedagogical and technological techniques in their online courses.

There was a great variance among online instructors on the degree of facilitating online discussion. This study revealed that the variance seemed to associate with a variety of factors (e.g. timing, course type, perceptions, moderating skills, etc.). There is a need to further explore how and to what degree each of these contextual factors affects instructor presence in online discussion. From this study, there was also an issue as to when to intervene in online discussion. For example, when some instructors found that their presence affected discussion flow, they completely withdrew from the discussion. While instructors in this study rightly realized that their transition from "dictator" or "lecturer" to "facilitator," they need more concrete ideas and strategies on how to facilitate in a way that does not interfere too much with student learning but yet contributes to content expertise and skill.

The findings related to instructors' perceptions of the social roles were highly similar to those of Conrad's study. As her work, there was a general lack of active social role in facilitating a learning community and limited awareness of the possible contributions of the social roles to online learning. Correspondingly, our surveys from students also revealed that the level of social presence in online courses was low. Though the importance of social dimension of online learning has been increasingly acknowledged in the literature, there is still a gap between the promises and the reality of existing practices in many online programs. This gap lies in the change of the fundamental conceptions of social roles. To assist with this change, there is a need for online instructors to be very explicitly educated in the importance of social roles and provided with convincing evidence of the relationship between social roles and cognitive learning. Data from this study indicated a need to further explore the relationship between an active social role on the part of the online instructor and learner engagement.

Both roles of "conference manager" or "organizer" emphasize the importance of "structure" (e.g., procedural rules, clear timeline, and clear directions) for maintaining disciplined participation of online learners. Consistent with previous studies (Heuer & King, 2004; Pincas, 1998), this study supported the notion that instructors perceived the "structure" to be an essential condition for providing a psychologically safe learning environment and sustaining continuous engagement in online learning.

The findings indicate that instructors' technical roles evolved from assisting with technical issues to identifying or developing online pedagogical tools to address ethical concerns of accessibility. Consistent with prior studies (Andreson et al., 2001;Concrad, 2004), the general technology used in this online MBA program did not present significant challenges to online instructors. Over time, the instructors reported that the technology became increasingly reliable and that the technical support from the organization had become more efficient. The emerging role of "media designer/developer" suggests the increased proactive attitude of online instructors to participate in designing and developing new pedagogical tools. While there was a sense of excitement and adventure as instructors seemed to be willingly utilizing and learning about new and emerging online technologies, the varying technical skills and lack of knowledge of best practices in technology integration remained a key issue.

We also noted that the tension of accessibility and sophisticated use of highly interactive learning tools is a significant and growing challenge for technology integration in online learning. We found that when instructors were trying to find the common denominator between high interactivity and accessibility, they often opted to play it safe and try simple tools and activities. Many practical reasons can be contributed to their conservative choices (e.g. lack of time, lack of extensive training, the rapid growth of this program, etc.). However, the lack of innovativeness or risk taking of the instructor seemed to be one of the key underlying factors. There is a need for organizational efforts to provide training and policies which reward online innovation in order to achieve a higher level of technology use.

Time management was identified as one of the factors that significantly affected the roles engaged in and caused significant tensions between different roles (e.g., employing a social role or a pedagogical role). This study reinforced the previous finding that time was consistently ranked as one of the top barriers for teaching online (Berge & Muilenburg, 2001). This issue indicated not only a need for online instructors to adopt efficient strategies to teach online but also a need to learn how to strategically unbundle some roles to ease the stress (Howell, Saba, Lindsay, & Williams, 2001). For example, delegating students to play moderator roles in online discussions or using virtual teaming strategies not only can reduce the workload of online instructors but also can enhance learner accountability while deepening their engagement. Inviting outside experts can enhance the interactivity of an online course with opportunities for real world experience.

## Conclusion

Exploration of instructors' roles across instructors in this study suggested that the interplay among online instructor roles is very complex. Instructors in this growing program have been successfully playing important roles and providing a satisfactory experience for online learners. However, it was noted that there was extensive variance among online instructors on how they play or perceive their roles in this program. This study also indicated that several prominent contextual factors affected their roles. And there are perceived tensions between different roles. It was encouraging to see online instructors strongly emphasize pedagogical roles to assure quality online education. However, there was also an urgent need to raise the awareness of the importance of social roles if they are to establish a more engaging and fruitful online learning environment.

To help online instructors make a successful transition for online teaching, data from this study indicated a need for institutions to not only plan future roles but also provide substantial training support and best practices regarding implementing those roles (Howell et al., 2001). As a program level case study, generalizations from the results in this study may be constrained. However, the analysis of emerging roles, issues and recommendations raised in this study provide highly valuable information and insights to assist distance educators and policy makers to make educational policies and practices for a successful transition for online instructors.

## References


Anderson, T., Rourke, L., Archer, W., & Garrison, R. (2001). Assessing teaching presence in computer conferencing context. *The Journal of the Asynchronous Learning Networks,* 5(2):1-17. http://www.aln.org/publications/jaln/v5n2/v5n2_anderson.asp

Ashton, S., Roberts, T., & Teles, L. (1999). *Investigation the Role of the Instructor in Collaborative Online Environments*. Poster session presented at the CSCL '99 Conference, Stanford University, CA.

Berge, Z. L. (1995). Facilitating computer conferencing: Recommendations from the field. *Educational Technology,* 15(1), 22-30. Online: http://www.emoderators.com/moderators/teach_online.html

Berge, Z. L. (2001). New roles for learners and teachers in online education. Online: http://www.globaled.com/articles/BergeZane2000.pdf

Berge, Z.L. & Muilenburg, L.Y. (2001). Obstacles faced at various stage of capability regarding distance education in institutions of higher education. *Tech trends,* 46(4), 40-45.

Bonk, C.J. (2000). My hat's on to the online instructor. *e-education Advisor: Education Edition*, 1(1), 10-13.

Bonk, C. J., Kirkley, J. R., Hara, N., & Dennen, N. (2001). Finding the instructor in post-secondary online learning: Pedagogical, social, managerial, and technological locations. In J. Stephenson (Ed.). *Teaching and learning online: Pedagogies for new technologies* (pp 76-97). London: Kogan Page.

Copplola, N. W., Hiltz, S. R., & Rotter, N. (2001). *Becoming a virtual professor: Pedagogical roles and ALN*. Proceedings of the 34th Hawaii International Conference on System Science. Maui, Hawaii.

Conrad, D. (2004). University instructors' reflections on their first online teaching experiences. *Journal of Asynchronous Learning Networks*, 8(2), 31-44. Online: http://www.sloan-c.org/publications/jaln/v8n2/pdf/v8n2_conrad.pdf

Eastmond, D. V. (1995). *Alone but together: Adult distance study through computer conferencing*, Cresskill, NJ,: Hampton Press.

Hara, N., & Kling, R. (2000). Students' distress with a web-based distance education course: An ethnographic study of participants' experiences. *Information, Communication & Society*, 3(4), 557-579.

Heuer, B.P., & King, K. (2004). Leading the band: The role of the instructor in online learning for educators. *Journal of Interactive Learning Online,* 3(1), 2004. Online: http://www.ncolr.org/jiol/archives/2004/summer/05/index.htm

Howell, S.T., Saba F., Lindsay N.K., & Williams P.B.(2001). Seven strategies for enabling faculty success in distance Education. *Internet and Higher Education*, 7(1), 33-49.

Johnson, C. M. (2001). A survey of current research on online communities of practice. *Internet and Higher Education*, 4(1), 45-60.

Kanuka, H & Caswell C (2002). University instructor's perceptions of the use of asynchronous text-based discussion in distance education. *The American Journal of Distance Education,* 16(3), 151-167.

Kerr, E. (1986). Electronic leadership: A guide to moderating online conferences. *IEEE Transactions on Professional Communications*, 29(1), 12-18.

Morine-Deshimer, G. (1996). What's in a case and what comes out? In J. Colbert, K. Trimble, and P. Desberg (Eds.), *The case for education: Contemporary approaches to using the case methods* (pp 100-123).

Needham Heights, MA : Allyn & Bacon.

Pincas, A. (1998). Successful online course design: Virtual frameworks for discourse construction. *Educational Technology and Society*, 1(1), 1998. Online: http://www.ifets.info/journals/1_1/pincas.html.

Powers, S., & Guan, S. (2000). Examining the range of student needs in the design and development of a web-based course. In: Abbey B. (Ed.), *Instructional and cognitive impacts of web-based* education (pp. 200-216). Hershey, PA: Idea Group Publishing.

Salmon, G. (2000). *E-moderating: The key to teaching and learning online*, London: Kogan Page.

Stake, R. (1994). Case Studies. In N.K. Denzin and Y. S. Lincoln (Eds.), *Handbook of qualitative research*. Thousand Oaks, CA: Sage.

Teles L, Ashton S., Roberts T., & Tzoneva I (2001). The role of the instructor in E-Learning collaborative environments. *TechKnowlogia*, 6/7.

Merriam, S. B. (1998). *Case study research in education: A qualitative approach.* Jossey-Bass Publishers, San Francisco, CA.

Salmon, G., and Giles, K. (1997). Moderating online, 1997. Online: http://www.emoderators.com/moderators/gilly/MOD.html .

Wenger, E. (1991). *Communities of practice: Learning, meaning and identity*. London: Cambridge University Press.

Wilson, B., Ludwidg-Hardman, S., Thornam C.L., and Dunlap J.C. (2004). *Bounded community: Designing and facilitating learning communities in formal courses.* Paper presented at the meeting of the American Educational Research Association, San Diego, CA. Online: http://carbon.cudenver.edu/~bwilson/BLCs.html

# The Development and Formative Evaluation of a Case Library as An Online Teaching Resource for Faculty

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## Background of the Study

Online teaching has become a more established practice in higher education. However, the quality of online teaching is still problematic and traditional faculty development activities have limited impact on faculty teaching. In this study, an Online Teaching Case Library (OTCL) was proposed as a resource to improve faculty online teaching. This case library is a repository of faculty online teaching courses and stories, which provide vicarious online teaching experiences to professors. The development and validation of a solution like this tends to be a long-term research project requiring a series of studies and multiple research strategies. Before making any substantial commitment to developing such a tool, I conducted an exploratory study to identify the initial evidence to support this solution.

## Purposes and Research Questions

The purposes of the study are twofold. The first purpose is to determine initial support for or evidence against this solution by exploring faculty perceptions of a case library prototype. This focus may help researchers and stakeholders of faculty development determine whether to pursue this solution in improving faculty online teaching. Assuming an OTCL is worth pursuing, the second purpose of this study is to generate design knowledge, including a set of high-level design guidelines for future development work in the similar context and a methodology on how to develop a case library. As I mentioned in the previous paragraph, this study is the beginning piece of study in a long-term research agenda. Design knowledge synthesized from this study may enlighten future research in this or similar projects.

Four research questions were asked to guide the study: (a) How do faculty members perceive a case library as a tool that supports online teaching? (b) What tasks do faculty members perceive that they would accomplish in a case library that supports online teaching? (c) What types of content do faculty members perceive that they would need in a case library that supports online teaching? (d) What major system features do faculty members perceive that they would need in a case library that supports online teaching? For each research question, there were two subquestions: (a) Is there a difference among faculty with different amounts of online teaching experience? (b) Is there a difference among faculty with different levels of familiarity with case methods?

## Theoretical Framework

The use of case libraries to enhance faculty online teaching is supported by theories and research in case methods (Merseth, 1996) and case-based reasoning (CBR) (Kolodner, 1993). Research shows that teacher knowledge is context-specific and situation-dependent (Calderhead, Clark & Peterson, Clark & Yinger as cited in Merseth, 1996). Teachers operate more from “induction from experiences” rather than “deduction from theoretical principles” (Merseth, 1996, p. 724). Therefore, it is important to provide direct and vicarious experiences to faculty to enhance their teaching. Cases have been used in various areas of teacher education (Merseth, 1996), and case libraries have been developed to provide case studies on technology integration (Krueger, Boboc, & Cornish, 2003; Wang, Moore, Wedman, & Shyu, 2003).

CBR (Kolodner, 1993) is another theory that supports the use of case studies in teacher education. CBR describes how human beings rely on concrete past experiences to solve problems. It emphasizes that vicarious experiences should be provided to support problem solving. Researchers in this field have built computer-based case libraries to support teaching and learning (Chandler, 1994; Domeshek & Kolodner, 1992).

## Methodology

To guide this study, I followed a three-component methodology (Ma & Harmon, 2005): development research, rapid prototyping, and qualitative methods. These components describe the methods for this study at three different levels. In the following paragraphs, I present the rationale for selecting these methods and discuss how they guided this study.

### Development Research

Development or design research (Reeves, Herrington, & Oliver, 2004; The Design-Based Research Collective, 2003) is an emerging research paradigm usually adopted for the dual purposes of addressing practical problems and developing context-rich theoretical knowledge. This study has both a practical goal of addressing a faculty development issue and a theoretical goal of constructing design principles for an OTCL. Therefore, development research is an appropriate methodology for this study.

Development research provides guidance on how a research project can be carried out from the long-term perspective. Literature on development research (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003; Collins, Joseph, & Bielaczyc, 2004; Reeves et al., 2004; Richey, Klein, & Nelson, 2003) prescribes that these research projects should involve (a) both development and research activities, (b) an iterative process and a long-term engagement; (c) collaboration between researchers and practitioners.

Development research provides high level guidance on how a project can be carried out. However, it does not prescribe detailed procedures on how to proceed with the project. This need can be met by the use of instructional development models (Gustafson & Branch, 1997). Rapid prototyping is one type of these models.

**Rapid Prototyping**

Rapid prototyping is an appropriate development model for this study. First, rapid prototyping is suitable for situations where complex factors make it difficult to predict the project outcome. Technology-based innovative learning environments are usually complex and many factors are involved in developing them (Hannafin, Oliver, Hill, & Glazer, 2003; Reeves et al., 2004; Reigeluth, 2003). In this project, there are many multifaceted issues in developing a case library. Some of the issues include stakeholder needs and requirements, user-interface design, system technical design, as well as the diffusion and adoption of these systems. Compared to traditional instructional design models, rapid prototyping can better handle such complexity. Second, rapid prototyping is especially applicable in situations where there is limited experience to inform the design process. The development of an OTCL is such a case. Third, rapid prototyping is appropriate when the development tools offer modularity and plasticity. An OTCL is computer-based, so rapid prototyping should be appropriate for its development.

Rapid prototyping provides a process view of how individual iterations progressively develop a problem solution and gradually build a knowledge base. I synthesized a rapid prototyping model (Figure 1 and Figure 2) based on the works of Tripp and Bichelmeyer (1990) as well as Dorsey, Goodrum, & Schwen (1997). This model shows that the study reported in this paper is the first iteration of a long-term research project. It also helps structure the development and research procedure for the current study. There are three major steps in the current study: conceptualization, development, and research.

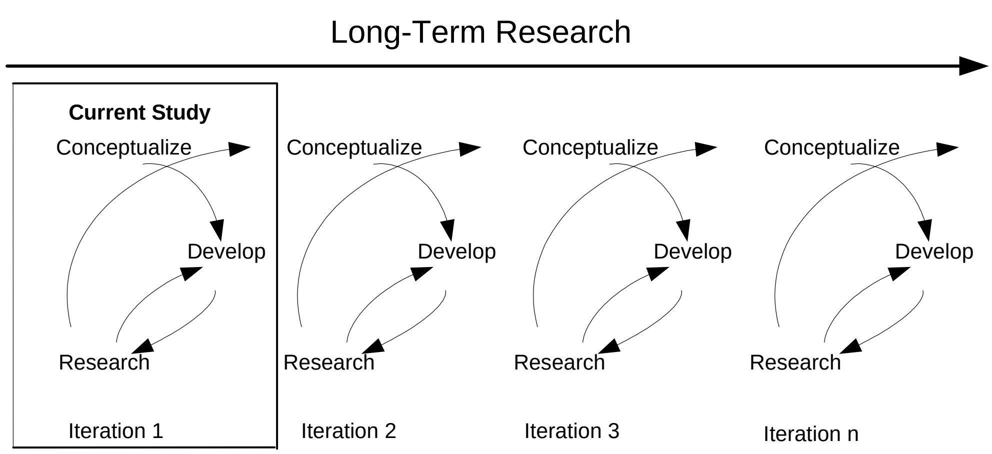



*Figure 1*. Current study from the long term perspective, adapted from Dorsey, Goodrum, & Schwen (1997) as well as Tripp and Bichelmeyer (1990).

At the conceptualization stage, I first identified the research problem and research questions. Then, I synthesized a problem solution from the literature and developed this solution into conceptual models that describe (a) the types of tasks faculty would accomplish in an OTCL, (b) the types of content faculty would need, and (c) the types of features should be available. These three models corresponded to three of the research questions.

During the development phase, I implemented the conceptual models in a prototype and addressed a variety of issues involved in prototype development. This prototype primarily includes two components. One is a case study on the design and delivery of an online instructional design course. It contains an overview of the course design and delivery, course materials, as well as the lessons that the instructor learned from teaching this course. The other component deals with a specific topic in online teaching. These two components represent two types of content in an OTCL. They allow the user to explore an OTCL from the perspectives of examining similar courses or investigating specific issues.

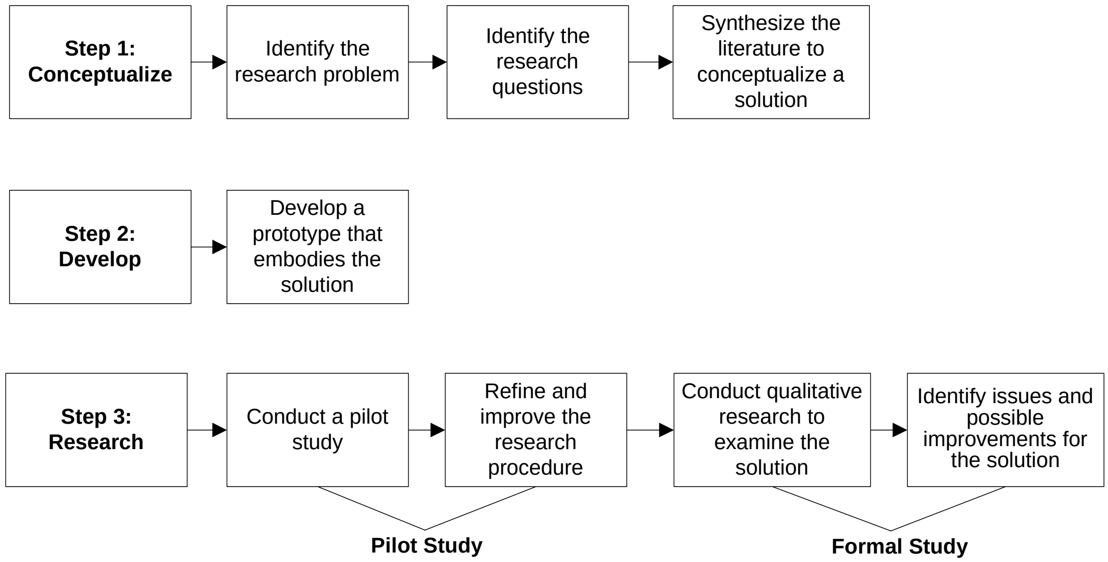



*Figure 2.* Development and research procedures for the current study.

Some of the development issues I addressed include scope of the prototype, tools and procedure used to develop the prototype, content selection and index selection. I limited the scope of the prototype to two common scenarios. I used HTML to create a Web-based medium-fidelity prototype (Leone, Gillihan, & Rauch, 2000; Snyder, 2003). To develop the prototype, I followed four steps synthesized from several interface development procedures (Ludolph, 1998; Mayhew, 1999; Weinschenk, Jamar, & Yeo, 1997): (a) chose the object-oriented design as the basic interaction paradigm; (b) developed primary user scenarios; (c) identified the objects and user actions (Weinschenk et al., 1997) in the scenarios; (d) developed the individual screens and major navigational pathways. The content for the prototype came from books, journal articles, and content experts. Indexing dimensions and values for cases are based on the indexing language of an existing case library (Wang et al., 2003), Gagne's taxonomy of learning outcomes (1985), Jonassen's typology of problem solving (2000), and Molenda's (as cited in Reigeluth, 1999) list of instructional methods.

At the research phase, I conducted a pilot study to refine and improve the research procedure. I then carried out a formal qualitative study to answer the research questions, identify issues and possible improvements for the solution. In this study, qualitative methods guided data gathering and analysis. The next section elaborates on these methods.

**Qualitative Methods**

Qualitative methods informed the data collection and analysis process of the current study. Qualitative methods seem to be especially helpful during the exploration phase of a development research project (Kelly, 2004; Shavelson, Phillips, Towne, & Feuer, 2003) when models (Sloane & Gorard, 2003), conjectures (Sandoval, 2004), or hypothesis (Kelly, 2004) are formulated in the context of real world problems and interventions. This study explores faculty perceptions of an OTCL, so qualitative methods are appropriate.

With the purposeful sampling technique, I recruited seven faculty participants who had different backgrounds and a range of experience related to online teaching and case based pedagogy. The data collection procedure (Figure 3) includes three stages: initial interviews, contextual interviews, and final interviews. The initial interview examines faculty experiences with online teaching and case-based pedagogy, which provide a context for reflective exploration of the prototype. The contextual interview (Beyer & Holtzblatt, 1998; Holtzblatt & Jones, 1993; Kensing & Blomberg, 1998) is an ethnographic field method in systems design. In this study, it involves observing and interviewing faculty participants while they were interacting with the conceptual models and the prototype. It consists of four steps. The first step was concept introduction and initial feedbacks. The participants were introduced to the conceptual models and they discussed their reactions to the models. The second step was scenario review. The participants reviewed a scenario, discussed their reactions, and talked about a similar experience they had. Discussions of their own experiences help enrich and personalize the scenario. In the third step, prototype exploration, the participants explored the prototype using the scenarios. During the process, I asked the participants questions in order to understand their thought process, expectations, as well as likes and dislikes. The last step was prototype walkthrough. I walked participants through the unexplored features and asked for feedback. Steps two to four were repeated for the second scenario. The final interviews investigated faculty overall perceptions of an OTCL after their interactions with an OTCL.

I consulted the literature on qualitative research to guide my data analysis. Two primary sources came from the works of Miles and Huberman (1994) as well as LeCompte and Schensul (1999). I transcribe video and audio data and combined them to generate transcripts. Then, I coded the transcripts into conceptual chunks and grouped them into categories. I drew flow charts to display and make sense of the relationship among the categories. Finally, I wrote up conclusions and verified.

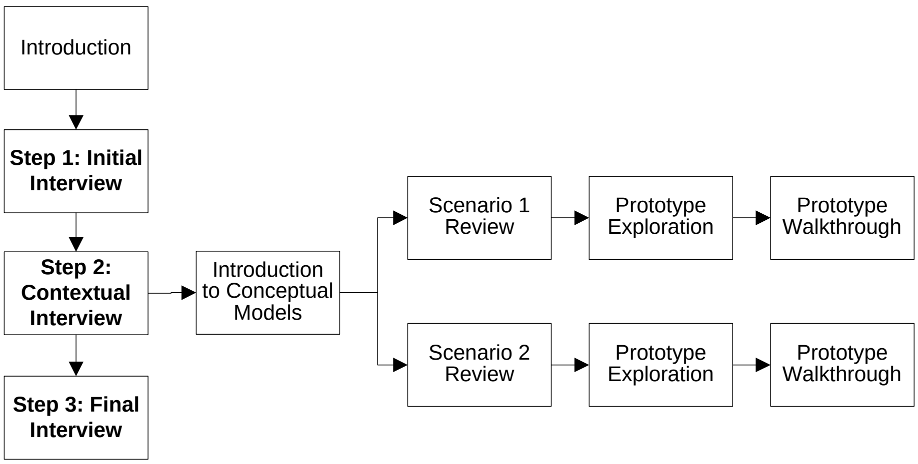



*Figure 3.* Data gathering procedure.

## Findings

This study intends to answer four research questions related to faculty overall perceptions of an OTCL as well as their perceptions of the tasks, content, and features that this case library should support. The following presents answers to these four questions and discusses the findings in the context of the literature.

### Overall Perceptions of an OTCL

Faculty members' perceptions of an OTCL focus on their decision to use this tool. Figure 4 shows that professors' perceived decision to use an OTCL can be explained by three main factors: (a) perceptions of how an OTCL supports the way they learn to teach (b) perceived usefulness, and (c) perceived usability of an OTCL. For the ease of communication, this figure is called Model of Perceived Decision to Use an OTCL (MPDUO).

Faculty participants in this study learned to teach from trial and error and from the experiences of other faculty members. They believe that an OTCL could support this type of learning. It could serve as an alternative to human mentors. Moreover, this tool could offer them a variety of perspectives and provide them with experiential knowledge at the time when they need it.

However, faculty might not adopt an OTCL unless it is perceived as useful and usable. Usefulness consists of two dimensions: applicability and relevance. An OTCL should be applicable in the sense that it supports the tasks that professors want to achieve during both course design and delivery, and it meets the needs of faculty who have different amounts of experience and preferences. This is the factor that has driven participants' perceptions of the types of tasks that they would accomplish with the use of an OTCL. Relevance is another dimension of usefulness. It refers to instructors' requirement that all the resources related to their tasks should be available in an OTCL, regardless of whether they are related to pedagogy, content, or technical solutions. This has influenced faculty perceptions of the types of content they would needed in an OTCL.

Usability includes two dimensions: effectiveness and efficiency. An OTCL should be effective in the sense that it should provide a shared language for the user to communicate with the tool. Efficiency is another important dimension of usability. Faculty wanted to quickly access the content to carry out their tasks. This need is reflected in their requirements for appropriate information presentation and organization features. Both effectiveness and efficiency are non-functional features faculty would need.

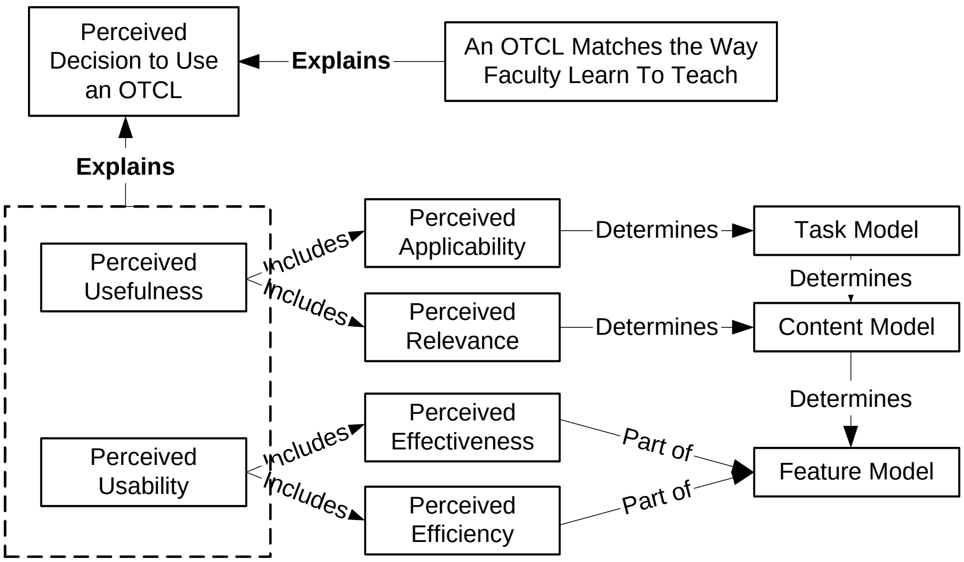



*Figure 4.* Model of perceived decision to use an OTCL (MPDUO).

Faculty members with different amounts of online teaching experience varied in their overall perceptions of an OTCL. Compared to novice online instructors, experienced online instructors better perceived the match between an OTCL and professors' apprenticeship approach to learning to teach. They also had more detailed vision of how an OTCL could support online teaching. Novice online instructors, however, were more concerned of the usefulness and usability of an OTCL, and they were more forthright in pointing out that they would not use an OTCL unless it could meet their needs. Their concern might be explained by the fact that the prospect of teaching online is already a challenge for novice online instructors and they would be pressed for time to put together a course; the idea of having to learn to use another tool in order to teach online can add to the stress. Despite their concerns, however, novice online instructors became more positive toward an OTCL once they had more experience with an OTCL. Faculty members with different levels of familiarity with case methods did not seem to have different overall perceptions of an OTCL.

**Perceptions of the Tasks Faculty Would Accomplish in an OTCL**

The tasks that participants perceived that they would carry out in an OTCL can be categorized as three primary tasks and two secondary tasks (Figure 5). The primary tasks include exploring possibilities, discovering issues, and identifying problem solutions. They are the reasons for professors to use an OTCL during course design and delivery. The secondary tasks consist of contributing to an OTCL and identifying the associated technical solutions. The need for completing these tasks would naturally arise as the user performs the secondary tasks.

Participants with different amounts of online teaching experience had different perceptions of the tasks. Novice online instructors tended to focus on exploring possibilities and identifying issues in online teaching, whereas more experienced instructors were apt to use an OTCL to identify solutions to specific problems. In addition, I expected that experienced online instructors might be more interested in adding stories and comments than novice online instructors. There was some evidence to support this assumption. Participants with different levels of familiarity with case methods did not seem to have different perceptions of the tasks.

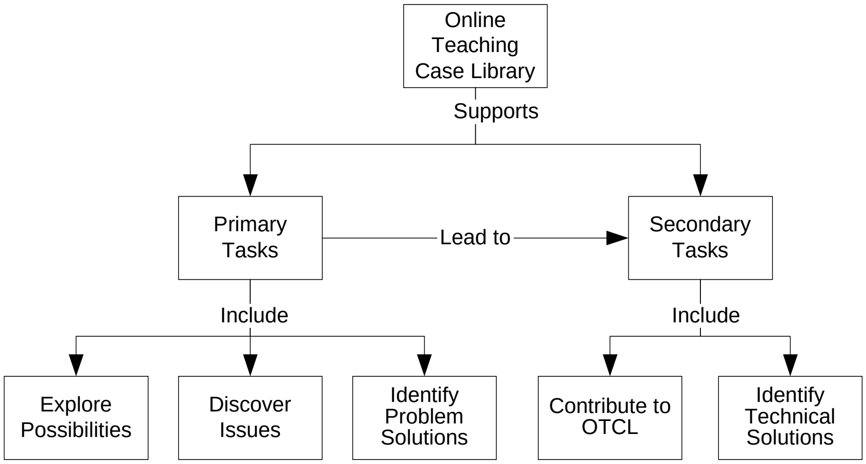


*Figure 5.* **Evolved task model**.

**Perceptions of the Types of Content Faculty Would Need in an OTCL**

The types of content that participants perceived that they would need in an OTCL include primary types of content and secondary types of content (Figure 6). The primary types of content are composed of cases and topics. A case has a case background, case details, and lessons learned. Case details consist of learning outcomes, teaching strategies, and course effectiveness. A topic is represented by guidelines and the stories that exemplify the guidelines. Stories come from the lessons learned. The secondary types of content refer to user stories and comments, as well as technical resources.

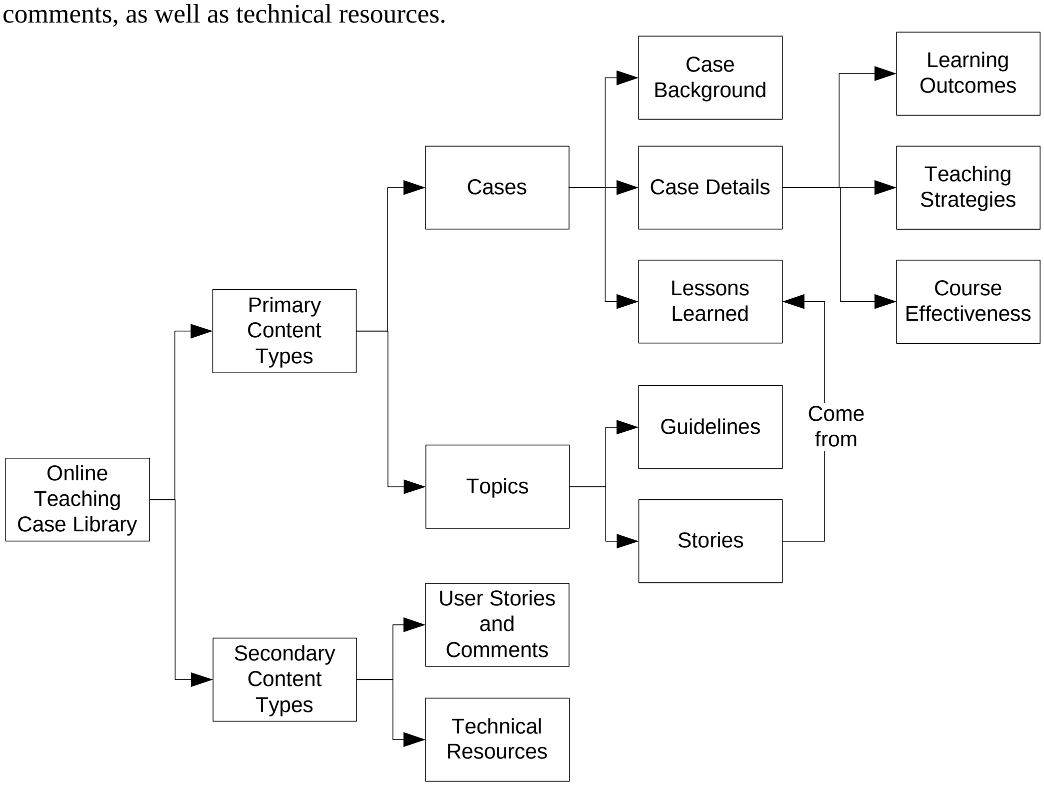
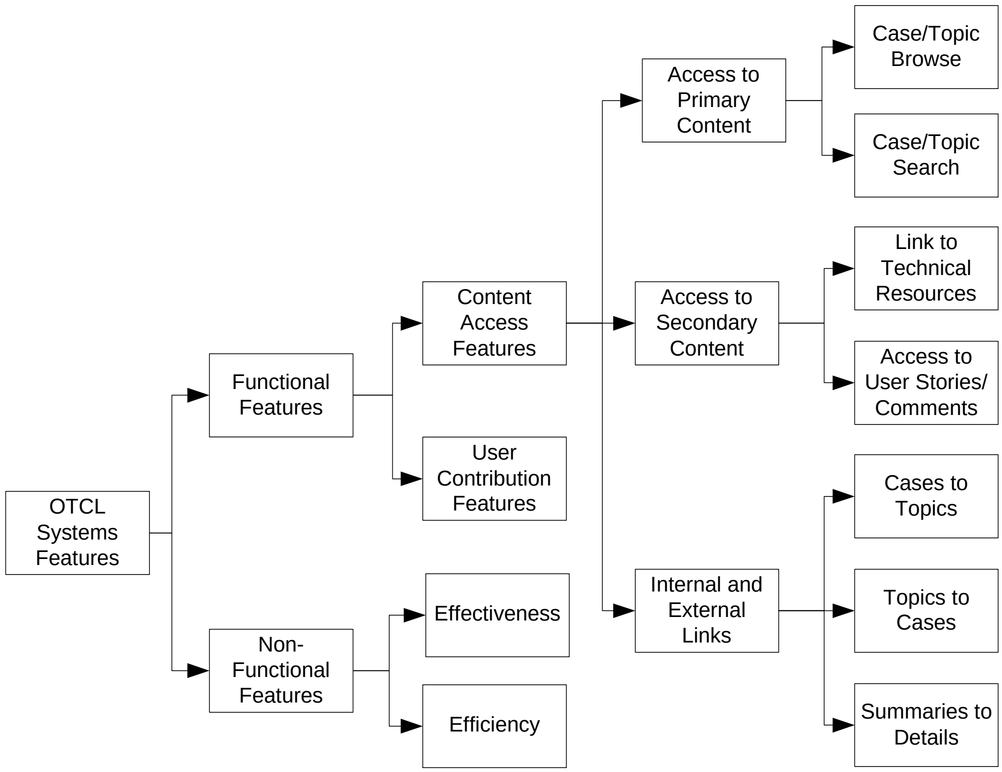



*Figure 6.* Evolved content model.

A little evidence shows that participants with different amounts of online teaching experience might perceive the content types a little differently. One participant perceived that novice online instructors would be more interested in cases, and topics would be more pertinent to experienced online professors. Participants with different levels of familiarity with case methods did not seem to have different perceptions of the content.

**Perceptions of the System Features Faculty Would Require in an OTCL**

The system features that faculty members perceived that they would need fall into the categories of functional and non-functional features (Figure 7). Functional features are services that an OTCL should provide to enable professors to accomplish their tasks, and non-functional features describe system properties with regard to how well the system provides the functional features.




* The arrow indicates that a type of features includes sub-types of features.

*Figure 7*. Evolved conceptual model of features.

Functional features faculty perceived that they would require can be classified as content access features and user contributions features. Content access features consist of those that give access to the primary types of content and secondary types of content as well as those that provide internal or external links. Case browse, topic browse, case search, and topic search are four content access features that provide access to the primary types of content; links to technical resources and access to user stories and comments are two content access features enables the retrieval of secondary types of content; case to topics, topics to cases, and summaries to details are three content access features that gives users flexibility to navigate among different types of content in and out of an OTCL. In addition to content access features, the other type of functional features is user contribution features, which are composed of add stories and add comments.

Non-functional features that participants considered as important are comprised of two usability dimensions: effectiveness and efficiency. These two features suggest that a variety of language issues as well as information presentation and organization issues be addressed.

Participants with different amounts of online teaching experience perceived some features differently. Compared to experienced online instructors, novice online instructors were more concerned with effectiveness and efficiency and would not tend to add stories or comments to the tool. Participants with different levels of familiarity with case methods did not seem to have different perceptions of the features.

### Implications of Study

The two purposes of the study were fulfilled. This project identified the initial evidence to support an OTCL as an online teaching resource. Faculty might use an OTCL, because it matched the way that they learned to teach. However, there were many challenges involved in making the tool useful and usable. This study would provide a base for decision makers to determine whether they would adopt this tool.

For those who do want to pursue this solution, a set of high-level design guidelines and a methodology on how to develop an OTCL were developed based on the findings of the study. These design guidelines include (a) enhance the perception that an OTCL supports the way faculty learn to teach, (b) enhance perceived usefulness of an OTCL, and (c) enhance the perceived usability of an OTCL. A methodology on how to develop a case library has evolved from this study. This methodology consists of three components: development research, rapid prototyping, and qualitative methods. Development research describes the nature of this methodology; rapid prototyping frames the development and research process; qualitative methods with the use of contextual interviews may guide data gathering and analysis.

In addition to attaining the two purposes, this study has contributed to the following overlapping areas of theories and research: challenges of online teaching for professors, faculty change and teaching improvement, faculty needs in online teaching, electronic performance support systems (EPSS), knowledge management systems (KMS), technology acceptance, as well as case-based reasoning and case methods.

### References


Beyer, H., & Holtzblatt, K. (1998). *Contextual design: Defining customer-centered systems.* San Francisco: Morgan Kaufmann.

Chandler, T. N. (1994). The science education advisor: Applying a user centered design approach to the development of an interactive case-based advising system. *Journal of Artificial Intelligence in Education, 5*(3), 283-318.

Cobb, P., Confrey, J., diSessa, A., Lehrer, R., & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher*, *32*(1), 9-13.

Collins, A., Joseph, D., & Bielaczyc, K. (2004). Design research: Theoretical and methodological issues. *Journal of the Learning Sciences, 13*(1), 15-42.

Domeshek, E. A., & Kolodner, J. L. (1992). A case-based design aid for architecture. In J. S. Gero (Ed.), *Artificial intelligence in design '92* (pp. 497-516). Dordrecht, The Netherlands: Kluwer Academic.

Dorsey, L. T., Goodrum, D. A., & Schwen, T. M. (1997). Rapid collaborative prototyping as an instructional development paradigm. In C. R. Dills & A. J. Romiszowski (Eds.), *Instructional development paradigms* (pp. 445-466). Englewood Cliffs, NJ: Educational Technology Publications.

Gagne, R. M. (1985). *The condition of learning* (4th ed.). New York: Holt, Rinehart, & Winston.

Gustafson, K. L., & Branch, R. M. (1997). Revisioning models of instructional development. *Educational Technology Research and Development, 45*(3), 73-89.

Hannafin, M. J., Oliver, K., Hill, J. R., & Glazer, E. (2003). Cognitive and learning factors in Web-based distance learning environments. In M. G. Moore & W. G. Anderson (Eds.), *Handbook of distance education*. Mahwah, NJ: Lawrence Erlbaum Associates.

Holtzblatt, K., & Jones, S. (1993). Contextual inquiry: A participatory technique for system design. In D. Schuler & A. Namioka (Eds.), *Participatory design: Principles and practices* (pp. 177-210). Hillsdale, NJ: Erlbaum.

Jonassen, D. H. (2000). Toward a design theory of problem solving. *Educational Technology Research and Development*, *48*(4), 63-85.

Kelly, A. (2004). Design research in education: Yes, but is it methodological? *Journal of the Learning Sciences, 13*(1), 115-128.

Kensing, F., & Blomberg, J. (1998). Participatory design: Issues and concerns. *Computer Supported Cooperative Work, 7*(3-4), 167-185.

Kolodner, J. L. (1993). *Case-based reasoning*. San Mateo, CA: Morgan Kaufmann.

Krueger, K., Boboc, M., & Cornish, Y. (2003). InTime: Online video resources for teacher educators featuring technology integration in preK-12 classrooms. *Educational Media and Technology Yearbook*, *28*, 183-197.

LeCompte, M. D., & Schensul, J. J. (1999). *Analyzing & interpreting ethnographic data*. Walnut Creek, CA: Altamira Press.

Leone, P., Gillihan, D., & Rauch, T. (2000). *Web-based prototyping for user sessions: Medium-fidelity prototyping.* Paper presented at the Society for Technical Communications 44th Annual Conference, Toronto, Canada.

Ludolph, F. (1998). Model-based user interface design: Successive transformations of a task/object model. In L. E. Wood (Ed.), *User interface design: Bridging the gap from user requirements to design* (pp. 81-107). Boca Raton, FL: CRC Press.

Ma, Y., & Harmon, S. W. (2005). *A development research methodology for developing technology-based innovative learning environments*. Unpublished manuscript.

Mayhew, D. J. (1999). *The usability engineering lifecycle: A practitioner's handbook for user interface design*. San Francisco: Morgan Kaufmann Publishers.

Merseth, K. K. (1996). Cases and the case method in teacher education. In J. Sikula (Ed.), *Handbook of research on teacher education* (pp. 722-744). New York: Simon & Schuster/Macmillan.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded source book* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Reeves, T. C., Herrington, J., & Oliver, R. (2004). A development research agenda for online collaborative learning. *Educational Technology Research and Development, 52*(4), 53–65.

Reigeluth, C. M. (1999). What is instructional-design theory and how is it changing? In C. M. Reigeluth (Ed.), *Instructional design theories and models: A new paradigm of instructional theory* (Vol. 2, pp. 5-29). Hillsdale, NJ: Lawrence Erlbaum Associates.

Reigeluth, C. M. (2003). Knowledge building for use of the internet in education. *Instructional Science, 31*, 341-346.

Richey, R. C., Klein, J. D., & Nelson, W. A. (2003). Developmental research: Studies of instructional design and development. In D. H. Jonassen (Ed.), *Handbook of research on educational communications and technology: A project of the Association for Educational Communications and Technology* (2nd ed., pp. 1099-1130). Mahwah, NJ: Lawrence Erlbaum Associates.

Sandoval, W. A. (2004). Developing learning theory by refining conjectures embodied in educational designs. *Educational Psychologist, 39*(4), 213-223.

Shavelson, R. J., Phillips, D. C., Towne, L., & Feuer, M. J. (2003). On the science of education design studies. *Educational Researcher*, *32*(1), 25-28.

Sloane, F. C., & Gorard, S. (2003). Exploring modeling aspects of design experiments. *Educational Researcher, 32*(1), 29-31.

Snyder, C. (2003). *Paper prototyping: The fast and easy way to design and refine user interfaces*. San Francisco: Morgan Kaufmann Elsevier Science.

The Design-Based Research Collective. (2003). Design-based research: An emerging paradigm for educational inquiry. *Educational Researcher, 32*(1), 5-8.

Tripp, S. D., & Bichelmeyer, B. (1990). Rapid prototyping: An alternative instructional design strategy. *Educational Technology Research and Development, 38*(1), 31-44.

Wang, F., Moore, J. L., Wedman, J., & Shyu, C. (2003). Developing a case-based reasoning knowledge repository to support a learning community - An example from the technology integration community. *Educational Technology Research and Development, 51*(3), 45-62.

Weinschenk, S., Jamar, P., & Yeo, S. C. (1997). *GUI design essentials*. New York: Wiley Computer Publishing.

# Understanding and Representing Learning Activity to Support Design: A Contextual Design Example

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**Abstract**

*Contextual Design is a well-defined method for gathering and representing user understanding within a coherent design process. This paper illustrates the value of Contextual Design to educational system design by describing a case study involving 14 contextual inquiry sessions that were carried out in and around the Indiana University music library, in support of designing technology for student learning. Findings are presented as diagrammatic work models, an affinity diagram, and a list of insights and design ideas. The utility of Contextual Design work modeling is assessed, and some limitations in its ability to represent learning are considered.*

## Introduction

Designing useful educational technologies requires us to understand the potential users of those technologies, the tasks the users bring with them, and the contexts of use. As we have developed our next-generation digital music library, Variations2 (Variations2, 2005), we have taken a valuable opportunity to gain this understanding by studying usage of its predecessor, the Variations system (Dunn & Mayer, 1999; Variations, 2005). This paper reports on the second in a sequence of contextual inquiry studies of digital music library use. Results from the first study have been partially reported (Notess, 2004a). A small subset of results from the present study were reported elsewhere (Notess, 2004b).

Contextual inquiry (Holtzblatt & Jones, 1993) is a naturalistic inquiry research method wherein researchers observe actual work in normal work contexts. The method is intrusive in that the observer sits with the participant and asks clarifying questions during and/or following the session. An advantage of contextual inquiry over an interview or questionnaire protocol is that it gets beyond the participants' beliefs about their activity and records actual practice, which often differs from how participants believe they behave. Data from contextual inquiry has proven very useful in information systems design. Recently, it has been applied to the design of educational technologies as well.

Contextual Design (Beyer & Holtzblatt, 1998) extends contextual inquiry by situating contextual data within a coherent design process. Central to the design process are five types of diagrammatic "work models" which serve to represent, consolidate, and communicate the findings of contextual inquiry in a manner useful to technology design. This paper illustrates the application of Contextual Design (CD) to educational technology using a case study of digital music library use at Indiana University.

Motivating the study were the following research questions.

- What is the role of the Variations digital music library in the studies of music students? Into what larger patterns of student work does a digital music library fit?
- How do students decide between using online and physical resources? For online resources, what use do students make of the non-library web?

Beyond these primary questions, we were also interested in characterizing the suitability of contextual inquiry and the CD work models for examining and representing student library work. The CD models were developed primarily for describing business-oriented work activity. Whether the models adapt well to representing learning activity is an open question.

After describing the digital music library technologies and the method for conducting the observations, this paper provides examples of the five CD work models, describes the useful outcomes of the study for Variations2 design, and offers a preliminary assessment of the CD models' utility in studying learning.

## Study Description

### Variations and Variations2

Variations is a large digital music library implementation at Indiana University (IU), in use since 1996 to provide streaming audio and digitized score images to music students at computers in the music library. The approximately 1500 School of Music students make frequent use of Variations for course reserves and personal study although anyone with an IU network login may go to the Cook Music Library and use Variations.

The collection includes over 10,000 digitized recordings. A Variations recording comprises a CD, CD set, LP, LP set, tape, etc.; hence, an item in the library catalog maps to a single Variations item. The Variations collection has grown through successive semesters of course listening reserves being requested by faculty. For copyright reasons, access to Variations is limited to PCs in the music library on the IU campus as well as to network ports in several music classrooms. Most usage of Variations occurs at the approximately 90 PCs in the music library. Recordings in Variations are accessed via a URL-based mechanism. URLs for Variations recordings are embedded in the online library catalog (IUCAT) records, but URLs are also available on HTML-based course reserve pages and can be put in any web page or typed directly into a web browser. Clicking on a Variations link or entering the URL in a browser brings up a web page summarizing the item and its contents. The Variations audio player is invoked by clicking on the a link to the desired side (or CD) listed on the web page. Since Variations recording files are stored on tape and copied to disk-based cache on demand, a user may have to wait several minutes for the player to appear if no one has requested that item during the previous day or two.

Variations2 is a completely new digital music library project that is replacing Variations at IU (the actual replacement occurred in May, 2005, subsequent to the present research). In addition to library functionality (resource discovery and access), Variations2 also provides pedagogical tools to support, for example, bookmarking, playlists, analytical and annotation tools, and listening drills. The research reported in this paper was carried out in support of designing Variations2 product features by better understanding how students work within the existing Variations tool ecology.

**Participants**

Our first study of Variations users had focused on undergraduate instrumental performance majors. For this study, we recruited four participants who were graduate voice students in a song literature class. We knew voice students had some needs we had not previously explored, such as viewing song texts, opera librettos, and their translations. Participants were selected from among volunteers signing up during a class presentation about Variations2. The selected participants, three males and one female, were the first four to reply to a follow-up email. Participants received a gift certificate in exchange for letting us observe and discuss approximately four to five hours of their academic activities.

**Method**

Observations occurred in sessions of between one and two hours in length. While we were primarily interested in their library work, we also wanted to get a broader picture of voice students' information needs in their academic activities. Therefore, we included observations of other activities such as voice lessons (both teaching and taking), class attendance, and ensemble rehearsal. In some cases, depending on the nature of the work being observed, it was possible to discuss aspects of the activity during the observation. For instance, during library stack browsing, it was easy to talk about what the student was looking for and why. During less interruptible activities such as taking a class or giving a voice lesson, the observer saved up questions and clarifications for a subsequent discussion with the participant.

Participants were requested to do their normal academic activities (whatever they needed to do next) and were observed in their usual contexts—library computer carrel or work table, classroom, or lesson studio. Data were collected with handwritten notes. No audio or video recordings were made. Artifacts, such as assignment sheets or student notes, were photocopied and annotated. At end of each observation, we talked with the participant to make sure we were understanding the observed activity correctly, to make any needed photocopies, and to set up any subsequent observation.

Contextual inquiry focuses on understanding the work being done, in all its richness. To collect these data, we ask questions to be sure we understand the triggers that initiate a work sequence, the intent to be fulfilled by the work sequence, the steps involved, the artifacts created or used during the work, the people communicated with, the pressures and influences that impact the work, the breakdowns that interfere with the work, and the environment within which the work occurs (Beyer & Holtzblatt, 1998).

Data from these sessions were represented in each of the five Contextual Design work models: Sequence, Flow, Culture, Physical and Artifact. Each type of model was then consolidated across the inquiry sessions to yield a consolidated model. Consolidated models indicate larger patterns without losing the detail of individual variation. Contextual design also includes an affinity diagram process, where researchers and volunteers create an extensive affinity diagram of "work notes", which can include nuggets of data from the models as well as data that did not fit neatly into any of the models.

## Findings

We conducted fourteen contextual inquiry sessions. For all of these sessions, our focus was on the information needs of the participants. Ten of these were observations of library work; the other sessions included a voice lesson for the participant, a voice lesson given by the participant to a non-major (called a "secondary voice lesson"), a class session, and an ensemble rehearsal. All sessions produced at least some useful data with the exception of the ensemble rehearsal. This rehearsal was a dress rehearsal for a ballet that included choral accompaniment, but the focus of the rehearsal had nearly nothing to do with the singers, who were merely commended for their excellent work.

The ten library sessions included observations of the following kinds of work:

- *Listening assignment*. Students listen to an assigned set of songs, or select from among assigned songs, and write brief analyses of what they hear and think.
- *Recital assignment*. Students plan an imaginary voice recital following one or more specific themes, such as British art songs related by some thread such as having the same poet or same subject matter.
- *Audition "package" preparation.* Students auditioning for a summer singing job or other opportunity select vocal material to polish that will meet usual audition criteria for quantity and variety while also showing off the strengths of their individual voices.
- *Lesson piece, recital or performance part preparation.* Students study a particular piece or part for performance in their lesson, recital or a production. Study includes not only listening to and/or watching various performances but also uncovering background information about the composer, the poet, the performers, and so on. Study may also include making a literal translation of the text.
- *Song analysis project.* Students perform an in-depth analysis of a particular song, tracing its history through various performers and performances.
- *Exam preparation.* Students study a body of work so that they can identify and discuss a given song upon hearing it in an exam.

**Work Models**

Models included in this paper are consolidated work models (Beyer & Holtzblatt, p. 23): they represent multiple observations of similar work. In Contextual Design, consolidated models are built by induction from examining individual work models (models representing a single observation).

*Sequence Model.* Nearly all the library work consolidated into one of the two sequences shown in Table 1. The two sequences share some steps ("intents" in CD terminology). The key difference between the two types of work was twofold: whether the materials were pre-identified, and the level at which the studying occurred. For the "Study in Detail" sequence, the library material to be used was known ahead of time, or was selected from a predetermined list, and just had to be located. For the "Collect and Select" sequence, the student started with criteria but not material. Finding material that met the criteria, through a process of building a candidate pool and then selecting from that pool, was part of the work itself. Materials were selected based on descriptive data (length, language, key, etc.) and a more cursory listen to the content than in the first sequence. In the first sequence, detailed, repeated listening to the content absorbed the attention and the descriptive data were used more sparingly (performer name was the most common).

Although our data did not show these two sequences in combination, it was clear that some tasks begin as "Collect and Select" but will later require "Study in Detail." The song analysis project, mentioned above, is one example: one first has to select seminal performances of a piece and then listen in detail to complete the musicological analysis.

The sequence model has an additional level of detail not shown here because of space limitations. The lowest level of detail, "abstract steps", describes the steps taken to accomplish the higher-level intent in the table. For instance, in the "Study in Detail" sequence, the "retrieve known recording" intent has the abstract steps shown in Table 2. Note: In Table 2 and elsewhere in this paper, the "BD"-prefixed comments refer to work breakdowns—observed difficulties.

Table 1. The Two Common Sequences of Library Work

<table>
<tr><td>Activity</td><td>"Study in Detail"</td><td>"Collect and Select"</td></tr>
<tr><td>Prepare to do library work</td><td colspan="2">• get headphones<br>• find available carrel<br>• locate assignment<br>• log in and locate on-line tools</td></tr>
</table>

| | | |
|---|---|---|
| | • select piece to study<br>• retrieve known recording<br>• retrieve known auxiliary materials (scores, texts, reference works) | |
| Work with library materials | • study material (listen, and follow along in score and/or text; repeat whole piece or key parts)<br>• make personal notes to capture key points gleaned from studying | • find candidate materials<br>• examine many details quickly to decide which to select (listen, check length, performer, key, etc.)<br>• make personal notes to guide selection |
| | • write assignment deliverable | |
| Wrap-up the work | • preserve notes and/or assignment deliverable (email to self, save on Zip disk or network drive, print)<br>• log out<br>• pack up<br>• return reserve materials<br>• return headphones | |

Table 2. Abstract Steps for "Retrieve Known Recording"

| |
|---|
| • Find course reserve list<br>• Scroll to desired recording (BD: reserve list may be very long)<br>• Select item (BD: easy to pick wrong item due to title similarities)<br>(or)<br>• Looking at assignment sheet, type Variations URL for item in browser field<br>(or)<br>• Enter search terms in online catalog<br>• Scroll through search results to find desired item (BD: easy to pick wrong item due to title similarities and lack of distinct visited-link color)<br>• Select item |
| • Select CD/Side within Variations web page |

*Culture Model.* The consolidated culture model, which captures the power, influence, and emotional dynamics between people and groups, is shown in Figure 1. This is not a particularly rich example of a culture model. The relative paucity of culture data likely results from the fact that the work observed was primarily individual study within a well-defined hierarchy (teacher-student). If our observations had focused on collaborative or competitive activities, more cultural forces would probably have emerged.

Of potential interest from this diagram is the one breakdown, shown in the diagram with a heavy zigzag. None of the participants was willing to recall material on loan to another patron. In one case, the participant justified his reluctance by saying that if someone else had it checked out, he/she probably has a greater need for it. This situation illustrates an important limitation of physical materials and also shows that at least some parts of the community of music library patrons view their use of scarce materials as a collaboration rather than competition.

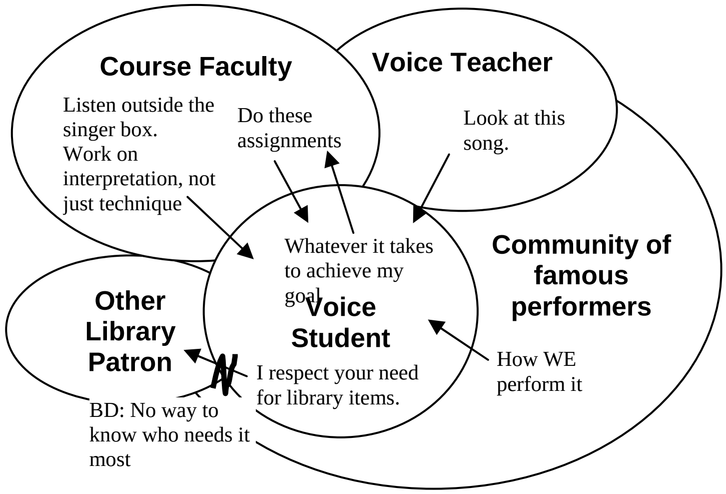


Figure 1. Consolidated Culture Model

*Flow Model.* The flow model (Figure 2) represents the movement of artifacts and communication between people (or roles) to accomplish work. Beneath each role are listed the observed responsibilities of that role. The arc labels in boxes represent tangible or virtual artifacts; the other arc labels indicate communication not formalized in an artifact.

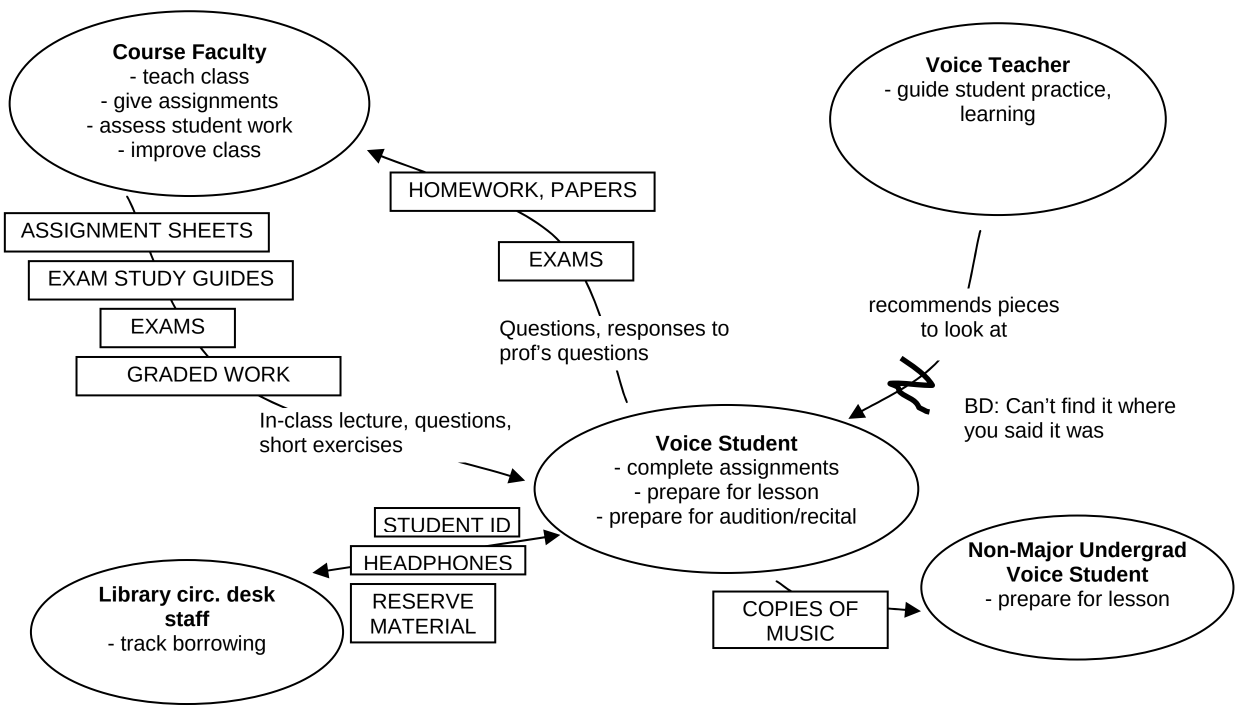


Figure 2. Consolidated Flow Model

As with the culture model, this flow model's relatively simplicity is due to the solitary nature of the observed activity. And again, it is the breakdown that is most interesting. In this case, we see that material known (or assumed) by one person may be unfindable by another. Two causes of this breakdown were observed. First, material may not be readily searchable using the terms in which people remember and describe it—looking for a particular singer may not work if works are cataloged using the name of the singer's ensemble rather than the individual performer. Second, it can be difficult to remember where materials reside—are they in the library or not?

*Physical Models.* A variety of consolidated physical models are possible, such as the arrangement of windows on a computer display, the library layout, or personal workspace. We show just one of these. Figure 3, the workspace, is illustrated with an annotated, mocked-up photograph taken in the actual carrels used by students. Usage of the workspace by students is remarkably uniform: students hold the auxiliary material (score, texts) in front of them, type with their arms lying across it, have a pile of other papers on their left (the right is kept clear for the mouse and the headphones cord) and use the shelves in front of them for other materials such as reference books. Backpacks are usually on the floor to the left of the chair. The carrels are uniformly sized, with no collaborative spaces available.

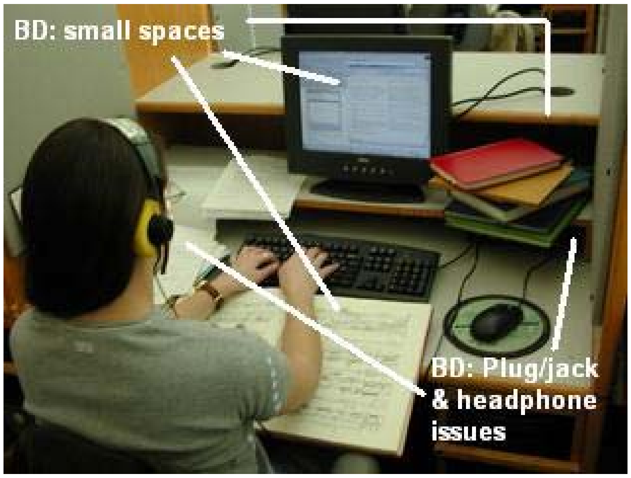


Figure 3. Physical Model: Library Computer Carrel

We noted several breakdowns in the physical environment:

- Headphones and headphone jacks sometimes do not work well. The ¼ inch jacks require students with their own headphones to buy and (more difficult) not lose a plug adapter.
- Sound quality is very important to voice students. They are also sensitive to background noise and to the sound leak from the open-ear headphones loaned by the library.
- The carrels, although capacious by some standards, are cramped work areas.
- During busy periods, students have to wait in line for a computer.

*Artifact Models.* In fact, multiple artifact models are needed: assignment sheets, completed assignments, graded assignments—these are the main artifacts. Space limitations preclude showing artifact models. The main breakdown associated with artifacts is that assignments were all paper-based. This introduced two difficulties: if a student forgets the assignment sheet, there is no way to retrieve it on line; second, long URLs and other text have to be retyped, sometimes introducing errors. The limited bibliographic data associated with Variations can be included in student deliverables via cut-and-paste, but the content (the recording) cannot easily be excerpted and used outside its context.

**Other Contextual Design Outputs**

*Affinity Diagram.* The CD process encourages capturing many "work notes" during modeling which are later turned into an affinity diagram. The affinity diagram is hierarchical, with the categories emerging from the low-level data. Starting with 138 total work notes, we ended up with five broad categories and one level of subcategories (Table 3).

Work note affinity diagrams are approximate, but they provide a fairly quick way of organizing a lot of information that does not always fit neatly into the more painstakingly constructed work models. Strangers to the project can use the affinity as an easy way to begin learning about at least one category of our users.

*Insights and Design Ideas.* The purpose of collecting and analyzing this mass of data is to arrive at useful insights into users, tasks, and contexts. Those insights in turn generate design ideas. Table 4 shows a sampling of the insights we gained. As the data reported in this paper are of necessity partial, some of the insights are from data or discussions not reported here. However, it is useful to show the full range of insights obtained.

Table 3. Top Two Levels of Affinity Diagram

1. The context I work in
   a. I have to work in a campus computer lab
   b. I have to learn the library
   c. Why I like Variations
   d. Problems I have with Variations
   e. I have to deal with my workspace
   f. How I manage my windows
   g. I have to manage lots of stuff
   h. I copy what I need
2. How I find
   a. How I find my tools
   b. I need the right song
   c. Search tools are clumsy and unforgiving
   d. I have to sift through results
   e. I try to find materials by browsing
   f. I use the web to find
3. Physical vs. Online Materials
   a. Why I won't/don't use physical materials
   b. Why I use physical materials
4. How I examine
   a. I need song length
   b. I have to assimilate lots of details
   c. How I decide what to sing
   d. How I prepare a song
5. What I have to do "for a piece of paper" [degree]
   a. [no subcategories]

Table 4. Insights and Design Ideas

| Insight | Design Ideas |
|---|---|
| It takes too long to find offline materials for short assignments. (This is perception…is it true?) | Locate computer carrels close to physical material, or push wireless and put tables near high-use materials. |
| Finding things serendipitously (by online browsing or shelf browsing—not equivalent) is important. | Provide a way to browse, not just search, the Variations2 collection. |
| The value of peripheral learning is not always realized by students. | |
| Public computers in library treat all users as first time users, offering them the same configuration choices, etc., each time they sit at a different machine. This is inefficient but accepted. | [This is well beyond our scope but can feed into design of future computer labs in the library.] |
| Web resources are very important, especially Google and recmusic.org. | Provide links within Variations2 bibliographic data to good external resources. |
| To plan recitals, users may want to listen to several recordings in order, either from same or different CDs. | Define comparison sets or collections. provide a way to define a list of songs/pieces from same or different containers, and listen to them in order. |
| Students sometimes need to retrieve all performances of a given piece. | Allow search results to list instantiations (performances) by a performer, sorted by date. |
| Singers do many library tasks in parallel—they might be listening, following along in score or text, taking notes, polishing a deliverable, and/or searching/browsing for additional information or new material. | Variations2 should support parallel, not just linear, activity. Is a specialized window organizer needed? |
| Students can copy and reuse Variations bibliographic, but the collection content (the recordings) are not readily reusable. | Bring up just one song, not the whole container. Provide a way to build and share personal collections of excerpts. Variations2 bookmarking moves in this direction but does not allow excerpt specification. |
| The composer's key isn't necessarily the singer's key. | For vocal works, indicate what keys work for different voice ranges. |

On the Variations2 development team, we have responded to the data in different ways depending on the nature of the finding. For example, after several observations demonstrated how important and challenging it was for participants to figure out song length, we immediately and easily added track length to the end of the track title in the Variations2 player. However, some ideas offer more fundamental challenges. Providing a way to retrieve all performances of a piece by date requires a substantial rethinking of the Variations2 search interface. It is not a quick fix, so it will be considered as a requirement for a future release. Similarly, including data on what keys work for different vocal ranges would require additions to our data model, changes to which ripple through several parts of the system.

It is the nature of contextual inquiry to generate data on a broad range of concerns, often much broader than we expect when we begin the study. We come up with ideas for new tools or new ways to organize the library's physical space. We pass the data and ideas along to other people who have an interest in the problems raised—library administration or faculty.

## Conclusions

### Where Variations "Fits"

Initially, we asked how Variations fits into the larger patterns of student library work. An examination of each consolidated model reveals the various dimensions of "fit."

*Sequence.* Variations is the tool of choice for "listening in detail" or doing the overview listening needed for the "collect and select" sequence. Variations is also useful for comparing performances and determining a piece's length.

*Culture.* Variations allows students to learn from the "community of famous performers" more extensively and efficiently than they would likely do if they had to use physical materials. But because the Variations collection is not comprehensive, the "community" may be artificially limited based on what faculty have chosen to place on reserve.

*Flow.* Recordings are put in Variations at faculty request and serve as reserve lists for classes. As a result, class assignments depend on Variations, often identifying specific recordings by their Variations URLs. Yet whenever possible, students also rely on Variations for assignments that do not identify recordings. Attempts to direct students to Variations material without providing a link or URL are potentially problematic.

*Physical.* Students can only use Variations at public computers in the music library. Thus they must deal with issues related to public access computer stations: availability, configuration, maintenance, limited work area, etc. Because Variations is a Windows-based application with a one-recording, one window model, and because students retrieve information from many online sources and use word processing tools, Variations lives on a complex, crowded desktop.

*Artifact*. Students often access Variations starting from paper. Only the (limited) Variations bibliographic data can be included in student deliverables, not the music itself. The content is "locked" in Variations; hence students must describe the content themselves but cannot illustrate their description with excerpts. Content cannot be collected easily and set aside for later use—it must be retrieved again.

Thus it has been possible to determine where Variations fits by looking at the broader context. Contextual inquiry forces us to lift our gaze beyond our small piece of software and grapple with its place in a user's full experience. While detailed analyses of software can uncover ease-of-use problems (cf. Blandford & Stelmaszewska, 2002), such analytical approaches cannot tell us much about usefulness.

**Physical vs. Online Materials**

*Deciding When to Use Which.* For recordings, online was the obvious choice and overwhelming preference. Participants exhibited visible dismay when the recording they were interested in wasn't available in Variations. The common explanation for this preference was the convenience and speed of online access. Participants were unwilling to request physical recordings for short assignments. For larger assignments, participants indicated plans to request recordings from the library or borrow recordings from other sources (dormitory CD libraries, friends with large CD collections). One participant spoke of plans to burn needed songs onto a personal CD using the library's CDs and music software. Apart from CDs, students may be losing familiarity with recording formats. One participant found a 78 RPM item in the catalog but was not familiar with that format.

For visual materials such as scores, song texts or librettos, or reference works, preferences were less clear. Online scores are still not common. The only observed computer-based score usage was from a participant's personally purchased copy of a commercial CD containing a score collection. Participants expected to have to find physical scores via the library catalog or shelf browsing.

On the other hand, song texts and librettos were regularly retrieved online. Participants used copy/paste to put a song text into a deliverable or to prepare to do a translation. In one case, finding an aria in a book was difficult because it was not indexed. Numerous resources are only available in books; participants were comfortable finding and using these—for longer assignments. For reference materials that were both online and on the shelf, preference seemed driven by familiarity and ease of access. One participant used the hardcopy *New Grove* dictionaries because he knew where they were; he didn't know how to access them online.

A lingering question is whether physical materials are as inefficient to retrieve as participants believe. Searching for online materials is not always fast or fruitful. With Variations, there is the potential for a several minute wait for the item to be copied to disk cache. An alternate hypothesis is that students don't want to get up and walk around the library more than they have to. Library carrels are a sometimes scarce and never secure workplace; it may well be that students are concerned about the security of their personal belongings and also do not want to "squander" a scarce resource—taking up a computer carrel but not sitting there. Another hypothesis is that online access "feels" more efficient even when it isn't.

*Non-Library Online Materials Usage.* Participants used non-library web resources extensively. For voice students, recmusic.org is well-known and heavily used. It contains a very extensive collection of art song texts and translations, and it can be searched and is indexed by title, composer, first line, language, poet, etc. Other web-based frequently used resources were Google, aria-database.com, and various commercial sites selling sheet music or scores.

**Assessing Contextual Design Work Modeling**

For solitary library-based learning activity, it is unsurprising that the culture and flow models are relatively sparse. Yet all model types have provided some amount of insight and provoked thinking about issues that might not otherwise have emerged from unstructured data. For example, participants did not mention feeling limited by not being able to excerpt Variations recordings, build a personal collection of them, or share them with others. This insight emerged from our design thinking based on the artifact model: creating artifacts is a process of taking raw material and turning it into something changed or new.

Some data of interest do not seem easy to capture in the existing work models and suggest the need to extend or adapt the models. The sequence model does not have a straightforward way of indicating the optionality of intents, or of showing the constraints that may determine whether a step is needed or not. For instance, if listening is for personal study and not a class assignment, some steps disappear (locate assignment, write assignment deliverable). While this can be modeled as two distinct sequences with separate triggering events, it would be more efficient to introduce a mechanism for indicating optionality based on constraints or personal preference.

The flow model describes how artifacts and communication move between people to accomplish work. But how does the work of individual learning occur? None of the models represents how learning occurs when students interact with library material. Insight into student learning likely requires a more detailed contextual inquiry than we conducted, examining student verbal reports of decisions and other thought processes. Yet had we gathered all that information—and we did gather some in the form of participants' notes and assignments—it is not clear where in these models we would represent such events as the dialog of students with their materials, the acquisition of skill, or the adopting of a perspective or cognitive framework. To represent learning, we likely need additional models whose constructs are grounded primarily in learning theory rather than in office-based work practice.

**Future Work**

This study produced a rich set of findings about where the existing Variations tool fit with student learning activities. It also yielded insights into how students decide between using online materials or physical materials. Finally, this example also suggested ways the Contextual Design models, developed in the context of information systems design, may need improvements to address the needs of learning technology design more effectively.

We plan to continue contextual inquiry into digital music library use, especially now that Variations2 has replaced Variations. We will continue to expand the variety of users and usages we study. Variations2 includes its own search interface as well as presentation of digitized scores, giving us new opportunities to explore the decision between using physical or online materials.

We also plan to explore methods compatible with the CD modeling approach that can capture data about how learning happens as students use digital libraries.

Contextual inquiry requires training and practice, is labor-intensive, and generates large amounts of data to interpret, model, and store. For researchers to be willing to use this method, they will have to be convinced of its value. A potential, largely unexplored value proposition is that CD models may permit meaningful, efficient comparisons between projects, enabling a core set of knowledge to be established. Having a core set of consolidated work models describing sets of teaching and learning activities might be quite valuable for instructional technology designers.

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**References**

Beyer, H., & Holtzblatt, K. (1998). *Contextual design : defining customer-centered systems*. San Francisco, Calif.: Morgan Kaufmann.

Blandford, A., & Stelmaszewska, H. (2002). Usability of musical digital libraries: a multimodal analysis. In *Proceedings of ISMIR 2002 Third International Conference on Music Information Retrieval* (Paris, France, October 2002, pp. 231-237), IRCAM – Centre Pompidou, Paris, France.

Dunn, J.W., & Mayer, C.A. (1999) "VARIATIONS: A digital music library system at Indiana University." *DL '99: Proceedings of the Fourth ACM Conference on Digital Libraries* (pp. 12-19), Berkeley, CA, August 1999. NY: ACM Press.

Holtzblatt, K., & Jones, S. (1993). Contextual inquiry: a participatory technique for system design. In A. Namioka & D. Schuler (Eds.), *Participatory design: principles and practice* (pp. 177-210). Hillsdale, NJ: Lawrence Erlbaum Associates.

Notess, M. (2004a). Applying contextual design to educational software development. In A.-M. Armstrong (Ed.), *Instructional design in the real world: a view from the trenches*. Hershey, PA: Idea Group Publishers.

Notess, M. (2004b). Three looks at users: a comparison of methods for studying digital library use. *Information Research, 9*(3).

Variations. (2005). Variations project website. Retrieved 12 October 2005, from http://www.dlib.indiana.edu/variations/

Variations2. (2005). Variations2 project website. Retrieved 12 October 2005, from http://variations2.indiana.edu/research/

# Student Reaction to a Spatial Alternative to Multiple-Choice Evaluation

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**Abstract**

*This paper presents an innovative software assessment instrument referred to as the Spatial Probability Measure (SPM). The instrument allows instructors to extend the multiple-choice testing method by allowing students to express their opinions on a continuum relative to available choices. Following a brief introduction to the SPM, the paper presents comments from students on their experiences. These comments highlight the potential benefits and limitations of using the SPM.*

## The problem with multiple-choice evaluation methods

Although efficient, multiple-choice assessment questions have a number of inadequacies. It is true that carefully designed questions have the capability of accurately assessing knowledge in most learning domains, even higher-order thinking (Haladyna, 1994), however, those indicators may miss much of the tacit-knowledge and self-knowledge that can inform an instructor on ways to improve and modify their instruction. By forcing students to select a single response to a question, instructors often reward students for guessing. Guesses, particularly guesses taken by a student skilled in test taking, may skew the feedback provided to an instructor.

In contrast, essay assessments force students to produce and construct a response. An essay may give an instructor an integrated and nuanced view of a student's knowledge base. Unfortunately, the time involved in evaluating essays may be prohibitive, particularly in classes with large enrollments. Further, technology has offered little assistance in improving the efficiency of essay evaluation. Thus instructors are forced to make choices when they select an evaluation technique. The technology described below is an attempt to provide instructors with an alternative that retains the efficiency of a multiple-choice test while expanding the range of data collected.

## Introducing the Spatial Probability Measure

The Spatial Probability Measure (SPM) is an assessment tool that presents multiple-choice style questions in a graphical manner. The software was adapted from the Admissible Probability Measure (APM) used in the PLATO IV computer-based instructional system (Bruno, 1987; Klinger, 1997; Landa, 1976). The SPM was created in Macromedia's Authorware™ and consists of a graphical triangle display presented to the learner through a web-browser. Each assessment question is embedded within this display. As demonstrated in Figure 1, the learners have the ability to place their cursor anywhere within the triangle, for example, in this demonstration case they are asked to give their opinion on their favorite color. Although the selection of color is a trivial application, the instrument can just as easily provide learners with an opportunity to express their opinion among any three choices. By using the SPM learners can express their opinion relative to the given choices, so no one alternative must be selected. For opinion related questions such as illustrated in Figure 1, learners can provide a nuanced response. For questions with a single correct answer the SPM provides the capability for expressing a level of certitude in one's answer, an important indicator of intellectual mastery (Mory, 1991).

Information on confidence and opinion is often difficult to gather and collate. It is hoped that this tool can allow instructors to quickly and efficiently gather a new set of data to inform their practice. By measuring the pixel distance from each corner to the point selected, one may record how strongly one feels about one's answer. Selecting a position directly in the center of the triangle may express the opinion that each of the available alternatives are believed to be equally as likely to be correct or, if the question is soliciting an opinion, then the choices are equally as likely to be appealing. Selecting a point closer to one corner demonstrates that a learner favors that answer relatively to the others. A working example and description of how to use the SPM is available at: http://oak.cats.ohiou.edu/~moored3/.

## Instructional uses of the Spatial Probability Measure

Besides the opportunity for an instructor to gather a detailed measure of a student's understanding, the SPM can provide students with critical information to inform their own metacognitive awareness. Metacognitive awareness depends upon a learner's ability to accurately and effectively monitor and their level of knowledge (Isaacson, 2004). Without this awareness students may feel that they know the material better than they actually do. The nature of traditional multiple-choice assessments may contribute to this feeling and thus reduce the perceived need for additional study. Isaacson (2004) states, “Clearly it is critical for students to know when they know and when they do not know, so they can engage or disengage in learning and adjust their learning strategies when the strategies do not result in mastery of the required material.” The SPM has been designed to remove the effects created by guessing. The SPM gives instructors a method for determining a learner's response certitude which can be a valuable asset in evaluating the success of instructional efforts.

It is hypothesized that points within the triangle can correlate a student’s response as being informed (point chosen closer to the “correct” answer”, uninformed (point chosen closer middle of the triangle) and misinformed (point chosen closer to the “wrong” answers) (Bruno, 1987; Moore, 2005). Each of these categorizations may be used to guide an instructional experience. Conceptualizations that are classified as “informed” may require only a brief visitation and review. Conceptualizations that are classified as “uninformed” may provide evidence that a student has no basis for making a choice and perhaps instruction should begin at a basic level. Perhaps most important for developing instructional material is the classification of “misinformed”, in this case, the student may likely have a misconception that may interfere with further learning and should be carefully “rooted out” (Moore, 2005; Zull, 2002).

### Student Response to the Spatial Probability Measure

Because the SPM instrument, implemented through the Internet, is a new configuration of the relatively obscure APM, there are a number of issues that are unresolved concerning this instrument’s effectiveness. Students’ reaction to the instrument provides a great deal of information as to its efficacy. Comments from thirty-nine students enrolled in a graduate level introductory instructional technology course were solicited. These students were presented with a web-based instructional module on trochaic poetry which was followed by fifteen questions presented in the SPM triangle format. The questions contained one correct example of trochaic meter along with two non-examples, usually consisting of iambic or dactylic meter. Instructional examples and assessment items were modified from those used in a study by Merrill and Tennyson, (1971). This subject matter was specifically chosen because it was unlikely that the students had any background in the subject. Students confirmed this unfamiliarity and reported uniformly low knowledge on the topic on a pre-survey.

Students were only asked for general comments; they could choose to comment on any aspect of the experience or were free to not comment at all. Comments ranged from discussing the subject matter to discussing the SPM instrument, however, only those comments highlighting the instrument are categorized and considered below.

### Student Comments

**Multiplicity of Answers**

- The triangle made the process a little better because I did not have to choose one answer, I could go between two or three answers.
- I liked how the program was able to measure the confidence in each (answer) and to show how much one answer was favored over another.
- I understand the instrument is used to show preference for a certain answer or more than one answer without expressing certainty. I liked the fact that if I could rule out one answer I could show that by putting my dot on the opposite side of the triangle between the other two answers. I'm not sure how teachers could use this instrument to assess whether students actually know the information, being able to rule out one answer or being torn between two answers doesn't show that the student necessarily knows what he's being expected to know. I think that this could be used to assess how much students know about a topic before it is studied because that is a time when definite answers aren't needed, just a general feel for what your students know and still need to learn.
- I understood how I was being assessed but I do not understand the poetry so it was a little frustrating. It was interesting how I could place the point between two answers I would like to see how exactly this would be looked at if all of my answers were in the middle of two options instead of deciding on one, how would you assess that person with this method. It was an interesting experiment.
- The instrument was very useful because I did not have to choose just one answer.

- Very interesting. I like being able to not give a one-hundred percent accurate answer.
- I think after awhile this could be helpful in answering questions.
- I understood the instrument real well. It helps you sort of break down what possibly could be the right without actually knowing.
- I understood the instrument and I think that it was good because many times I feel that I can't decide between two answers but I am leaning towards one. For an assessment over material like this (the poems and such) I think that this is very good, but maybe over more clear answers like the president one at the beginning it wouldn't be as successful. Anyways it is a good idea.

**Traditional expectations of multiple-choice instrument**

- The instrument was kind of confusing for me because I thought I was looking for the one answer that was correct. The triangle option was good with the colors because I like both red and blue but red slightly more then blue. However; when using the triangle as a tool for a question where there is one right answer I felt like I sometimes wanted to put it in the middle of the two that I thought it might be or if I thought only one was correct it seemed like I couldn't get the dot right on the correct point of the triangle. Depending on a person I think that could be confusing or misleading.
- I understood the instrument; I don't really like this more or less than multiple choice though. How would you grade something like this? I am really indifferent about it.
- I understood it, I think it could be valuable to assess kids in this way. It makes it more fair

**Encouraging indecisiveness**

- The triangle to answer questions made it slightly more difficult to make a definite answer because I was tempted to just choose the middle when I was unsure.
- I understood the instrument in that it allows you to express your confidence but I felt that it made me second guess my answer. I think if it was on a test that I understood the material previously that it may have some counterproductive effects. I may not be as confident in my answer and play it safe by putting the dot more towards the middle. Interesting though.
- I was less reluctant to pick an actual answer. Knowing that the option was available for me to be indecisive, I think that I was less sure then I would have been if I could have only chosen one answer.

**Interesting behavior**

- I noticed that my favorite color on the triangle corresponded with the majority of my answers on the poetry section.
- I liked it, but I think it would be hard to use it for a written test. It almost has to be used with a computer test.
- I like the instrument but it might be better tested in a subject more readily understood.

**Clarity of the instrument**

- Marking the spot in the triangle was understandable
- I understood the instrument and think it's a really novel idea.
- I feel like when I was given the choice of 3 and I could pick any space between them.

**Deficiency of the software trial**

- The ability to change your mind before submitting might be handy.
- The assignment was easy to understand; but time consuming. As a result; I lost interest by the end.
- Too many examples of using the triangle. I did not even look at the last five or six, I just marked the middle because I didn't know.

**Discussion and Classroom Implications**

Many of these students favored not being forced to select a particular answer. These positive comments may highlight the fact that a multiple-choice test is a particularly artificial type of assessment. Norman (1988) points out that the environment in which we apply knowledge provides an information-rich context that we react to and interact with; without these cues we often are less certain about our knowledge base than is commonly accepted. The students' comments may recognize the artificial nature of discrete responses.

The SPM instrument was new to the students in this demonstration and it is likely to be new to most students who encounter it. Like other instruments, such as Classroom Assessment Techniques (Angelo & Cross, 1993), learners require some degree of introduction, explanation, and perhaps training and experience to grasp the meaning and purpose of the instrument. While students are becoming familiar with an instrument such as the SPM, it may be best used informally and perhaps with the results being reviewed as an in-class group exercise. A productive implementation could be a classroom outfitted with a digital projector that displays the response triangle and a group of students' responses. Students can be asked to explain their selections and their assumptions regarding their responses. This approach may be able to clarify the students' intentions.

The comments revealed a certain uncertainty among the respondents concerning the SPM. It is likely that students have a preconception of what a legitimate assessment instrument looks like. Many students appeared not to understand the notion of a continuum of answers compared to the discrete responses required in multiple-choice tests. With this in mind, many students discussed a potential downside of the SPM. Many students expressed the opinion that the nature of the SPM encouraged indecisiveness; that it allowed them not to think carefully about the question. It remains to be seen whether this perception would endure once their experience with the instrument increases.

Based on these comments, the SPM instrument seems to hold he potential for further experimentation and investigation. The SPM has the potential to efficiently gather data that highlights a student's comprehension level in a unique way. Instructors and researchers are encouraged to test and try out the instrument in their own classrooms. Additional technical details, demonstration, and question templates are available at http://oak.cats.ohiou.edu/~moored3/SPM.

## References


Angelo, T., & Cross, P. (1993). *Classroom assessment techniques: A handbook for college teachers* (2nd ed.). San Francisco: Jossey-Bass Publishers.

Bruno, J. E. (1987). Admissible probability measures in instructional management. *Journal of Computer-based Instruction*, *14*(1), 23-30.

Haladyna, T.M. (1994). *Developing and validating multiple-choice test items.* Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Isaacson, R. M. (2004, Date?). *Effective and ineffective meta-cognitive knowledge monitoring in post-secondary education: The consequence of poor knowledge monitoring and a program to facilitate it*, Paper presented at the MWERA Conference, Columbus, OH.

Klinger, A. (1997). *Experimental validation of learning accomplishment*. Retrieved July 11, 1997, from ASEE/IEEE Frontiers in Education Conference Web site: http://fie.engrng.pitt.edu/fie97/1271.pdf.

Landa, S. (1976). *CAAPM: Computer-aided admissible probability measurement on PLATO IV*, DARPA #189-1, R-172-ARPA, March

Metcalfe, J. (1986). Feeling of knowing in memory and problem solving. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *12*(2), 288-294.

Moore, D. R. (2005). A software architecture for guiding instruction using student's prior knowledge. In M., Orey, M. A., Fitzgerald, & R. M., Branch, (Vol. Eds.), *Educational Media and technology yearbook: Volume 9 2005(pp.52-59).* Westport, CT: Libraries Unlimited.

Mory, E. H. (1991). The use of informational feedback in instruction: Implications for future research. *Educational Technology, Research and Development, 40*(3), 5-20.

Norman, D. (1988). *The design of everyday things*. New York: Basic Books.

Zull, J. E. (2002). *The art of changing the brain*. Sterling, VA: Stylus Publishing, LLC.

# Teaching and Learning for Performance: A Motivational Instructional Design Model for Improving Student Academic Achievement in a Hybrid Learning Environment

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## Introduction

The theory (Teaching and Learning for Performance – *TLF*) that has been formulated in this paper focuses on expositing the practical ways in which an instructional design model can be used to ascertain the achievement of increasing performance in instruction and learning in the domain of natural languages and other content-rich courses. College-bound and post-secondary learners are the primary focus of this theory.

Since the combination of perspectives or philosophies is an important aspect of the new paradigm of instructional theories, and as David Jonassen states, some of the best environments use combinations of methods (Reigeluth, 1999, p. 217), this theory's framework straddles the "broadly constructivist" theory of David Perkins and Chris Unger, and the cognitivist theory of Jerome Bruner.

This paper elaborates on the following topics:

- Definition of Instructional Design Theory
- The theoretical framework and precursors
- Design components
- Goals and preconditions
- Values

  Team work and Motivation of learners
  Learning in a mode that fosters unrestrained academic interaction and creativity learners
  Effective and efficient acquisition, construction and transfer of knowledge
  Cultural Diversity
  Preparation for Lifelong Learning
- Learners
- Content
- Environment/Medium of Delivery
- Teaching versus Learning Styles
- Instructional methods
- Assessment/Evaluation methods

## Conclusion

- Major contribution (s) of the theory in the domain of instructional design theories and models
- The future of instructional design theory

## Definition of Instructional Design Theory

As stated by Charles M. Reigeluth, instructional design theory is a theory that provides clear guidance on ways to effectively help people learn and develop (Reigeluth, 1999). This theory is concerned with ways that learners may be helped to obtain higher rates of success at the individual as well as at the group level.

## Theoretical Framework

In instructional design, **t**he subject (course) determines the theoretical tilt of the design. (cf. *Instructional Design and Learning Theory* http://www.usask.ca/education/coursework/802papers/mergel/brenda.htm#The%20Basics%20of%20Constructivism Additionally, task-based language teaching (which forms part of the language lesson content e.g. how to write a business letter) is concerned with communicative and **cognitive** processes" (*Approaches to Foreign Language Syllabus Design* http://www.ericdigests.org/pre-928/design.htm.)

As has been said, the focus of this theory is on language teaching and learning, and although Bruner (1983) has to do with language acquisition by young children http://tip.psychology.org/bruner.html, his instructional theory principles can be **adapted** to the instruction of older children.

Since therefore *TLF* theory hinges upon a principle of Bruner's instructional theory of cognitive development (*Instruction must be structured so that it can be easily grasped by the student (spiral organization*), and Howard Gardner's theory of Multiple Intelligences which applies to all ages (http://tip.psychology.org/gardner.html), design components appropriate for language instruction and learning have been identified in the process of developing this instructional design theory that is also derived from David Perkins' and Chris Unger's *Teaching and Learning for Understanding* (TfU) theory (*Knowledge construction, that is, understanding, requires performance*) which assumes a broadly constructivist perspective to instructional design (Reigeluth, 1999, pp. 91– 114)

**Design Components**

Robert Gagne originated systematic instructional design, analyzing learners and course goals to make objectives, sequence instructional experiences, set the medium of instruction, and assess student performance and the course *(*re: Judith V. Boettcher, Ph. D. http://vccslitonline.cc.va.us/usingweb/bckgrnd.htm). This systematic design of instruction has the primary goal of helping students learn.

**Goals and Preconditions**

The goal and precondition of this theory are to achieve the impartation of knowledge and to foster learning in a safe, caring, supportive and non-threatening but work-oriented and performance-provoking face-to-face and online environment.

**Values**

**Team work and Motivation of Learners**

Motivation through the use of collaborative learning segments, especially in the case of online portions of a course, is a possible way of reducing the attrition rates.

The Geese Illustration: The quality of support in teamwork and communication demonstrated by geese is worth emulating. This lesson from nature can be applied to support, and communication (transfer) of knowledge among learners. According to a scientific study, geese fly in a V formation (a principle employed by the *Tour de France* bicyclists) for reasons of efficiency. "It's called "drafting" -- **the geese** use the air currents created by the birds in front of them to fly more efficiently. The aerodynamic V shape reduces the air resistance, which lets the geese fly up to 70 percent farther than if they were flying alone. And since the bird at the front of the "V" encounters the most wind resistance, they all take turns at that position." (*Ask Earl*, http://yahooligans.yahoo.com/content/ask_earl/page?d=20020808). "Flying in a "V" also has social advantages: it allows birds to communicate with each other while on the wing." (*Bird flight explained***,** http://news.bbc.co.uk/1/hi/sci/tech/1608251.stm)

Responsibility (assignment of tasks that require a learner to be responsible to fellow learners, e.g. preparation of a presentation on a topic), interdependence and respect of others, and the boosting of each other's self esteem (while telling each other the truth about their performance when called upon to make peer evaluations) are ways of motivating learners to stay focused on learning.

Display, by the instructor, of all work accomplished by students, without showing the individual students' names, on a web page accessible to the public (parents, students, et al) with comments regarding what features made which work outstanding, and with the explanation that it is a method of encouraging learners to aim higher in their learning and performance.

Mid-Term Awards and End-of-Quarter Awards, etc. are additional extrinsic motivational factors. Further, r**esponsibility and boosting of self-esteem** could be achieved through cooperative learning http://www.jigsaw.org/overview.htm.).

**Learning in a mode that fosters unrestrained academic interaction and creativity among learners**

When learners feel safe to unveil their inadequacies of knowledge and ask "stupid" questions, they will learn from the correct answer offered by the instructor or by peers. The generation of knowledge could result under such circumstances.

**Effective and efficient acquisition, construction and transfer of knowledge**

The creation of a relatively relaxed learning atmosphere could foster the acquisition, construction and transfer of knowledge. This situation could be created through the removal of the threat of failure or the threat of the less-knowledgeable gaining grounds and out-performing the brilliant student - there is no harm if all students' performance is at a peak. However, healthy competition should be encouraged.

**Cultural Diversity**

With various parts of the world becoming multicultural through globalization, educators should recognize good aspects of "foreign" cultures. The literature texts could be enriched by drawing from this store. In H. Gardner's Multiple Intelligences, "each culture tends to emphasize particular intelligences" http://tip.psychology.org/gardner.html . Hence, the cultural context is a value in instructional design theory.

**Preparation for Lifelong Learning**

Students should be enabled to acquire the discipline of life-long learning which is facilitated by the Internet with its often overwhelmingly rich store of resources. Dewey, for example, claimed that education should enable individuals to continue growing all their lives intellectually, artistically and socially http://www.siu.edu/~deweyctr/a_short_annotated_reading_list.htm

**Learners**

The learners that are addressed in this theory are college-bound and higher education students.

**Content**

As has already been stated, the content for the design theory is natural languages and other content-rich courses. Conscious effort should be made to present instructional material in a form that facilitates storage and retrieval by learners.

**Environment/Medium of Delivery**

The courses are hybrid, that is, part face-to-face, and part online. The learning environment and the testing environment should be very similar so as to aid recall of subject-matter areas that are tested (re: )

**Teaching versus Learning Styles**

It is imperative that in the new instructional paradigm where instruction is learner-oriented (Reigeluth, 1999), teaching styles be predicated upon learning styles and on the learning goals.

**Instructional methods**

Learning styles-dependent, the instructional methods should be multivariate in nature in order to allow for a fair coverage of multiple intelligences (linguistic, musical, logical, spatial, kinesthetic, intrapersonal, and interpersonal) (Reigeluth, 1999). "A good teacher will incorporate activities in the classroom to facilitate learning for each of the seven intelligences." *A Collection of Theories and Theorists: an aid to the student of educational theory*. http://www.theshop.net/aboatman/edtheory.htm#Hunter. This makes it imperative that the instructor know his/her students.

Further, the graduation of tasks from simple to complex makes for the building of new knowledge on previous knowledge and allows for effectiveness and efficiency in teaching and learning. But we realize that sequencing may not always prove to be the best trail to follow as the students are guided through the twists and turns of the knowledge labyrinth. Spiral organization of the curriculum helps students continually build upon prior knowledge (cf. Constructivist Theory (J. Bruner) Overview http://tip.psychology.org/bruner.html

Even though Bandura states that we can learn novel behavior without any practice or direct reinforcement (Learning by observation), this theory posits that there are cases where practice (e.g. performance of a task with acquired skills (Reigeluth, 1999) aids memory and learning and this demonstration of knowledge through practice enables the instructor, the learner and the public to fully ascertain that the learner has understood the lesson. Thus, since, as Mayer states, "the instructional designer's role is to create environments in which the learner interacts meaningfully with academic material, including fostering the learner's processes of selecting, organizing, and integrating information" (Reigeluth, C. *Instructional-Design Theories and Models*,1999, p. 144), there has been a conscious effort made to ensure the proper functioning of this design for the purpose of facilitating and enhancing the learning process in a way that could spike learners' performance.

The responsibility, punishment and reward systems that have been put in place e.g. doing homework, filling out a progress chart and making graphs from it to see their learning curve periodically (with the help of the instructor), participation in team work, and Drill-and-Practice exercises accompanied by the instructor's open approval of students' good performance, disapproval or ignoring of student misbehavior if any, and disapproval and genuine show of concern and of disappointment at student poor performance if any, are such as are intended to encourage learning.

Retention of students' attention (e.g. by:

1. **abruptly** changing the **tone** of voice or
2. **periodically stopping** within the lesson to **ask a question** that requires a feedback from students to keep on course any whose thoughts may have wandered off) a key to fostering learning. The following activities can be included to make learning meaningful and interesting.

**Short story (used as an advance organizer):** Told by teacher or solicited from students, a short story, aptly used, can clarify the lesson (Reigeluth, 1999, p. 155).

**Questions** (including within-the-lesson attention retainers), **Quiz or Puzzle:** These can serve as lesson reinforcers.

**Video Shows:** Although the combination of words with other words can achieve much more than what images and acts can achieve, combining words with images and/or acts proves to be an even more powerful and productive strategy (cf. Bruner, 1964, p.2, cited in Driscoll, 2005, p. 229).

**Individual attention given to students:** This could be the answer to many students' learning needs.

**Reference to prior taught content:** The spiral nature of the lessons make for continuous retention of lesson content.

**Provision of Online Tutorials/Tutorial Software (CDs, DVDs, etc.):** They serve as untiring instructors**.**

**Online Quiz/Drill-and-Practice Software:** This is very useful for lesson reinforcement.

**Music**: For musical learners, the occasional putting of salient lesson points to music will help some learners in retention of the lesson (cf. Gardner's Multiple Intelligences, in Reigeluth, 1999)

**Poems:** The use of poems could also foster learning for the poetically-inclined.

**The "Listen-While-You-Read" Program with streaming audio or downloadable audio lesson segments** (cf. Audiobookshelf: http://www.audiobookshelf.com/eom_feb04.html ). This program has been found to be of immense help to students, helping them to read more and probably faster, in the case of slow readers. Audio design is needed for education to fully profit from its use in formatting educational content. Knowledge is needed regarding cognitive load and effective multimodal strategies (Sweller, 1988; Sweller, Merrienboer, & Paas, 1998; Mayer, 2001; cited in Barron, 2004). For example, embedded audio should be manipulable in the sense that learners should be able to adjust the volume or turn it off as needed.

**Drawings, maps, pictures, cartoons, illustrations, animations** (Reigeluth 1999, page 155). These bring the lesson to life, reinforce it and improve understanding, thus helping learners integrate knowledge. However, they and other graphics should not be redundant so as not to interfere with the retention of more relevant information (cf. Reigeluth. 1999, page 153)

According to Bandura, we store events in two ways-through visual images and through verbal codes.

**Worked-out Examples and Elaborative questions:** It has been proven that, students who received elaborative questions performed better in problem-solving and remembering lesson content (Reigeluth, 1999, p. 155).

**Color coding of text: This serves** to enhance the learning process (Erlauer, 2003; Hall & Sidio-Hall, 1994).

**Short-term Job Placements (Internship)** also help to reinforce educational content (cf. *Learning by Doing* theory of Instructional Design in Reigeluth, 1999, pp.161 – 181).

**Discussion among students** (face-to-face and online): Communication among students as well as between students and the instructor helps students get the lesson straight if they failed to do so when the lesson was first taught.

**Internet search** (it is hoped that the school's filters are effective):

Directed internet search where students are given precise instructions regarding the search (objectives are clear), instead of being let loose on a wild goose chase in the internet resource jungle. (cf. Jerome Bruner's learning theory, in http://vccslitonline.cc.va.us/usingweb/bckgrnd.htm) is an instructional method that can yield good fruits.

**Presentation by instructor:** Presentation by the use of software such as PowerPoint adds interest to learning. The use of powerful summaries by instructors and instructional designers in course materials will foster student learning.

**Team Teaching:** Most students who participated in a study believed eventually that team teaching fostered their understanding of the learning content (Hwang, Hernandez, & Vrongistions, 2002; Wenger & Hornyak, 1999, cited in Hwang, Hernandez, & Vrongistions, 2002).
**Preparation and Delivery of Presentations by students:** Students' performance can be openly and fairly confirmed.
**Preparation and Production by students of Movie Project** (under instructor's or a Subject-Matter Expert's supervision)
**Teaching of Specialized topics by a Subject-Matter Expert**: Engaging a subject matter expert (SME) to teach a specialized topic is a way of helping learners learn.
**Use of repetition and emphasis** (up to six different times if necessary) and summary cf. Mayer (1993, cited in Reigeluth, 1999, page 152)
**Use of analogies, synonyms and examples:** These help to make the lesson easier to remember (Reigeluth, 1999).
**"Concretization" of abstract information** through e.g. "picture words" and symbols in explanation
**"Accelerated Learning"** segments through the use of

1. Faster audio clips cf. audiotape use in Audiobookshelf: http://www.audiobookshelf.com/eom_feb04.html
2. Accelerated Writing (making students practice to write faster so as to liberate time for the completion of more learning and the demonstration of understanding through performance, thereby probably increasing learning outcomes).

**Flexibility**

Any of the above can serve as an entry point into the lesson (Reigeluth, 1999, pp. 8, 25)

**Assessment/Evaluation**

The use of multiple assessment methods helps to incorporate all learning styles, ascertaining the comprehensiveness of the assessment/evaluation:

1. Class work
2. Attendance and Participation in Class Discussions (face-to-face and online) (to test critical thinking skills)
3. Homework (to assess autonomy levels)
4. Team work (to test collaboration skills)
5. Project/Presentation (to test creativity, organization, evaluation, judgment)
6. Short-term Job Placement (to test performance in application environment. According to Dewey, what happens in the classroom should be an integral part of the activities of the wider community http://www.siu.edu/~deweyctr/a_short_annotated_reading_list.htm )
7. Student portfolio of reflection and products in course
8. Traditional method: Examination (multiple-choice, fill-in-the-blanks, open-ended questions)

**Grading rubrics** (should be made public to students, administrators, parents) to provide evidence of fairness and quality. Further, the rubric makes room for contingencies (unforeseen positive performance "surprises").

## Conclusion

**Major Contributions**

In the face of positive global development strides that have been taken in various areas especially in science and technology, efforts are being made in education to prevent the formation of a yawning gap between the "classroom" and "real life" in the society. This leads to the making of contributions in the domain of instructional design theory by instructional designers. Hence, following are this paper's contributions to instructional design theory:
**"Accelerated Reading and Writing"** could spawn novel levels of academic performance
**Creation of an environment to foster the sharing and hence the generation of knowledge** by learners due to the absence of the threat of the less knowledgeable outperforming those who freely shared knowledge.

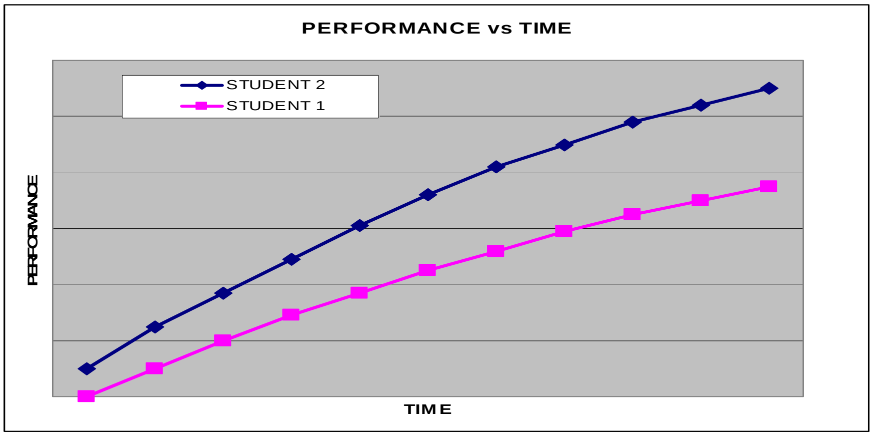
Formative evaluation of the theory will be carried out and the external validity of the research will be assessed.

**The Future of Instruction, Learning, Instructional Design and Assessment**

The enlargement and enrichment of the curriculum, a feature of the new paradigm of instruction, has implications for instructional design theories. Due to the growing body of knowledge about instruction

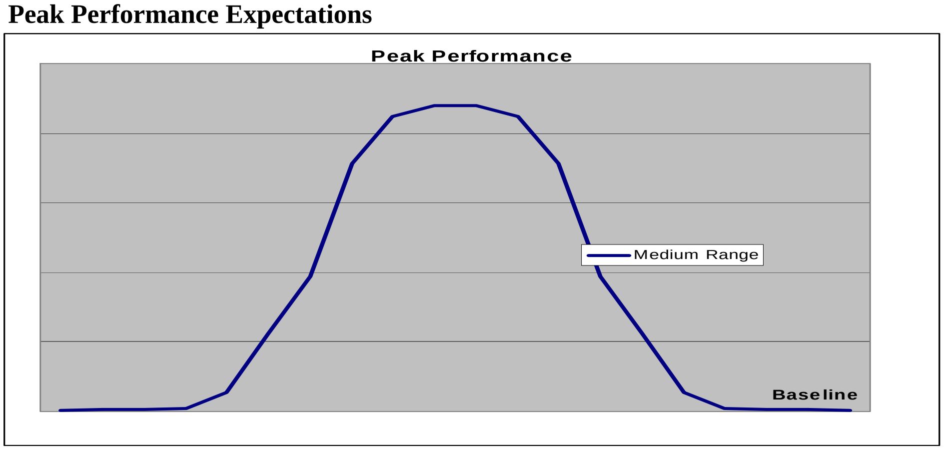
(Reigeluth, 1999) theorists have to rethink and bring forth theories that will be suited to the meaningful customization of instruction, for example. This development equally has major implications for professional development - instructors may have to relearn how to teach effectively and efficiently in the future classroom. The introduction of assessment options in training and higher education looks feasible already. Educators will have to set new performance standards and further adapt instruction to the needs of individual learners.

**Figure 1: Student Progress Information**



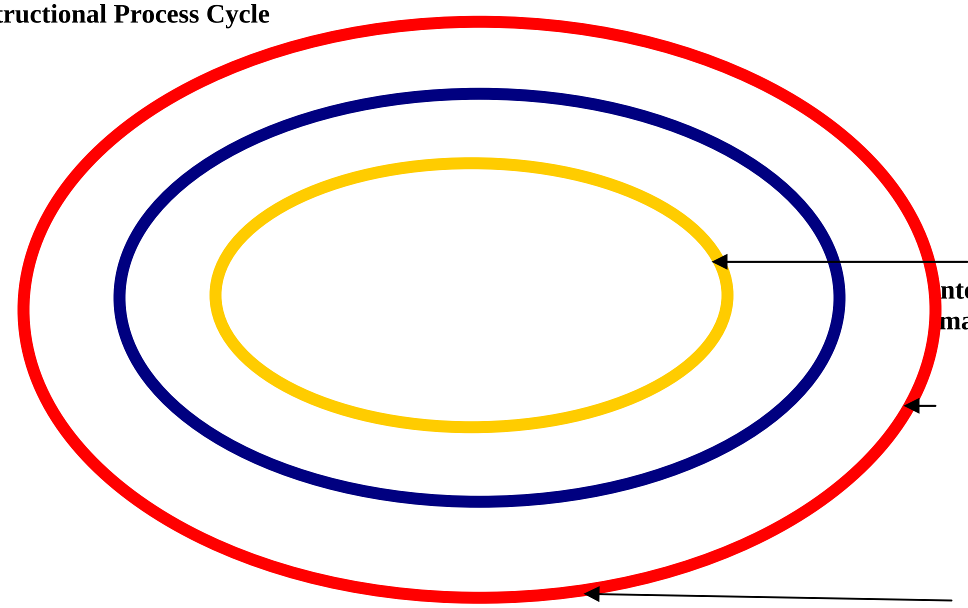

Each learner's starting point in a course should be noted in the chart in order to determine individual progress rate. The effect of differentiating instruction is variation in course completion time among students.

**Figure 2: Peak Performance Expectations**




Learners could also be motivated through the graphical representation of their performance in relation to the course objectives and peak performance expectations at various stages in the course.

**Figure 3: Instructional Process Cycle**



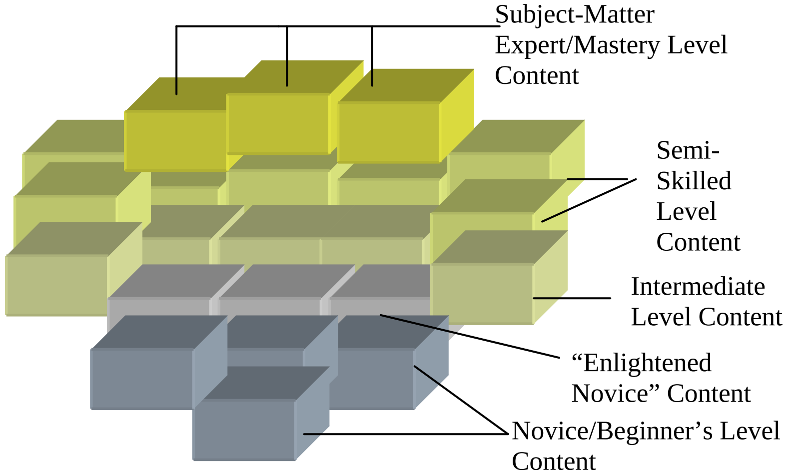

Instruction begins with a preliminary content summary, leading to entire course content presentation in units, and then ending in a summary of crucial course content.

**Figure 4: Motivational Instructional Design Model (Derived from Dick, Carey, & Carey, 2005 and Motivated Strategies for Learning Questionnaire, MSLQ):**

**Analysis of Learner and Instructor Characteristics and their goals for the course——— Environmental design**

**Course objectives and Expectations——— Content design (for differentiated instruction)——— Design of Motivated strategies for instruction and learning——— Assessment instruments design——— Evaluations (formative and summative)**

**Figure 5: Teaching and Learning for Performance (TLP) Design Model for Content**




## References


A Collection of Theories and Theorists: http://www.theshop.net/aboatman/edtheory.htm#Hunter Retrieved in October/ November, 2004.

"Audio Bookshelf". http://www.audiobookshelf.com/eom_feb04.html and http://www.audiobookshelf.com/listen.html Retrieved in October/ November, 2004.

Barron, A. E. (2004). Auditory instruction. In D.H. Jonassen (Ed.). *Handbook of research on educational communications and technology*, (2nd ed., pp. 949-977). Mahwah, NJ: Lawrence Erlbaum Associates.

Constructivist Teaching And Learning Models. http://www.ncrel.org/sdrs/areas/issues/envrnmnt/drugfree/sa3const.htm Retrieved in October/ November, 2004

"Creating Better Student Assessments" *Improving America's School: A Newsletter on Issues in School Reform- Spring 1996* http://www.ed.gov/pubs/IASA/newsletters/assess/pt1.html Retrieved in October/ November, 2004

"Critical Issue: Providing More Time for Professional Development". http://www.ncrel.org/sdrs/areas/issues/educatrs/profdevl/pd600.htm Retrieved in October/ November, 2004

Dewey http://www.siu.edu/~deweyctr/a_short_annotated_reading_list.htm Retrieved in October/ November, 2004.

Driscoll, M. (2000). *Psychology of Learning for Instruction* 2nd Ed.). Boston, MA.: Allyn and Bacon.

Hwang, Y. S., Hernandez, J., & Vrongistions, K. (2002). Elementary teacher education students' perceptions of team teaching. Education 123, 2, 246 – 252, 288.

Erlauer, L. *The Brain-Compatible Classroom: Using What We Know About Learning to Improve Teaching.* ASCD.

Hall, R. H., & Sidio-Hall, M. A. (1994). The effect of student color coding of knowledge maps and test anxiety on student learning. *The Journal of Experimental Education*, *62*, 291-302. (Abstract only).

Learning Guides. *John Dewey: His Life And Work*, with Larry Hickman, PhD. http://www.davidsonfilms.com/dewey.htm Retrieved in October/ November, 2004.

Learning theories of instructional design. http://www.usask.ca/education/coursework/802papers/mergel/brenda.htm

McGraw-Hill Higher Education. *Social learning theory of Albert Bandura* http://www.mhhe.com/socscience/comm/bandur-s.mhtml#5 Retrieved in October/ November, 2004.
Montessori, Maria http://www.webster.edu/~woolflm/montessori.html and http://www.ccma.ca/ccma/aboutmon.htm Retrieved in October/ November, 2004.
Motivated Strategies for Learning Questionnaire http://www.ulc.arizona.edu/quick_mslq.html Retrieved on 10/14/05
Pathways to school improvement http://www.ncrel.org/sdrs/ Retrieved in October/ November, 2004.
Perkins, D., & Unger, C. (1999). In C. Reigeluth (Ed.), *Instructional-design theories and models: A new paradigm of instructional theory*. Mahwah, NJ: Lawrence Erlbaum Associates
Reigeluth, C. (1999). *Instructional-design theories and models: A new paradigm of instructional theory*. Mahwah, NJ: Lawrence Erlbaum Associates
*Some performance assessment techniques*. gopher://vmsgopher.cua.edu/00gopher_root_eric_ae%3A%5B_alt%5D_techn.txt Retrieved in October/ November, 2004.
Teaching Methods Resources: http://www.mhhe.com/socscience/education/methods/resources.htm Retrieved in October/ November, 2004.
"What Are Promising Ways to Assess Student Learning?" *Improving America's School: A newsletter on issues in school reform*- Spring 199.6 http://www.ed.gov/pubs/IASA/newsletters/assess/pt3.html Retrieved in October/November 2004

# Instructional Design Theory for Integrating Learner-Centered Perspectives into Entirely Web-Based Courses in Higher Education

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**Abstract**

*This study developed an instructional design theory to provide theoretically sound, practical guidelines that incorporate learner-centered and collaborative approaches into entirely Web-based ESL pragmatic courses. The formative research methodology was used to create and refine the design theory. The initial theory was developed inductively based on various resources. For the theory refinement, the prototype model was formatively reviewed by experts invited from related fields. The refined design theory identifies instructional values and instructional conditions and suggests instructional methods.*

## Web-Based Instruction in Higher Education

Internet technology continues to accelerate the growth of distance education in higher education (Molenda & Harris, 2002; NEA, 2000). According to a survey of the National Education Association (2000), 90 percent of higher institutions offered distance courses and programs and the Web is the most used delivery mode for distance courses (44%). Advocates note that the Internet makes education more flexible and accessible for traditional and non-traditional learners (Web-based Education Commission, 2000) and its technology-rich environments create dynamic instructional contexts that are different from traditional classrooms (Kahn, 2001). Research has also shown that the Internet has the potential to promote interactivity (Polin, 2004), foster higher-order thinking skills (Bonk & Cummings, 1998), and promote social interaction among participants (Oren, Mioduser, & Nachmias, 2002).

However, teaching online is a challenging task to many faculty accustomed to traditional teacher-led approaches (Ko & Rossen, 2004; Palloff & Pratt, 1999). Many qualified faculty hesitate to participate in it (Betts, 1998; Schifter, 2000). When asked about barriers inhibiting their participation in distance education, faculty rank the lack of guidance for pedagogy in designing instruction as one of the barriers for their willingness (Park, 2004). Furthermore, there are some misconceptions about teaching online. Some faculty and administrators are misinformed that there is no difference in practice between face-to-face courses and Web-based courses (Hill, 1997). This misinformation leads them to transfer the lecture-based teaching pedagogies to teaching Web-based courses (Knowlton, 2000). Often, it is observed that intuition or tacit knowledge is used to design online courses without considering critical components of Web-based instruction (e.g., course content, pedagogical value of the instructor, the characteristics of learners, and learning context) (Garrison, 2000; Taylor, 2002).

Another concern is that for the design of Web instruction, instructors tend to choose software packages based on their low cost or availability (Cyrs, 1997; Palloff & Pratt, 1999). Bonk and Dennen (2003) note that most e-learning tools provide "templates and guidelines for warehousing students and providing static course material" (p. 332). Duffy and Jonassen (1992) attribute the static design to objectivist principles on which current instruction is typically based. Such design principles cannot utilize the potential the Web affords and generate low interactions, boring classes, and arbitrary schedules that result in decreasing students' motivation and increasing the dropout rate of the course (Update, 2002).

To overcome the problems, researchers propose new pedagogical approaches for Web instruction design that support major skills, such as collaborative knowledge construction, learner initiative, and reflection (Oliver & McLoughlin, 1999). Reigeluth (1999; 2003) draws attention to the need for the new paradigm of instruction to meet the demands of a rapidly changing society (the information age). He calls for new instructional design guidelines to foster abilities, such as creative, self-regulated, and collaborative competences with critical thinking skills and problem solving skills.

## Web-Based Instruction in the ESL Field

Since the Internet was introduced to the English as a Second Language (ESL) field as a new instructional medium in the 1990s, teaching and learning – that mainly took place within a classroom alienated from the actual use of native speakers of English – have changed. Web-based instruction has supported instructors in creating authentic and collaborative learning contexts for more dynamic language learning (Kramsch, A'Ness, & Lam, 2000). Long and Richards (2000) claim, "Because computers have opened up new opportunities for communication between both learners and teachers and among second language users themselves, many language teachers see great potential in computer mediated teaching and learning" (p. ix). Learners also take advantage of the Internet in ways that were not possible before. They can have access to myriad resources related to course content from remote locations around the world. Web-based instruction as an open system allows learners with more room for consulting outside experts. Classroom activities are no longer limited to interaction with peer students in the class (Kern & Warschauer, 2000). Kern and Warschauer claim,

> If our goal is to help students enter into new authentic discourse communities, and if those discourse communities are increasing located on-line, then it seems appropriate to incorporate on-line activities for their social utility as well as for their perceived particular pedagogical value (p. 13).

Citing Kramsch et al (2000), Reynard (2003) emphasizes, "Use of an electronic medium, such as the computer, to teach language has developed a greater need and expectation of authenticity and authoring on the part of the learner" (p. 7). It is important to note that authenticity, authoring, and active learner participation in Web-based language learning environments cannot be achieved by the use of traditional teacher-led approaches, which are viewed as problematic since teacher dominance, passive students, lack of authentic inputs and interactions, and unnatural communications cannot foster students' use of language in a meaningful way (Kasper, 1997; Meskill & Ranglova, 2000). Levy (1990) claims, "Our teaching philosophy, method, or approach needs to be broadened to encompass new technologies and the interrelationship between language teaching and computing needs to be carefully explored" (p. 5).

## Needs of Instructional Design Theory

However, despite the expansion of online courses and the growing need for instructional frameworks and guidelines, a dearth of knowledge about online pedagogy and few design theories for an entirely Web-based ESL course have been developed. Egbert, Chao, and Hanson-Smith (1999) note, "Although most CALL[22] texts are themselves technology driven, that is, organized around the types of activities computers are able to do, few have spoken to the need for a specific framework based on the best of second language acquisition (SLA) research." (p. ix). Furthermore, it is observed that some guidance for Web-based language learning is still descriptive or overlooks some critical elements that have been consistently emphasized in the education and WBI fields.

To take fully advantage of Internet technology, researchers should pay attention to a new paradigm of instruction for online language teaching and learning and address critical issues to answer the question of how to integrate Web technologies most effectively and most efficiently into Web-based language learning courses (Kern & Warchauer, 2000). Therefore, it is important to create an instructional design theory to provide practitioners with theory-based and practical design theory to achieve better learning outcomes (Reigeluth, 2003).

## Purpose of the Study

The purpose of this study is twofold. First, this study explores how learner-centered instructional approaches and Internet technology can be incorporated into ESL language courses (more specifically, English pragmatic courses) and what issues should be addressed to help instructors plan and teach online courses. Pragmatic competence refers to a speaker's ability to use English form and meaning appropriately in a given context (Canale, 1983; Hymes, 1972). It is related to a speaker's competence "to effectively address issues of politeness, formality, metaphor, register, and culturally related aspects of a target language" (Carel, 1999, p. 11). Pragmatic competence of ESL learners is considered as important as grammatical competence for successful communication (Kasper, 1997). However, research on pragmatics mainly focuses on "detailed descriptions of realization strategies for perhaps eight speech acts in a variety of situations" (Cohen & Olshtain, 1993, p. 34), while the design of instruction for pragmatics has received little research attention, and few design theories have been created to develop learners' pragmatic competence. Although knowing pragmatic theory and research is important for instructors to decide what to

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teach (Kasper, 1997), the descriptive nature of pragmatic theory makes it difficult for practitioners to apply it to their instructional problems and identify methods for a specific situation (Reigeluth, 1999). Prescriptive instructional design theory, which focuses on methods of instruction, is necessary to offer pedagogical guidelines for the design of online ESL pragmatic courses.

For the second purpose, based on interview data, analysis of pragmatic lessons, the researcher's experiences, and a broad review of literature, this study is intended to create an instructional design theory which provides faculty in higher education with practical guidelines to incorporate user-centered and collaborative learning approaches into their entirely Web-based courses. These pedagogically sound strategies support the target audiences to design Web-based instruction to increase ESL learners' pragmatic awareness and assist them in engaging students in their learning process and improving their learning outcomes. The function of new instructional and communication technology is empowered by this design theory.

**Learner Centered Perspectives**

For this study, the learner-centered perspective is selected as a design approach to develop a new instructional design theory. As a researcher who tries to find better ways to facilitate learning, the researcher would rather take pragmatic and eclectic approaches. That is, the goal of this research is to draw useful methods from diverse theoretical perspectives to achieve stated learning goals (Reigeluth, 1992; 1999). For this study, the learner-centered perspective does not refer to one specific educational perspective or philosophy or set of principles. Rather, it refers to a movement started by many researchers who raised questions about the instructional effectiveness of traditional teacher-led approaches (APA, 1997; Bonk & Cunningham, 1998; Bransford et al., 1990; Cuban, 1993; Duffy & Jonassen, 1992; Freire, 1972; McCombs, 2001;Reigeluth, 1999; Perkins, 1992; Wagner & McCombs, 1995). From their perspectives, it is viewed that the learner-centered approaches place learners and their learning in the center of the instruction, value learners' needs, and emphasize learning and their active roles in their learning processes.

Reigeluth (1999) discusses learning-focused instruction as a new paradigm of education in contrast to sorting-focused instruction as an old paradigm of education. He pays attention to changing needs of the new society by delineating the key markers of the industrial age and the information age. According to Reigeluth, the current system of education is based on standardization, conformity, and the parts-oriented paradigm of the industrial age, and it fails to prepare students for new abilities that the information age requires, such as problem solving skills, collaborative learning skills, and self-regulated skills.

The two approaches (traditional and learner-centered) are incompatible perspectives in terms of learning and the way each perspective fosters learning. The traditional approach, grounded in the objectivist philosophy, assumes that knowledge can be transferred from teachers to students (Duffy & Jonassen,1992). In class, instructors focus on the delivery of predetermined knowledge and help students to master the knowledge. The types of learning that instructors teach are mainly knowledge and understanding levels. During the learning process, instructors have the authority to decide and control course content, objectives, strategies, and assessment for students (Wagner & McCombs, 1995). At that time, learner differences and needs are often overlooked for logistical and economical purposes (Reigeluth, 1999).

In contrast, learner-centered approaches, which are highlighted by the Learner-Centered Psychological Principles of American Psychological Association (APA), show different perspectives from traditional approaches. The APA's learner-centered principles provide "a knowledge base for understanding learning and motivation as natural processes that occur when the conditions and context of learning support individual learner needs, capacities, experiences, and interests." (McCombs, 2001, p. 185). The fourteen learner-centered principles are categorized into four domains: metacognitive and cognitive factors; affective and motivational factors; developmental and social factors; and individual difference factors. The metacognitive and cognitive factors draw attention to the importance of knowledge construction through nurturing meaningful experiences, goal-directed and self-regulated learning, strategic learning skills, higher-order metacognitive strategies, and supportive learning contexts. To accomplish these learning goals, the principles focus on instruction which promotes student motivation, reflects individual differences in learning, and nurtures social interactions.

Learner-centered approaches can be summed up as follows: in a learner-centered classroom, learners are no longer passive recipients of decontextualized skills and knowledge transmitted by instructors. They are encouraged to be active participants, co-producers, and disseminators of knowledge in their learning process. Instruction helps learners learn through interactions with peers, instructors, and experts. They, as a group, engage in tasks which are more personally relevant to them. At this time, instruction promotes learners' curiosity and intrinsic motivation to help them link new information to what they already know. As a result, shared knowledge is generated and disseminated among members. Traditionally an instructor is the only one who has authority over the instructional process. In a learner-centered classroom, learners are asked to bring their own needs and experiences, and instructors address their needs in instruction and strategies to promote learners' ownership and responsibility for learning. As a result, the learner-centered perspective creates more meaningful and dynamic environments.

Researchers advocate that learner-centered instructional techniques embedded in Web based instruction have many benefits (Bonk & Cummings, 1998; Miller & Miller, 2000; Warchauer, 2000). They argue that it generates authentic learning environments that help engage learners in personally meaningful activities and provide instructors with a variety of methods to accommodate individual student learning styles and needs. For instance, Bonk and Cummings (1998) used APA principles to design and implement Web-based educational psychology courses offered to preservice teachers at Indiana University. They report that learner-centered pedagogical activities used in the course support student participation, foster student thinking skills, problem solving abilities, teamwork, and social interaction and debate. They also state that the approach helps students to have opportunities to experiment with their instructional ideas and reflect on the teaching and learning activities they observe from field experiences. From the experiences, they suggest 12 recommendations for Web-based instruction. Their guidelines include:

> establishing a safe learning community, fostering student engagement, giving students choice, facilitating learning, offering public and private feedback, apprenticing student learning, employing, recursive assignments, utilizing electronic writing and reflection activities, building on student Web link suggestions, providing clear expectations and prompt task structuring, evaluating student electronic work, and personalizing learning as technology advances (p. 82-89).

As presented, learner-centered perspectives and Web technology have the potential to work synergistically to overcome the limitations of teacher-led approaches. Considering that the goal of this research is to design a Web-based guideline for developing students' pragmatic awareness, methods that encourage rote memorization of facts and rules cannot turn learners into successful language users (Kern & Warchauer, 2000; Reynard, 2003). Providing natural and meaningful interactions in an authentic context should be the key conditions for the course design.

## Methodological Process

This research started with a pilot study in which the researcher interviewed language instructors and faculty teaching English, Spanish, or French to second-language learners in higher education in the United States. The interviews helped the researchers to understand the current face-to-face instructional language learning situations (including ESL pragmatic learning) and their interests and concerns about the use of Web-based instruction for their courses. The interview data showed that there were some constraints for the current face-to-face classrooms to develop learners' ESL pragmatic skills. The limitations were linked to the current curriculum, time, lack of knowledge of methods, inappropriate ESL textbooks, passive students, and lack of interactions in terms of authenticity, quality, and quantity. When asked, many instructors showed their interest in WBI and willingness to participate in teaching online if the chance were available, whereas some of them expressed concerns about a few pedagogical guidelines, their technology skills, and lack of interactions among participants in Web-based courses.

In response to these needs and concerns, this research study has developed this IDT from the learner-centered instructional perspective to assist instructors to integrate Web technology and resources into their entirely Web-based ESL courses.

Creation of this IDT has been guided by the five-stage theory development process of the formative research methodology (Reigeluth & Frick, 1999). The process included the following phases:

(1) Create a case to help generate the design theory

In this phase, the case included the design of the online pragmatic course (one-credit, supplementary English course for graduate and undergraduate students) and the IDT side by side. The initial IDT has been developed inductively based on various resources: interview data from ESL faculty and instructors, analysis of university ESL pragmatic lessons, the researcher's teaching experiences, and a broad review of theory and research findings from learning theory, instructional design theory, Web-based learning, second-language acquisition, and second-language pragmatics.

(2) Collect and analyze formative data on the instance

For the theory revision, seven experts from WBI teaching and design and second language education, including the TESOL, Spanish, and Italian language fields, were invited to review the IDT and asked to make suggestions for ways of refining it. Multiple data collection rounds were used until the researcher obtained consistency of results among participants.

(3) Revise the instance

The initial prototype model was revised based on the formative data from the expert review.

(4) Repeat the data collection and revision cycle

The second and third rounds of the data collection and revision were conducted.

(5) Fully develop the tentative theory

Based on the data from the expert review, the initial theory has been revised and finalized.

**Outline of the Initial IDT**

This initial IDT consists of the key components of instructional design theory suggested by Reigeluth (1999): (1) instructional conditions, (2) instructional values, and (3) instructional methods. The instructional conditions of this IDT include the content to be learned, learner's and instructor's characteristics, and learning environment and constraints. The values of this IDT include: (1) learner-centeredness, (2) customized learning, (3) dynamic learning through collaboration, and (4) supportive and respectful relationship.

The method sections of the initial IDT are structured by four key design methods, which provide detailed sub strategies and guide users to decide when to use and how to use the suggested strategies for a supportive, authentic, collaborative, and customized learning experience. The first design method aims at providing technological, pedagogical, and social supports to help students to acclimate to new instructional environments. The second design method suggests means to utilize Web resources as authentic materials and to structure activities to be situated in real world contexts. The third design method concerns strategies for fostering collaborative learning through a sense of community among participants and the use of synchronous and asynchronous activities. The forth design methods suggests a means to nurture learner control and motivation.

**Findings and Revisions from the Expert Review**

The initially developed IDT was tested formatively by seven experts representing WBI and second-language education fields. Through multiple data collection rounds, the researcher was able to obtain constructive comments and suggestions about the initial theory. The identified weaknesses of the methods have been addressed as follows (Table 1).

Table 1 *Findings from the Expert Review and Subsequent Modifications*

| Category | Identified Weaknesses & Modifications |
|---|---|
| Issues on Methods | ➢ Clarify the learner-centered perspective used in this IDT.<br>➢ Suggest methods maximizing customized learning while dealing with instructors' workload and students' concern for grading.<br>➢ Promote authentic and elaborate inputs and also caution against challenges in using authentic resources.<br>➢ Address the development of the verbal pragmatic competency.<br>➢ Recommend multi-evaluation strategies to handle issues, such as free-riding, inactive participation, and complaints about grading.<br>➢ Incorporate mid-term evaluation to identify students' perceived problems and attitudes towards instruction during the semester.<br>➢ Reemphasize the importance of ground rules in order to increase mutual understandings between students and instructors about the course.<br>➢ Highlight methods promoting meaningful interactions and collaborations among participants.<br>➢ Reemphasize the importance of learning community and the benefits of synchronous communication to foster a strong sense of community.<br>➢ Suggest new tools for fostering synchronous communications. |
| Issues on Organization, Clarification, | ➢ Increase connections between the suggested methods and ESL pragmatic learning contexts, and focus the connection among the three key design methods of this IDT. |

&Redundancy

- Provide additional information related to the background of this IDT and field-specific terminologies.
- Clarify ambiguous wording and structure.
- Remove redundant and overlapping components and methods.

**Outline of the Revised IDT**

The framework of the IDT remains unchanged. It consists of instructional conditions, instructional values, and instructional methods. In contrast, some parts of the methods section have been changed significantly to increase links between the key design methods and the focused learning contexts and to elaborate the initial methods. The first key design method concerns learning strategies that help students to acclimate to new online instructional environments that are different from typical face-to-face teacher-led classrooms. The second key design method presents sub-strategies for enhancing ESL pragmatic learning, including: (1) choose appropriate topics and tasks which are closely linked to ESL learners, (2) use authentic resources, (3) promote interaction and collaboration, (4) provide constructive and timely scaffolding and feedback, and (5) use multiple assessment strategies. The third key design method recommends a means to nurture learner control and motivation promoting independent and motivational learning in Web-based environments.

Future users of this IDT are strongly encouraged to adapt it to accommodate their unique instructional situations considering special needs of students and their current levels of understanding and performance. Users' active modification will contribute to make this IDT more usable and practical.

**References**

Betts, K. S. (1998). Factors influencing faculty participation in distance education in postsecondary education in the United States: An institutional study. Ph. D. dissertation. The George Washington University.

Bonk, C. J., & Cummings, J. A. (1998). A dozen recommendations for placing the student at the center of Web-based learning. Educational Media International, 35 (2), 82-89.

Bonk, C. J., & Dennen, V. (2003). Frameworks for research, design, benchmarks, training, and pedagogy in Web-based distance education. In M. G. Moors & W. G. Anderson (Ed.), Handbook of distance education (pp. 331-348). Mahwah, NJ: Erlbaum.

Carel, S., (1999). Developing awareness of French pragmatics: A case study of students' interactive use of a foreign language multimedia program. Journal of Educational Computing Research, 20 (1), 11-23.

Cyrs, T. E. (Ed). (1997). Teaching and learning at a distance: What it takes to effectively design, deliver, and evaluate programs. Jossey-Bass Publishers.

Duffy, T.M., & Jonassen, D.H. (Eds.) (1992). Constructivism and the technology of instruction: A conversation. Hillsdale, N.J: Lawrence Erlbaum.

Egbert, J., Chao, C. C., & Hanson-Smith, E. (1999). Computer-enhanced language learning environments: An overview. In J. Egbert & E. Hanson-Smith (Eds.), In CALL environments: Research, practice, and critical issues (pp. 1-13). Alexandria, VA: TESOL.Alexandria, VA: TESOL. interviews. New York: Academic Press, Inc.

Garrison, R. (2000). Theoretical challenges for distance education in the 21st century: A shift from structural to transactional issues. International Review of Research in Open and Distance Learning, 1(1). Retrieved 2005 from the World Wide Web: http://www.irrodl.org/content/v1.1/randy.pdf.

Kasper, G. (1997). The role of pragmatics in language teacher education. In Bardovi-Harlig, K. & Hartford, B. S. (Eds.) Beyond methods: Components of language teacher education (pp. 113-136).

Kern, R., & Warschauer, M. (2000). Theory and practice of network-based language teaching. In M. Warschauer & R. Kern (Eds.), Network-based language teaching: Concepts and practice (pp. 1-19). New York: Cambridge University Press.

Khan, B.H. (1997). Web-based instruction (WBI): what is it and why is it? In B. H. Khan (Ed.), Web-based instruction (pp. 5-18). Englewood Cliffs, NJ: Educational Technology Publication.

Knowlton, D. S. (2000). A theoretical framework for the online classroom. In R. D. Weiss & D.S.

Knowlton & B. W. Speck (Eds.), Principles of effective teaching in the online classroom. V84. (pp. 5-14). San Francisco, CA: Jossey-Bass, Inc.

Ko, S., & Rossen, S. (2004). Teaching online. A practical guide. Boston, MA: Houghton Mifflin Co.

Levy, M. (1990). Towards a theory of CALL. CALL Journal, J (4), 5-7.

Meskill, C. & Ranglova, K. (2000). Sociocollaborative language learning in Bulgaria. In M. Warschauer & R. Kern (Eds.), Network-based language teaching: Concepts and practice (pp. 20-40). New York: Cambridge University Press.

Molenda, M, & Harris, P. (2001). Issues and trends in instructional technology in Branch, R. & Fitgerald, M. A. (Eds). Educational Media and Technology Yearbook. Englewood, CO: Libraries Unlimited.

National Education Association (NEA). (2000). A survey of traditional and distance learning higher education members.

Oliver, R., & McLoughlin, C. (1999). Curriculum and learning-resources issues arising from the use of web-based course support systems. International Journal of Educational Telecommunications, 5(4), 419-436.

Oren, A., Mioduser, D., & Nachmias, F. (2002). The development of social climate in virtual learning discussion groups, International Review of Research in Open and Distance Learning. Retrieved September, 2003, from: http://interact.hpcnet.org/webcommission/index.htmhttp://www.irrodl.org/content/v3.1/mioduser.html

Palloff, R., & Pratt, K. (1999). Building Learning communities in Cyberspace. Jossey-Bass Publishers. San Francisco.

Park, Y. J. (2004). Why Faculty Participate or do not participate in Distance Education in Higher Education: Factors Influencing Faculty Participation in Distance Education. Presented in the annual Association for Educational Communications and Technology Convention. Chicago, Illinois.

Polin, L. (2004). Learning in dialogue with a practicing community. In T. M., Duffy & J. R. Kirkely (Eds.). Introduction: Theory and practice in distance education (pp. 17-48). Lawrence Erlbaum Associates, New Jersey.

Reigeluth, C. M. (1999). What is instructional-design theory and how is it changing? In C. M. (Ed.), Instructional design theories and models: A new paradigm of instructional theory (vol. 2, pp. 5-30). Hillsdale, NJ: Lawrence Erlbaum.

Reigeluth, C. M. (2003). Knowledge building for use of the internet in education. Instructional Science, 31, 341-346.

Reigeluth, C. M., & Frick., T. W. (1999). Formative research: A methodology for improving educational theories and models. In C. M. (Ed.), Instructional design theories and models: A new paradigm of instructional theory (vol. 2, pp. 633-651). Hillsdale, NJ: Lawrence Erlbaum.

Reynard, R. (2003). Using the Internet as an instructional tool: ESL distance learning. In 2003 conference proceedings of the eighth annual mid-south instructional technology conference.

Schifter, C. C. (2000). Faculty motivators and inhibitors for participation in distance education. Educational Technology, 40 (2), 43-46.

# Using Automation for Conducting a Large-Scale Task Analysis

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**Abstract**

*A traditional Task Analysis (TA) usually involves conducting data collection through focus groups, observations, interviews and review of existing courseware and documentation. At a minimum, the TA focuses on the capturing of specific data elements, knowledge, skills, and attitudes (KSAs), along with difficulty, importance, and frequency (DIF) indicators and conditions and standards. These elements may be stored as either paper-based products or in electronic means, as documents, spreadsheets or local database driven applications. However, such a traditional approach to conducting a TA has its challenges.*

*The level of difficulty involved is dependent upon the scope of the TA in question. There may be coordination and management issues due to the size of the effort and the number of individuals (subject matter experts (SMEs), facilitator(s) and support personnel) involved. Administrative support issues may also come into play, such as the logistics of meeting locations, breakout rooms, flight schedules and preparation of printed and electronic presentation materials. The issues may become even greater if the participants involved are distributed remotely, leading to scheduling complications for face-to-face sessions. Staffing and administrative factors aside, the breadth of the data to be collected may turn into a configuration management nightmare on its own. All of these factors constrain the collaboration process.*

*So, how can collaborative efforts be successfully managed within a TA environment? First and foremost, advancements in technology provide the backbone for large-scale TA projects to incorporate collaborative tools, such as synchronous, asynchronous, automated/pre-programmed and one-way communication styles. Programs, such as the Army's Future Combat Systems (FCS) and the Navy's Transformation in Training, have already begun the successful use of custom web-enabled tools to automate the TA and collaboration processes from the ground up. For example, beginning with the end result in mind and the participants involved, web-enabled tools have been developed for FCS to aid in the compilation, management, storage, reporting and most importantly, collaboration in the collection of data and metadata for a TA. In such a case, participants, such as program managers, team leads and SMEs are collaborating successfully and effectively from remote locations across the nation. Large-scale projects involved in these analysis efforts are seeing the benefits of seamlessly incorporating both over-the-counter software packages, known as shrink-wrap, and custom-developed software solutions.*

*Secondly, the collaboration effort itself must be examined. The methods of collaboration may be different and dependent upon the effort at hand and the needs of the program. Determining the right methods of collaboration will result from asking the right questions. How will those involved in the analysis effort collect information? How must the information be stored and shared? What exactly will be required for interaction—face-to-face or through other remote means? Namely, to what degree will there be collaboration and on what levels?*

*This paper focuses on three key issues promoting automated collaboration within a large-scale TA effort. Large-scale equates to multiple distributed sites, various teams, the use of metrics (e.g., keeping track of task progress or establishing automated reviews) and the collection of TA data and metadata. These key issues are:*

- *The challenges in automating a successful collaboration process. In particular, the need for automated tools (shrink-wrap and custom) to facilitate a seamless process is examined.*
- *The communication structure itself. Namely, the most common styles of communication needed in such automation.*
- *The implementation of these communication styles as software.*

*Additionally, usability (ease of use for the end user) will ensure the success of this process in such complex automated tools. Essentially, what steps can be taken early in the development of such tools to*

*ensure they are indeed applicable to the effort at hand. Should human factors play a key role in providing a liaison between that of development and the end-user? These issues will be examined.*

## Introduction

Lastly, the TA data itself (which has been captured using groupware and database-driven technologies) is the basis of an Instructional Designer's design and development strategy. So, why not leverage this same technology so it aids the Instructional Designer in providing Instructional System Design (ISD) capabilities, such as storyboarding and authoring? Why should the designer have to pull this data from one system into another (or multiple systems), in the process inheriting migration costs, so that the data can be analyzed and developed? Depending on the TA data and groupware capabilities, Instructional Designers may be able to define what to train, what type of medium to train within and to guide designers in creating a course outline. And, if enough information is contained with the TA data, it

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Lastly, the TA data itself (which has been captured using groupware and database-driven technologies) is the basis of an Instructional Designer's design and development strategy. So, why not leverage this same technology so it aids the Instructional Designer in providing Instructional System Design (ISD) capabilities, such as storyboarding and authoring? Why should the designer have to pull this data from one system into another (or multiple systems), in the process inheriting migration costs, so that the data can be analyzed and developed? Depending on the TA data and groupware capabilities, Instructional Designers may be able to define what to train, what type of medium to train within and to guide designers in creating a course outline. And, if enough information is contained with the TA data, it can serve as appropriate data for creating learning objectives and content.

**The Challenges**

Advancements in technology provide the backbone for large-scale TA efforts to promote communication. Through the integration of collaborative tools, otherwise known as groupware, communication can be elevated onto a new level, incorporating vehicles to promote successful collaboration between participants that was once unachievable via traditional means. In some instances, shrink-wrap groupware may be available, providing an out-of-the-box solution that can be cost-effective and quickly integrated. In other instances, custom tools may need to be developed, providing custom made solutions to the challenges at hand. Regardless to whether shrink-wrap or custom groupware is used, both have their share of challenges.

Let's begin with shrink-wrap groupware. There are a number of over-the-counter software packages available providing capabilities such as email, instant messaging and video/audio conferencing. This groupware in some instances may be inexpensive to purchase, or depending on the licensing, may be available for free commercial use. In other cases, groupware, providing the same or similar capabilities, may already be available as part of the TA infrastructure, such as the ability to send and receive email. Given the nature of the groupware and popularity, participants may already be familiar with the technology, requiring little or no training. It may also meet less resistance in its use by the participants because of their comfort level with the software as opposed to the sometimes common resistance met by participants who are unfamiliar with a technology and as a result simply refuse to learn how to use it.

The downside to using shrink-wrap groupware is the simple fact that it may not completely meet the collaborative needs of the TA effort. This may require the use of more than one software product or a suite of products. The other complication is ensuring the seamless integration of the groupware in such a way that it aids in collaboration without hindering it. The groupware should help facilitate communication within the effort. It should not impose constraints, additional requirements, or force participants to perform steps that would not normally have to be performed when communicating.

Custom groupware, on the other hand, if developed properly with the participants and needs of the effort in mind, should integrate seamlessly. It should provide customized solutions to meet the exact needs of the TA effort allowing the participants to communicate with ease. Depending on the collaboration required, the custom groupware might consist of one product or multiple products using a common framework. For example, the groupware may be a content management system allowing multiple participants at remote locations to collaborate on the development of tasks via tools incorporated into the groupware system. Once authenticated, participants can simply use the system to communicate with each other while they work, without the need to use external means.

Custom groupware does have its downside, however. First of all, this groupware must be developed, in most cases resulting in a much higher price tag than that of shrink-wrap. The development of this groupware can become an effort in itself, requiring an analysis of the TA effort clearly outlining the types of collaboration needed, a thought out design, time to develop and document (online help), integrate, and finally, allow the participants involved to evaluate. This doesn't even include the cost and time to train the participants on its use. Although training of participants is not the main focus of this paper, it is highly recommended to set aside the time to train "end-users" and to have available either online help or a job aid, or both, on proper use. In addition, reach-back to the development team, for participants who are having difficulties in using the tool, should be a consideration as well. All of these steps must occur well in advance of the groupware's anticipated use.

The development team may also have to be used during the TA effort as "bugs" are found in the groupware. If new requirements are introduced during the effort, the groupware must be modified and/or new functionality added. It may also cause potential delays in the TA effort as the modifications/new features are integrated into the groupware. Not to mention the time to train the participants on the new capabilities and changes. There may also be opposition to its use, particularly if the groupware is not intuitive. Participants may simply gravitate to using other software and methods they are comfortable with or simply take the stance "…we're doing it this way. This is the way we've always done it."

One of the most important lessons learned in the integration of collaborative groupware, whether it's purchased off-the-shelf or custom developed, is that recruitment must occur early and across the different echelons of participants involved, from management to end-users. In order to be more successful in getting positive participation, the purpose of the use of groupware must be clearly established, outlining the exact benefits of using such groupware. In other words, what is the return on investment? Is it monetary? Is the result more efficiency or less time to perform a task? How will the groupware help the participants? Why should the participants be on board with using this technology?

The list of challenges could go on and on. In fact, the challenges in automating a successful collaboration process through the use of groupware merits its own paper. Knowing the challenges and the lessons learned is the first step in understanding how to overcome them. So, how exactly does one do this? The answer depends entirely on the needs of the TA effort. Later in this paper, we'll point out some of the most common lessons learned. First, however, we'll be examining the communication structure itself--namely, the most common styles of communication needed in such automation.

## Styles of Communication

Introducing technology into a TA effort without understanding how the participants will communicate will hamper productivity and frustrate those involved. Technology is but one part of the equation. Collaboration is only achieved when the groupware is successfully married with the processes in place, and information can be shared as closely as possible in a real-time fashion. This must occur across all the locations and with all participants involved. So, understanding the different styles of communication employed is also needed. Books have been written on the subject of communication ranging from its history to cultural studies, and so a deep understanding of such is out of the scope of this paper. What is discussed, however, are the most common styles employed when automating collaboration as part of a large-scale TA effort. Let's begin by examining synchronous and asynchronous communication styles.

### Synchronous Style

This is a style of two-way communication between participants that appears to occur with no time delay. It allows the participants to communicate (respond to each other) in real-time. By real-time, we mean there is no noticeable time delay, even though in actuality one may exist. To the participants, they are communicating as if they where simply speaking to each other face-to-face.

### Asynchronous Style

The asynchronous style, on the other hand, is a two-way communication that occurs with a noticeable time delay. Participants know they are not communicating in real-time. This style is also less stringent than synchronous. Asynchronous communication allows participants to respond at their own convenience.

From an automation standpoint, communication can be achieved using these two styles. Most groupware used today still appears to be asynchronous, even though this seems to be changing with enhancements such as instant messaging and voice over IP technologies. The synchronous and asynchronous styles provide two-way communication, but, are not enough when automating collaboration as part of a TA effort. One-way communication is also needed; namely, automated/pre-programmed and one-way communication styles.

### Automated/Pre-Programmed Style

Similar to the asynchronous communication style, automated/pre-programmed appears to occur to the participants with a noticeable time delay. Unlike both the synchronous and asynchronous communication styles, automated/pre-programmed provides no means for the participant to respond. It is strictly a one-way communication style. In addition, it is not participant controlled. Meaning, participants cannot initiate the communication or control when the communication occurs. (This is important, simply because it is the only difference between automated/pre-programmed and the one-way communication styles.) This style is mostly used in management or system level activities, such as in the emailing of notifications (e.g. notifications that a new release of the groupware software is now available).

**One-Way Style**

Very similar to the automated/pre-programmed communication style, one-way communication occurs with a noticeable time delay. It provides no means for participants to respond. However, it is participant controlled. Participants have full control as to when the communication takes place. One such example would be a report of milestone status to project managers.

**Implementing the Communication Styles**

Understanding your TA effort and the communication styles, which will be used, is vital to implementing the right technologies. As we've discussed, though, this is not necessarily a simple task. So far, we have addressed some of the challenges in automating a successful collaboration process along with the styles of communication found in most large-scale TA efforts. In this section, we identify these communication styles and applicable technology. Table 1 displays a matrix organizing technology by communication style.

Table 1: Technology by Communication Styles

| Communication Style | Technology |
|---|---|
| Synchronous Style | • Video/Audio/Data Conferencing<br>• Electronic Whiteboards<br>• Application and File Sharing<br>• Guided Web Browsing<br>• Streamed Media<br>• Telephony<br>• Instant Messaging<br>• Chat Rooms |
| Asynchronous Style | • Discussion Forums/Boards<br>• Email<br>• Mailing Lists<br>• Newsgroups<br>• Stand-Alone Applications<br>• Downloadable Media<br>• Electric Calendar Systems |
| Automated/Pre-Programmed Style | • Automated Email Notifications |
| One-Way Style | • Reporting |

This is in no way an exhaustive list, but lists those "types" of technologies with which most are familiar. Keep in mind there are a number of open source and proprietary shrink-wrap products available on the market today. These products can support each of these technologies if not spanning a multitude of them such as in the case of Lotus software by IBM ® (IBM, 2005).

In providing an example of how these communication styles might be used in conducting a TA, we will engage in a scenario. After the development team meets to establish the project's needs and focus, channels are set by which the team members will conduct their varied forms of communication. For initial data collection, the Instructional Designer and SME both participate in the gathering of existing materials, and must maintain in contact with their progress, sharing notes, questions, suggestions, and decision-making on a continual basis. To this end, those involved in the TA will use all styles of communication.

In the project scenario, the SME and Instructional Designer may communicate synchronously via audio conferencing to coordinate and delegate data collection and file sharing; implement guided web browsing for research purposes; and engage in instant messaging to enable immediate inquiries and feedback. Asynchronously, the SME and Instructional Designer can track their internal milestones in TA via electronic calendar systems; maintain continuous contact via email; and continue to explore their research via discussion boards, mailing lists and newsgroups. With a project management application tracking milestone achievement, email notifications are triggered to ensure the team members are aware of the next steps to perform for the project, or to assure all elements were covered in the completed milestone. Upon milestone completion, Task Analysis Reports and Learning Analysis Reports are standard formats for reporting progress and preparation towards the development of training.

Keep in mind that if shrink-wrap is used, the actions discussed in the previous scenario might entail the SME using multiple software applications, some of which may not work well with each other. It may also mean the participants may have to be trained on each application. If custom groupware is developed, all of the actions described may be integrated into a single enterprise solution providing all the capacities required. This approach may produce the best seamless results, but at the same time may be the most time consuming and costly. As a result, a combination of both shrink-wrap and custom solutions may be the middle ground leveraging the benefits of each, and at the same time attempting to minimize costs.

**Usability and Evaluation**

Groupware usability appears to be a hot topic. There have already been a number of publications on the subject, which have ranged from the usability of specific groupware systems to “How exactly do you go about evaluating groupware?” Of these topics, however, the evaluation of groupware, or lack there of seems to be getting the most interest. In a review of groupware evaluations (forty-five papers total), Pinelle and Gutwin (2000) concluded that formal evaluation was lacking in one-third of the groupware system evaluations they examined, resulting in a further conclusion that there was additional room for low-cost and simple evaluation techniques.

So, why is the evaluation of groupware so difficult? Well, there are different answers to this. Some believe that it is a factor of not knowing what evaluation approach to use. Others believe that many of the groupware systems available are too complex and difficult to be properly evaluated. Others insist that the evaluation approaches available are not sufficient. Generally, formal groupware evaluation can be approached in different ways. The most common we have experienced has been examining how participants collaborate in the real world as it applies to the TA effort in question. Other methods take more scientific approaches, using methods (e.g., automatically, empirically, formally and informally (Nielsen, 1994; Usability Inspections, 2001)) to measure usability without having to incur the costs of shadowing multiple participants as they perform their responsibilities within the effort. In other words, they evaluate groupware through usability inspection methods (Steves, Morse, Gutwin & Greenberg, 2001). (Usability inspection has been around for a number of years. Countless papers and books have been published and courses are available on the subject and so a full discussion on this topic is simply out of the scope of this paper. To put it simply, usability inspection is nothing more than a generic way of describing a number of methods for finding usability problems with software in the hopes of debugging, improving code and enhancing user interfaces (Nielsen, 1994; Usability Inspections, 2001).)

From our own findings and experiences, groupware evaluation is a difficult problem to solve. Overall, there seems to be little known about the usability of groupware systems. What we have learned in the case of custom-developed groupware is that usability needs to be examined early in the development process. We have seen that those TA efforts, which ultimately provided the best use of groupware to participants, were those in which the participants were involved during the development of the groupware. Meaning, participants were involved in the testing and evaluation as capabilities and features where ready. This provided the opportunity for participants to use the groupware and give feedback as to what they liked, disliked and what needed improvement and how. This approach not only provides developers immediate feedback on development efforts, but also allows the participants to become familiar with the groupware and comfortable with the technology. This approach recruits participants very early in the effort.

Human factors have also been shown to be invaluable to these types of efforts, particularly in the area of graphical user interface development and layout. This has helped in the design of the groupware, catching problems and usability issues early in development prior to participant testing and evaluation.

Involving developers, human factors experts, participants and SMEs early on does have its share of challenges. First, this approach assumes there is adequate time to develop the groupware prior to the start of the TA effort. It also assumes that participants are available for testing and evaluation during development. This may not always be the case. Even if participants are available, they may not fully understand the responsibilities that will be required of them. This leads to inadequate evaluation and limited feedback. This approach can also be very costly.

To summarize, the following outlines what steps can be taken early in the development of groupware to ensure they are indeed applicable to the effort at hand.

- Set up meeting(s) to identify stakeholders and participants. Namely, who should support the collection of data and what type of data and elements should be collected. This meeting could be face-to-face or conducted using synchronous styles of communication discussed earlier.
- Once these individuals are identified, designate a subset of these participants across the various functional areas as those who will be aiding in the testing and evaluation of the groupware. These participants will act as SMEs and should have enough knowledge of their functional area and of their responsibilities within the TA effort to speak for their team who will also be using the groupware and performing the same jobs.
- Determine milestones for the collection of data. If there are several jobs being investigated, determine if the data can be collected simultaneously or if one job affects the data collected of a different job.
- Develop groupware based on the structure of the data and the type of access required by participants (i.e., single users or multiple users of groupware and so forth). Human factors experts may be of significant help in this area in the design of user interfaces and other usability matters.
- Use a spiral development approach, as milestones and major functionality are ready for feedback by participants; conduct a mock-up TA via the groupware in question. Work with participants to acquire feedback on usability.
- Evaluate the feedback, prioritizing requests that can be easily integrated into the groupware system first. Keep in mind that not all the requests can be implemented or done so immediately given the technology, budget and time constraints.

As for the usability of shrink-wrap groupware, our experiences have been very similar. Participants should be involved in the selection of the groupware to be used in the effort. This does not mean that they need to be involved in the initial trade study to determine the potential groupware systems candidates, but should be involved in the final selection of one or more of them for use in the TA effort. To summarize, the following outlines what steps can be taken early in the selection of shrink-wrap groupware to ensure they are indeed applicable to the effort at hand.

- Set up meeting(s) to identify stakeholders and participants (as described earlier).
- Designate a subset of these participants to aid in the selection of the groupware.
- Determine milestones for the collection of data.
- Select the groupware systems based on the structure of the data and type of access required by participants. Keeping in mind, of course, that there may be other factors contributing to the section as part of the trade study (e.g., costs and technological considerations).
- Allow participants to be involved in the evaluation of the groupware systems determined to be a potential fit as part of the trade study.

**Linkage of Task Analysis Data to the ADDIE Model**

The traditional instructional design process typically involves five phases: analysis, design, development, implementation and evaluation, otherwise known as the ADDIE model. The TA data, collected and stored using groupware and database driven technologies, is a big part of the analysis phase of the ISD process. How can this data be automatically migrated to other tools for the design and development phases? Can database-driven groupware tools be linked to these outside software packages in order to decrease the design and development time? Can the same groupware be enhanced to perform the capabilities needed by the Instructional Designer?

With advancement in technology, standardization being put in place on baseline configuration of computer systems (such as Distance Learning XXI (Baseline Home Computer, 2004)), and the greater need for software components to work together, the challenge appears entirely achievable. A basic TA includes the elements of KSAs, DIF, conditions, standards and performance measures. So, why not include elements that allow the input of learning objectives (LOs)—both terminal objectives (TLOs) and enabling objectives (ELOs)—to be linked to the proper tasks or steps? In addition, the LOs can be connected to the best learning medium (a model that is run based on additional elements (bulleted below) tied to the LOs). Consider the following additional elements that could be included in the groupware for additional automated processes:

- Task Selection Model, an algorithm using the task difficulty, importance and frequency data to determine what task to train or not to train. This helps to prioritize task development. For example, a task that is not difficult, not important and infrequently performed may not require formal training but could be easily learned on-the-job (Task Selection Model, 2005).

- Learning objective fields could be built into groupware that allow the designer the ability to input TLOs and ELOs and then link those objectives to the proper task or sub-steps. This type of organization may also point out which combination of tasks is being over-taught or which tasks could be combined. It is the electronic organization of this data that can provide a detailed report of task data associated with objectives that may otherwise be overlooked.
- Media selection algorithm is based on elements such as cognitive type (from the simplest recall of facts to higher levels of mental processing, such as analysis of data), working environment under which the task must be performed for training, tied to the learning objective (hence performance level) to be achieved.

The following types of media are being investigated for consideration in the development options for training. Some are legacy (in use today) while others are more advanced awaiting the technology for implementation:

- Interactive Multimedia Instruction (IMI) – most future delivery methods are via the web and should contain various interactivity levels, leaving behind the "page turner" application. IMI delivers structured content while tracking learning objectives.
- Part Task Trainer (PTT) – use of computer generated animations (usually on a desk-top computer), or, simulator or limited simulator training that enable interactions to replicate hands-on exercises. For example, operation of a communications radio within the cockpit of an aircraft.
- Full Task Trainer (FTT) – simulated equipment closely replicating real-life task performance. For example, a flight simulator replicating the entire cockpit.
- Live Simulations - real entities (people) are operating in a real environment using real equipment. For example, an aircraft may be on a mission to hit a target but using fake munition.
- Virtual Simulations - real and computer generated entities are present and interact within the environment. You may be logged on as a particular entity (person) in a simulated environment. Your simulated movements are tracked against computer generated entities (which could be the enemy).
- Constructive Simulations - all entities are computer generated. In this case, you are simulated in a simulated environment (which may be a game environment) in which other elements are completely simulated as well.
- Interactive Electronic Technical Manuals (IETMs) – text-based procedural processes with visual supplements. Interactive IETMs entail interactive visuals that use scalable graphics, for example, a person could click on the outer shell of an engine and watch it slowly break apart to show internal detail. Whereas, future IETM development involves being linked to equipment and/or maintenance network and integrates diagnostics.

As a final note, each project may require a backup of communication data and support documentation for decisions made throughout the project. Using such tools as groupware can simplify the reporting of this information to the customer. These reports can also include why a certain learning objective was developed and/or why a specific medium was chosen over another. The key here is that the groupware ties in all data no matter what the use within the project.

**Conclusion**

Communication is the key to the successful completion of a TA. We should not work within a vacuum and then distribute the information upon completion, but instead information should be shared along the entire process with all participants. This is where the need for automated collaboration comes in to play. The following summarizes some of the lessons learned from our experiences in developing, integrating, using and managing groupware within TA efforts.

- The biggest hurdle in implementing groupware is convincing the participants to use it. Ensure the participants clearly understand the benefits in using the groupware. In other words, begin recruitment early.
- Proper training is required to make participants comfortable in using it. Insufficient training leads to misuse or misunderstanding of the groupware, which leads to its non-use.
- More than likely, a combination of both shrink-wrap and custom groupware may have to be used. Using all shrink-wrap typically doesn't fit into the TA effort's processes unless the processes are

then changed to fit the existing groupware, while an all custom solution is typically costly and may require too much advanced time to be developed.

- The groupware must be seamlessly used within the TA process. The focus of the end-user should be placed on the process, not the groupware. Therefore, if possible, it is best to choose technologies that fit the processes in place.
- The communication styles discussed, synchronous, asynchronous, automated/pre-programmed, and one-way have all been typically used in some capacity, especially with large-scale TA efforts. Do not force-fit these styles into the TA effort in question, but instead, only use those, which seem to work naturally within the TA effort.
- Developing a more robust groupware application to handle not only the TA but the segments of design and development should lead to huge cost savings through automation and reuse of data.
- Being able to follow a path of decision points that are electronically captured, be it email strings or reasons behind medium selection, can be important to the wrap-up of a project.

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**References**

Baseline home computer configuration for interactive multimedia instruction (IMI) courseware. (2004). Retrieved July 20, 2005, from MINIUM Web site: http://www.atsc.army.mil/itsd/imi/documents/bhcc_Sep04.htm

IBM ® (2005). Lotus software. Retrieved July 7, 2005, from IBM Web site: http://www. 306.ibm.com/software/lotus/

Nielsen, J. (1994). *Usability inspection methods.* Proceedings of Conference Companion, CHI 1994, Boston Massachusetts, April 24-28.

Pinelle, D., and Gutwin, C. (2000). *A review of groupware evaluations.* Proceedings of Ninth IEEE WETICE 2000 Workshops on Enabling Technologies: Infrastructure for Collaborative Enterprises, Gaithersburg, Maryland, June 14-16.

Steves, M., Morse, E., Gutwin, C., & Greenberg, S. (2001). ***A comparison of usage evaluation and inspection methods for assessing groupware usability.*** Proceedings of ACM Group 2001, Boulder CO, p.125-134

Task selection model, Appendix A (n.d.). (2005). Retrieved August 11, 2005, from Fort Sill, Oklahoma Web site: http://sill-www.army.mil/FDIC/stafffaculty/satdref/appa.htm

Usability inspections (2001). Affectus AB, Peter Almstrom. Retrieved July 7, 2005, from Affectus AB Web site: http://www.affectus.se/publicerat/usabilityinsp/#usabinspectionmethod

# The Educational Technology Implementation Plan (ETip): Why, What, and How?

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### Why Use the ETip Model?

The ETip model grew out of the need to move away from previous technology integration models that have conceptualized technology integration in a narrow manner. For instance, educational institutions in the past would simply provide Power Point training on a yearly basis. Professional development practices should model the social learning practices that schools want their teachers to utilize in the classroom.
Schools need to have a clear vision for how technology is going to be used in their environment. This vision needs to be aligned with the school environments' vision for quality learning and instructional practices. Additionally, change agents need to understand that teachers' use of technology evolves over time. There is a developmental continuum that teachers tend to progress through as they begin to use technology in educational environments (Sherry, L., Billig, S., Tavalin, F. and Gibson, D., 2000). Professional development should vary depending on the needs of the majority of participants as well as unique situated needs of individuals. In order to do this, careful planning and a solid understanding of what technology integration is and how technology is diffused into an educational environment is needed. Thus, we developed a model that pulls research from the fields of social learning, change management, innovation diffusion, motivation, teacher technology adaptation growth processes, and the best practices of professional development.

### What is the ETip Model?

| | Level I | Level II | Level III | Level IV | Level V |
|---|---|---|---|---|---|
| Educational Environment's Vision | **Goal @ Level 1:** Members of the educational community become technology users. | **Goal @ Level 2:** Technology is utilized to assist with classroom productivity. | **Goal @ Level3:** Curriculum is enhanced by technology. | **Goal @ Level 4:** Students construct knowledge utilizing a wide range of tools depending on the subject matter. Technology is one of the tools that students may utilize. | **Ultimate Goal:** Students and Teachers use technology as tools for communication, collaboration, and analysis. |
| Teacher Target | **Personal Productivity:** Teacher uses technology for personal and task management concerns. | **Professional Productivity:** Teacher uses technology in their classroom for professional task management concerns. | **Professional Enrichment:** Teacher builds a clear relationship with technology and curriculum. | **Paradigm Shift:** Teacher changes the manner in which they teach and assess. The use of technology becomes invisible. | **Visionary:** Teacher shares experiences based on own research and develops improvements in practice. |
| Role of Teacher in PD Process | **Learner**: teacher spends time learning how to use the | **Adopter**: teacher adopts their personal use of | **Adapter:** teacher uses the technology for instruction rather | **Designer:** teacher improves the use of technology for instruction to more | **Leader:** teacher trains other teachers on the area of technology |

| | | | | | |
|---|---|---|---|---|---|
| | technology. | technology for professional productivity. | than in support of instruction. | closely match the students' needs. | integration in which they excel. |

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|---|---|---|---|---|---|
| Pedagogical focus of the teacher | | | **Instructionism—Transmission** Learning by teacher driven projects. Student as *static learner.* | **Constructivism--Constructionism:** Learning by Making. Student as *apprentice*. | **Participatory Constructionism:** Group learning in authentic context and situated learning. Student as *creator*. |
| PD Bridge | | **WebQuest Model** | | **ICON Model , with Big 6 and other information literacy models** | **Virtual Collaboration Support** |
| PD Product | **Individual Growth:**<br><br>• Workshops,<br>• Lunch Bytes,<br>• Mentor,<br>• On-line Just-in-time (JIT),<br>• Tutorials (online & paper-based) | **Support Instruction:**<br><br>• Workshops,<br>• Lunch Bytes,<br>• Mentor,<br>• On-line JIT,<br>• Resource search engine,<br>• Tutorials (online & paper-based) | **Enrich Instruction:**<br><br>• Mentor,<br>• Modeling,<br>• Lunch Bytes,<br>• On-line JIT,<br>• Resource search engine | **Support Development and Implementation:**<br><br>• Virtual Mentor,<br>• On-line JIT,<br>• Resource search engine | **Student-Centered Learning:**<br><br>• Virtual collegial collaboration,<br>• Resource search engine. |
| Role of Change Agents<br><br>It is important to note that this section provides general guidelines. The leadership in the school should decide the appropriate approach for moving teachers through the levels of technology implementation based on the teachers' needs and school resources. | **Technology Facilitator (TF):** Provide workshops and In-building tech assistance. Also, create a technology help line. Begin building an on-line just-in-time repository on the schools website that teachers can easily access. Also, post on the Website tutorials for the common software that the school owns.<br><br>**Administration (Admin):** Require email for school-based communication and provide email accounts to teachers. Also, implement the use of a school-based | **TF:** Continue providing workshops. Target train tech savvy teachers in order to enable the teachers to work with other teachers in the school, continue the use of the help line, add to the online resources.<br><br>**Admin:** Provide access to equipment in the classroom and support after school workshops. Encourage use of technology. Administration should also provide time for PD and promotes/encourages teachers to particpate. Teachers should | **TF:** Move away from formal workshops towards modeling and mentoring. Continue to utilize the assistance of tech savvy teachers. Also, utilize students as informal tech assistants. Continue developing technology-related online resources for teachers.<br><br>**School Library Media Specialist (SLMS):** Mentor and Model the use of information technology for research through information literacy collaborations with teachers. Also, Alternate Lunch Byte sessions with the TF and collaborate with the TF to create a | **TF:** Utilize virtual mentoring rather than face-to-face modeling and mentoring. Continue utilizing the assistance of tech savvy teachers, and students as informal tech assistants.<br><br>**SLMS:** Utilize virtual mentoring for information literacy collaborations with teachers.<br><br>**Admin:** Continue with what was done at level 3 and if possible reward people monetarily and/or with equipment for progressing to these student-centered levels on a daily basis. | **TF** and **SLMS**: Work collaboratively with teachers and students in group learning experiences. Continue utilizing the virtual environment that you used to mentor teachers but at this stage the interactions should be more collaborative. Also, introduce new and innovative technologies and resources as they become available.<br><br>**Admin:** Allow time for teachers to collaborate. Also, provide budget based incentive programs shiftring from capital to operating through leasing. |

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|---|---|---|---|---|---|
| | Website. Lobby the school board to make email an official form of communication and eliminate paper-based daily bulletins. | receive CEUs upon completion of a product. | resource search engine.<br><br>**Admin:** Administration promotes and encourages project -based CEUs for teacher PD. Teachers receive CEUs once project is complete. Administration also encourages curriculum specific project-based PD. | | |
| Motivation | **Success**: Create an intrinsically motivating tech project that utilizes process goals rather than product goals. The subject matter should be grounded in what the teacher does. Provide follow-up PD. | **Success:** Use process goals with projects that use technology to automate professional tasks. The subject matter should be grounded in what the teacher does. Provide follow-up to PD. | **Public Praise:** Disseminate praise for exemplary student work. ***Focus on the instructional method not the technology.*** Provide follow-up to PD. | **Public Praise:** Disseminate praise for exemplary project. Ed Tech newsletters or show case in Tech Brief. ***Focus on the instructional method not the technology***. | **Rewards:** Incentive for facilitation opportunities; Showcase exemplary practices. Ed tech roundtables during teacher workdays. |
| Examples | Teacher uses E-mail to communicate with friends and family. | Teacher uses DreamWeaver, to create a basic Webpage to post class news, links and homework assignments. | Teacher adopts a WebQuest.<br><br>Best Practices: China WebQuest | Teacher creates their own web quest and technical tools are in the hands of the students. Teacher also collaborates with colleagues.<br><br>Best Practices: Geometry in the Real World | Teacher engages in virtual collaboration with a scientist to solve a local authentic problem.<br><br>Best Practice: Oral History project |

Figure 1: Educational Technology Implementation Plan (ETip)

The ETip model extends the work of Sherry, L., Billig, S., Tavalin, F. and Gibson, D. (2000) and their Technology Adoption Model. Sherry et al's model was based on the Hall and Hord's Concerns-Based Adoption Model (CBAM) and Everitt Rogers, Diffusions of Innovations (1995). The failure to consider human affect and perceived value tends to lead to failure in technology integration. This viewpoint parallels Hall and Hordes' CBAM. Hall and Hord's CBAM model is an appropriate model for technology integration due to the emphasis on the human and social side of adopting an innovation. It is the human element that moves the technology through the implementation process, this is why we added a motivational category to aid the school's change agent in motivating teachers to utilize and eventually integrate technology into the curriculum.

The motivational category is based on Keller's (1983) ARCs model. Keller's ARCS Model of Motivation posits that if the learning experience attracts the learner's attention, has relevance to the learner, allows the learner to build confidence in their abilities to succeed with the task and provides a satisfying experience then the learners will be more likely expend the effort with the learning experience.

The ETip model also incorporates what the authors refer to as "professional development bridges" to aide teachers with progressing through the levels of the ETip model. It has been our experience that often times teachers' instructional practices with technology tend to plateau at a specific level. Therefore we include in the ETip model research-based techniques that can aide in moving teachers to the next level. These bridges are based on social learning principles, our own research and experiences, Bernie Dodge's work (1995, 2001), and the work of Black and McClintock (1995). The bridges along with recommended professional development strategies, that are based on best practices in professional development (Rogers, 2001), provide the tools that change agents can use as a bridge from one level to the next.

**How is the ETip Model Used?**

In order to use the ETip model, schools need to first determine their vision for technology use in their school. This vision needs to be a shared vision that the entire school community buys into. Then the school needs to determine how the teachers in their environment are currently using technology in the classroom. Schools can either make their own inventory or utilize a ready-made inventory such as the technology use instruments that Moersch (2002) evaluated.

Once the school has a strong understanding of how the teachers are using the model, they can plan professional development activities based on the level that the majority of the teachers are at on the ETip model. If there are small clusters of teachers at other levels then unique professional development offerings can be developed based on the model to meet the specific needs of the teacher.

The E-TIP model builds on what we have learned about social learning, change management, diffusion of innovation, teachers' development of technology utilization, and best practices in professional development. To be successful in the development of a technology professional development plan, a district must first recognize that quality learning is made possible through technology. Then school districts can use the ETip model to further the use of technology in classroom practices.

**References**


Black , J. B., and McClintock, R.O. (1995). An Interpretation Construction Approach to Constructivist Design. in B. Wilson (Ed). *Constructivist Learning Environments.* Englewood Cliffs: Educational Technology Publications. Accessed on 3/10/05 at http://www.ilt.columbia.edu/publications/papers/ICON.html .

Dodge, B. (1995). *Building Blocks of WebQuests*. Edited by Byles, B. and Brooks, S. 2000. Accessed 3/12/05 at http://www.internet4classrooms.com/buildingblocks.htm

Dodge, B. (2001). FOCUS: Five Rules for Writing a Great WebQuest. Learning & Leading with Technology, v28 n8 p6-9 Hall, G.E. and Hord, S.M. (1987). *Change In Schools: Facilitating The Process*. Albany: State University of New York.

Keller, J. (1983). Motivational design of instruction. In C. M. Reigeluth (Ed.) *Instructional Design Theories And Models*. Hillsdale, NJ: Erlbaum

Keller. J. (1987). Strategies for stimulating the motivation to learn. *Performance and Instruction Journal,* 26 (8), 1-7.

MacGregor, S. K. and Yiping, L. (2004). Web-Based Learning: How Task Scaffolding and Web Site Design Support Knowledge Acquisition. *Journal of Research on Technology in Education*, 37 (2), 161-176.

Moersch, C (2002). Measurers of Success: Six instruments to assess teachers' use of technology. *Learning & Leading with Technology*, 30 (3), 10-28.

Rogers, D. L. (2000). A paradigm shift: Technology integration for higher education in the new millennium. *Educational Technology Review*, 13, 19-27.

Rogers. E. (1996). *The Diffusion Of Innovations*. (4th ed.). New York: Free Press.

Schunk, D. H. and Ertmer, P.A. (1999). Self-Regulatory Processes During Computer Skill Acquisition: Goal and Self-Evaluative Influences. *Journal of Educational Psychology*, 91 (2), 251-260.

Sherry, L., Billig, S., Tavalin, F. and Gibson, D. (2000, February). New insights on technology adoption in schools. *T.H.E. Journal*. Retrieved October 29, 2000, from http://www.thejournal.com/magazine/vault/A2640.cfm

Supovitz and Zief (2000). Why They Stay Away: Survey Reveals Invisible Barriers to Teacher Participation. *Journal of Staff Development*, 21 (4). Retrieved October 29, 2000, from http://www.nsdc.org/library/publications/jsd/supovitz214.cfm

Zhao, Y., Pugh, K., Sheldon, S., & Byers, J. (2002). Conditions for Classroom Technology Innovations. *Teachers College Record*, 104 (3), 482-515.

# Using Digital Storytelling with Advanced Hypermedia Authoring Systems as Tools for Teaching Learning by Design Methods to Teachers.

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## The Problem

According to Thomas (2003) instructional designers, instructional technologists as well as educators in general, face two vexing questions. How do we improve our instructional materials in general? And how can learner perspective or culture be included in our designs to make them more effective and relevant. In current teacher education contexts the increasing pressure to "prepare preservice teachers theoretically and practically to teach culturally, linguistically, and learning diverse students" (Harris et al 2005) is central to these design related questions. Allowing preservice teachers to become designers of digital stories or life centered products using advanced hypermedia with multimedia authoring software provides an important response to these critical questions.

The purpose of this paper is to discuss the manner in which advanced hypermedia and digital story telling were used to engender a learning by design environment for teacher education students. In combination the discussion will also address the value of such complex multimedia software tools for making instructional materials more learner centered and commensurate with the students' perspective.

## Theoretical Framework

Educational theory and research indicate vast potentials for increased student learning by adopting a "learner as designer" approach (Jonassen 2000, Liu 1998; Reeves, 1998; Erickson & Wilhelm, 1996; Beichner, 1994; Lehrer, Erickson, & Connell, 1994; Spoehr, 1994.). Contemporary instructional technologists have suggested that "a learning by design" (Jonassen, 1998, 1999; Jonassen et al, 2000; Resnick, 2003) approach is an effective way to enhance content knowledge. Based upon his own experiences in developing Instructional materials Jonassen has argued that "The people who learn the most from the design and development of instructional materials are the designers."(undated). Diffusing design principles and instructional methods to pre-service teachers is an effective way for us to improve instructional technology programs. This approach then, should in part, characterize how teacher education technology courses are designed.

In this regard "learning by designing" or "learning by authoring" has been found to have a number of positive effects on learning in different settings. Primarily this approach allows learners to become producers of information than simply consumers. For such learners technology becomes more than a tool for reproducing or giving information (Jonassen 2000; Nicaise & Crane, 1999).

Traditional approaches to learning by design have centered on the use of computer based objects for problem solving and process thinking (Resnick, 1998; Resnick et al 1991). These approaches are usually centered in the mathematics as well as science classroom and involve the use of computer programming such as LOGO. These approaches though effective, are often divorced from the experiences of most teachers. The use of LEGO/Logo programmable blocks or other types of manipulatives may not be patently obvious in language arts, social studies or other none mathematical or science based setting. In the interest of meaningful or authentic learning this approach to learning by design has to be repurposed for the general population of teachers. The use of hypermedia or multimedia design is an important part of this endeavor. There is in fact an emerging body of literature which supports the use of hypermedia (hypertext and multimedia) design in educational contexts (Jeehon, 2004; Liu et al 1997).

The use of digital storytelling in this context provides a basis for infusing learner voice or perspective in this design activity. Digital storytelling is an emerging instructional practice for broadening learning in many instructional contexts (Bull and Kajder, 2004). To be sure, constructivist theorists have long called for the use of stories as a way of infusing stories for instructional supports for problem solving (Jonassen & Hernandez-Serano, 2002). The central premise of digital storytelling is that it "allows the author to experience the power of personal expression" (Bull & Kajder, 2004. pp.48). This personal connection provides a basis for problem solving and creative thinking. Both of these are constructs which are important to a learner's "meaning-making".

Learning by design provides a compelling research-centered way for teachers becoming designers of instructional materials on the one hand. On the other digital storytelling provides a basis for integrating learner centered experiences into the instructional setting. As learners develop digital stories they actively engage in selecting a narrative or an experience that emerges from their own socio-cultural context. These are usually by default complex emotional experiences that students may not usually bring into a technology education context. This provides the real-world experience that allows learners to remain engaged and motivated throughout the project.

Multimedia is defined as by Peck (1999) as a blending of two or more types of media "to create a sequence of events that will communicate an idea visually with both sound and visual support" (Peck cited in Speaker, 2004 pp.242). Hypermedia on the other hand refers to linked media or interactive media. Hypermedia is rooted in Bush's (1945) concept as articulated in his widely known article "As We May Think." Recently there has been considerable fusion and interchange of these concepts. For our purposes we use the words hyper/multimedia to describe those elements that reflect both interactive linked media as well as multiple types of media.

A review of the literature reveals positive effects with student created multimedia projects. Beichner (1994) in a study of middle school-age students found that learners where highly motivated and increased time on task while developing multimedia. He further found that while engaging in this process learners become more concerned with the accuracy of the information in their , products, learners willingly became self-regulated and decisive about content as well as editing processes and learners engaged in deep research on different instructional materials in order to gain information about their products. Lehrer et al (1994) supported much of Beichner's findings.

Liu and Rutledge (1997) investigated the learning by designing approach motivated at-risk high school students in designing multimedia. They found that authoring multimedia gave students high levels of intrinsic motivation. Students also indicated that learning by design allowed them to interact with design skills such as planning, presenting, collaborating, mental effort and interest (Jeeheon, 2004).

Studies among older students reveal that through learning by designing of hyper/multimedia learners are able to think about concepts in a more sophisticated way (Oughton and Reed 1998). Oughton in a study of knowledge acquisition, problem solving and general design skills of 15 high school students, found *inter alia* that "the use of hypermedia to provide opportunities for students to construct knowledge can be a means of providing meaningful learning activities" (p.363).

In a very revealing study of graduate students' development of hypermedia with concept mapping, Oughton and Reed (2000) found that hypermedia development was influenced by learning styles. They found that student hypermedia concept maps were more developed if according to the Kolb's Learning Style Inventory they were Divergers or Assimilators. They explain that:

> Divergers have the ability to see many perspectives, gather wide-ranging information, and generate many ideas (Jonassen & Grabowski, 1993). Assimilators have the ability to assimilate wide-ranging ideas and create multiple perspectives (Jonassen & Grabowski), characteristics that the other two learning styles do not possess. It may be that these strengths of Assimilators and Divergers enabled them to be more productive when generating their concept maps (cited in Oughton & Reed, 2000).

In providing effective cognitive apprenticeships for preservice teachers we can benefit from adopting the development of hyper/multimedia with a learning by designing approach. This allows preservice teachers to interact with complex skills as well as cognitive processes (e.g. planning, presenting, collaborating, critical thinking and interest) which they will apply daily in the context of their career. Additionally, this approach allows preservice teachers to learn to use technology in a way that they can later apply in their own teaching settings.

In implementing a learning by design environment for creating hyper/multimedia production, teacher educators need software tools that allow preservice teachers to become actively engaged in complex cognitive processes. Considering what is known about the efficacy of this approach, such software tools should be selected based upon their ability to engender the complexity and authenticity that is required for the effective development of digital stories. These tools should be selected for their effectiveness, instructional adequacy, interface design & navigation, program adequacy and documentation (Gibbs et al, 2001).

## Advanced Hypermedia

There are multiple software packages that we can use to involve preservice teachers in learning by design when developing digital stories. Generally speaking the best types of tools to use are multimedia tools. We argue that Type 5 multimedia tools are the most effective. Type 5 tools are synchronized video creation with hyper/multimedia tools. These tools have recently found maturity and are available in commercial versions as Microsoft PowerPoint Producer, Articulate Presenter and Macromedia Captivate. All allow for the creation of interactive media that accept user input e.g. hyperlinks from within the project to other sites, branching via a table of contents and the synchronization of voice, video & slides for publishing online. Articulate Presenter allows for the saving of notes, viewing of references, adding of bookmarks and annotations within the project. s allow for the saving of notes, branching through a table of contents and use multiple viewing avenues. These include synchronized sound, video and pictures. There real power lay in their ability to engage students in creating with multiple types of complex media including synchronized video, sound, and slideshows.

Traditional multimedia tools have been classified by Roblyer (2004) on a four-tiered typology. These categories reflect the level of complexity of mental processes that each set of software tools activate during the design or application process. These tools have traditionally been used in hyper/multimedia learning by design settings. Roblyer suggests that Type 1 authoring systems are primarily Presentation Software; Type 2 is Video Production and Editing Systems; Type 3 is Hypermedia Software and Type 4 is Virtual Reality and Other immersion systems

Presentation software such as slideshow presentation tools e.g. Microsoft PowerPoint, Star Office Impress, and other linear tools are used to create as well as engage in descriptive or content presentations projected off a screen (or viewed on a computer). These slideshow presentations usually integrated sound, pictures, video and text. This approach to media development has come under increasing criticism. Some argue that its use makes complex concepts as well as ideas appear too simplistic and to some extent bears some responsibility for the Columbia shuttle disaster (Thompson, 2003). Others say this approach reduces the "quality and credibility" of communication (Tufte, 2003a, 2003b). Still others argue that this approach to communication and presentation represents a type of "hegemonic visualism" (Tietje & Cresap, 2005) that values one approach to presenting and communicating over others.

Video production and editing systems is conceptualized by Roblyer as type 2 multimedia tools. In recent times Apple and Microsoft have begun to disseminate free versions of video production and editing tools. Apple iMovie and Windows Movie maker are now widely distributed through packaging with the standard operating systems of these companies. This has led to the widening development of movie production in k-12 schools. Apple has a web based project devoted to these types of productions among k-12 students called the Apple Learning Interchange (http://ali.apple.com/).

These tools involve the creation and later viewing (or publishing on the www) moving video. These tools allow for easy capturing of videos from a camera or VCR. They are then edited by cutting, pasting, adding still pictures, effects, transitions and soundtracks. These videos can then be saved back to a tape or processed for publishing on a website. They are often used to create interesting digital stories about student life in school or to present content from lessons or fieldtrips.

Research on the cognitive uses of video production and editing for students in an instructional setting remains sparse. We can however argue that as with other types of multimedia production, video has the potential to increase engagement as well as interest and motivation. Students interact with complex operations such as sequencing, research around topics or content, organizing and selecting while using these tools. As our society continues to rely more on videos video production will invariably help students to assess how visual images are used to persuade, communicate biases and form a basis for public education or influence (Roblyer, 2004).

Type 3 tools are those tools that involve the use of Flash cards or webpages as interactive hypermedia. For Roblyer, Hypermedia software is distinct from the previous tools because they engage the learner in non-linear design activities. Such tools encompass hypermedia tools such as Macromedia Authorware, Director, and Flash as well as stack or card software tools such as HyperStudio. They also include web authoring tools such as Microsoft FrontPage, Macromedia Dreamweaver and non commercial products (freeware) tools such as NVU. These tools allow the learner to create html type web pages or animations that employ branching, linking, and multiple access points to information. While developing these types of products learners are constantly engaged in organizing, sequencing and navigating through information. They are also actively engaged in assessing their product since they recognize that others will be viewing it as well (Roblyer 2004).

Virtual reality (VR) authoring systems are still in a nascent stage of application in educational contexts. VR interaction systems such as games, tutorials and instructional tools however have gained popularity for educational use (). Roblyer sees these tools as type 4 multimedia tools. They involve the use of multimedia elements that immerse the learner into a realistic context where the learner can explore, view how systems work as well as interact and engage in practice. Commercial products such as encyclopedias (e.g. Encarta) and online courseware (e.g. River Deep) makes extensive use of these types of systems. They are also common in educational games.

Unlike the previous systems type 5 authoring systems allow for the linking of audio, moving video, still pictures, slide shows and html pages. This multifaceted environment also allows for the synchronization of sound with videos so that viewable activities can be timed and harmonized. Users can also interact with these elements by clicking on links that branch to different points of the presentation rather than move through the show in linear fashion as in traditional slideshows.

PowerPoint producer for example has a complex but navigable production interface (fig.1). As the figure below shows, this software tool allows the user to interact with multimedia elements within one interface. This captures all of the cognitive elements of all of Roblyer's media categories. For example, the story can have a multimedia slideshow with hyperlinked elements on the slides while retaining voice narration that is then synchronized with video segments throughout. The creator can include a table of contents for quick viewing as well as other elements such as running notes for users to follow along or save for further review.

These authoring systems are easily associated with the process of learning by designing. They promote high levels of problem solving; they promote engagement, require hands on learner participation and allow for the creation of real-world artifacts. Produced elements can actually be published to a variety of media (World Wide Web, CDROM, and computer) and in a variety of formats from presentation movies that include slideshows, to compelling online tutorials that act as showcases of student knowledge.

## Methodology

Advanced multimedia projects created by 34 students in an undergraduate applied instructional technology course were examined. Most students developed projects in dyads, however some students developed their own individual projects. A total of fourteen projects were reviewed using Liu's (1998) categorization about implementing a learning by designing environment as a framework for analysis.

### The Learning Environment

For the past year we have implemented the use of these advanced hyper/multimedia authoring systems with 34 students in an introductory instructional technology course for teacher education students. Students were placed in dyads and asked to create a digital story project using PowerPoint Producer 2003. The design framework used in this process was centered on Lehrer and his colleagues as well as Liu's work on learning by designing with multimedia (Lehrer 1993; Lehrer et al 1994 & Liu 1998), this involved a four phase approach planning, designing, producing and evaluation and revision.

Table 1. Cognitive Skills Related to Learning by Design with Multimedia Design Model

| Phases of Design Model | Design Component & Activities | Cognitive Skills Targeted* |
|---|---|---|
| Planning | Defining the Nature of the Problem<br>- Viewing other digital stories<br>- Instructor led tutorials, discussions & demonstrations<br>Problem Decomposition<br>- Process diagrams or establishing timelines | Posing questions, problems or challenges<br>Dividing tasks with collaborators/peers<br>Determining the elements (tasks) of the problem<br>Analysis and conceptualization of solution<br>Creating a timeline<br>Electronic database & document searching |
| Designing | Finding Information<br>Developing New Information<br>- Storyboarding, concept mapping, sketching, outlining<br>Selecting Information | Taking notes making annotations<br>Narrative or script writing<br>Deciding on process and structure |

| | | |
|---|---|---|
| Producing | - Group discussions<br>Organizing Information<br>Representing Information<br>Applying multimedia tools in through scaffolding (PowerPoint, web pages, video editing then synchronization)<br>Acquiring graphics, pictures or sounds<br>Applying animations, transitions and varied effects | Use of Database Tools, Semantic Mapping<br>Segmenting Video & Sound<br>Interweaving Media, Graphic & Video Production<br>Representing what is known via different media<br>Transmit elements to diverse media<br>Managing limitations (time, resources, tools etc) |
| Evaluating & Revising | Ongoing self- evaluation of the design<br>Group evaluation of the design<br>Instructor evaluation of the design | Receiving and applying feedback (peers, instructor & via reflection)<br>Going public via demonstration/presentation |

* These thinking skills are those cited by Liu from Carver et al 1992

**Results**

Students generally produced projects that fell into three categories, a.) Self-identity or culture based projects b.) Professional need or practice projects and c.) Digital stories of dramatic or historical events projects. These choices were interesting in and of themselves for they clearly reflect the desire on the part of students to represent their own interests in the design of multimedia learning materials. Each type of project that was created in some senses reflected different levels of interest on the part of students but involved complex design tasks nonetheless.

Self-identity projects involved the creation of projects that reflected the cultural experiences of students. In figure 2 for example students retold the story of “How dogs became man’s best friend” in Russian and English. A video of students retelling the story and wearing Russian traditional dress were juxtaposed with a slideshow of interesting words and events. Other interesting projects included the retelling of Maya Angelou’s *And Still I Rise*, Dr. Seues’ *The Sneetches* and a Native American folktale *The Rough Faced Girl*.

Professional practice projects were based on the creation of lesson materials and classroom management slideshows for students and parents to use. Figure 3 depicts an open house production that a mathematics teacher created as an introduction to the school and classroom environment. Other ideas included lessons and tutorials on American Sign Language, letters of the Alphabet and book summaries.

Students also used this medium for creating digital stories that depicted personal experiences or historical events. Students drew upon the civil rights movement. Using a wealth of resources they produced a rich media production that juxtaposed images of the civil rights movement (project called the Watsons – based on the book *the Watson’s go to Birmingham*) with voice narration as well as inserting speeches from that era e.g. Dr. Martin Luther King’s *I have a dream* (Fig. 4). Other projects included personal experiences on the Tsunami in Sri Lanka.

The finished hyper/multimedia is published to a website where it is viewable in any standard web browser. The software packages automatically generate the table of contents, as well as layout, and entry (or exit) of synchronized elements. At the production level the creator simply sequences the main elements (audio, video, pictures and slideshow) on the timeline as well as edits the table of contents.

These types of projects allowed students to be centered in the learning context and provided motivation for them to be actively engaged. As is commensurate with previous findings (Beichner, 1994) my students were often willing to put in longer hours in the lab to develop projects and schedule time outside of class to meet in production teams for filming video footage and recording voice narrations. They were also continuously engaged in research for source materials (pictures, music, articles, books) that would help them to represent their content better using the media.

Previous studies identified that while developing multimedia learners “internalize various design skills (Liu p. 388).” In these studies “students reported increases in mental effort and involvement, interest, planning, collaboration, and individualization” (Liu p. 388).” In our own work with advanced hypermedia we observed that students engaged in these elements as well. One student commented that this approach increased their collaborative experiences and reflected their perspective. She states a positive likeness toward this approach “because I continue to get experience in group work, and getting along with others. It also showed how each of us had a different view on how we wanted the video [digital story] and the type of books we wanted. But digital storytelling lets the students express their views.”

Of the three project types that students opted to create, the digital story was found to be more complex and more media rich. Perhaps because of the number of digital resources available on the world wide web surrounding important historical events these projects tended to be more sophisticated. For example, students would try to join two audio clips or video clips related to the event. So the Watsons project begins with the *I have a dream* speech but then goes into the authors, voice narration. Students would also conceptualize different scenarios for representing an event that was sometimes beyond the limits of the software. E.g. the Tsunami project authors wanted to show an animation of how the moving flood waters forever altered the South & East coastlines of Sri Lanka.

The most interesting result of this process at least from the standpoint of the instructor is the extent to which students were able to represent the complexity in their own thinking using this tool. One student felt that the complexity of the media by fusing video, slideshow and voice narrative allowed for the organizing, sequencing and publication of complex thoughts that would have otherwise been difficult to achieve. In synchronizing this with a table of contents and various hyperlinks to other aspects of the story, the viewer can interact with this complex experience that would have been impossible through the traditional approaches to storytelling (face-to-face) as well as traditional approaches to moving video (basic video production). The digital storytelling approach allowed students to draw upon rich media in order to transmit complex thoughts.

As is commensurate with Oughton and Reed (1998) it was found that students did deeply engage in complex cognition and problem solving as they interacted with by developing digital stories through the use advanced multimedia. Through this process preservice teachers engaged in problem solving in an ill structured learning domain. Preservice teachers learned to use PowerPoint Producer not simply to learn about the tool but they also learn important tasks such as planning, designing, evaluating as important design principles. Students appreciated the assessment and revision aspect because it allowed them to refine their products as one student stated. This approach “gave students time to perfect their work, and fix mistakes they weren’t suspected to run into!”

These stories played an important role in infusing the learners perspective into the material designed. The use of digital storytelling allowed the preservice teachers to engage in the use of complex media in order to represent complex content. Students commented on the fact that digital storytelling in this way could be carried out through different types of media. Additionally, they recognized that whatever is designed inherently carries the learners perspective. Student comments ranged from “Through digital story telling, all students are able to benefit from visual and audio technologies since both reinforce learning.” As well as including comments like, “I can see that each student might approach the story differently with various reading styles and pictures. Also different takes on the message of a story can come out in this storytelling technique and be shared with other students.”

Another important result was the fact that student projects reflected nuances toward important skills required particularly among diverse populations such as ESOL or struggling English Language learners. While developing the scripts and narratives for the production preservice teachers engaged in developing lengthy narratives. Additionally, the slideshow portions made extensive use of text. In this regard language skills were brought into the production as a central tool for product completion. Some students actually chose to create the narrative before developing the storyboard as they felt that this was a better way to organize their thoughts.

The PowerPoint Producer software tool was observed to be effective tools for preservice teachers to use. Students were able to complete highly developed rich media projects within the context of the overall semester (one summer session of 8 weeks and a regular 16 week session) along with other curricular projects as well. Students did not display great difficulty in navigating the PowerPoint Producer software. In an informal survey students expressed that the digital storytelling project allowed them to see how different technologies can be applied on comment said that, “the digital storytelling project did help me to realize different perspectives and different uses of technology.”

**Implications**

The use of advanced multimedia as a software tool for developing digital stories is compelling. In large part these tools are just emerging as robust and applicable to the educational context. In education in general and in our own case in particular these tools remain underused. This media should be exploited especially in relation to digital story telling as the digital story provides the complexity for the media to be effectively used.

Using this type of software tool with digital storytelling is different from simple slide show digital stories or even traditional moving video. These traditional types interact with a single set of source files that form the focal point of the production i.e. slideshow or video. In the case of the advanced multimedia products there is an opportunity to select any of three main media types as the focal point. This means that there is an inherent complexity that lends itself to representation of complex content.

Advanced hypermedia of this type 5 category, has implicit value for infusing learning by design among ESOL students or other students with emerging language skills. The use of the narrative script and the slideshow form important scaffolds to getting new or emerging English Language learners to use the language openly and freely with what is known to be an engaging approach. Students who are gifted or are highly technologically literate will also find intrinsic value in using this approach as well. Primarily type 5 hypermedia with digital storytelling engages the learner because of the pedagogical value not because of the technical or aesthetic factor. Preservice and Inservice teachers that utilize this approach will find great value in it for giving students voice and perspective.

**Graphics**

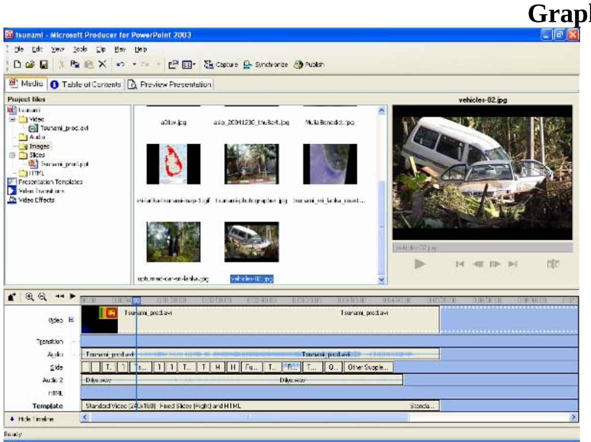

Fig. 1: Production interface of PowerPoint Producer

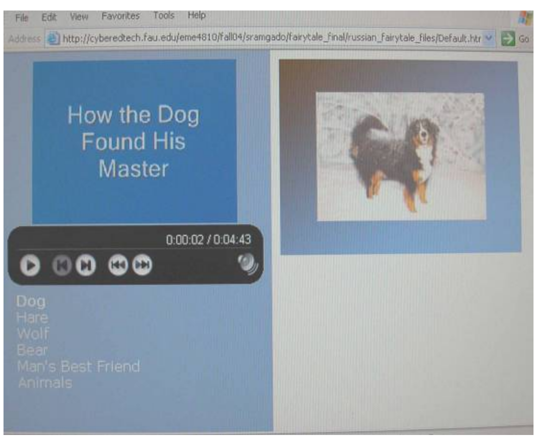

Fig.2: English & Russian Folktale (with video & voice)

Fig. 3: Open house classroom production

Fig.4: Civil Rights Digital Story in PowerPoint Producer 2003

**References**

Beichner, R. L. (1994). Multimedia editing to promote science learning. *Journal of Educational Multimedia and Hypermedia*, 3(1), 55-70.

Bull, Glen & Kajder, Sara (2004). Digital Storytelling in the Language Arts Classroom. *Learning and Leading with Technology*, Vol. 32 No. 4

Bush, V. (1945). As We May Think. *The Atlantic Monthly*, 1945, 176(1), 101-108

Fitzgerald, G. E Hardin L, and Hollingsead C. (1997). Engaging preservice teachers in hypermedia authoring: process and outcomes. *Journal of Educational Computing Research* V. 16 no. 2 (1997) p. 191-207 Peer Reviewed

Garthwait Abigail (2001). *Factors Influencing Technology's Effect on Student Achievement and a Caution About Reading the Research*. College of Education & Human Development University of Maine and the Penquis Superintendents' Association Occasional Paper No. 40

Gibbs, W., Graves, P. R., & Bernas, R. S. (2001). Evaluation Guidelines for Multimedia Courseware. *Journal of Research on Technology in Education*, 34(1), 2-11.

Harris, R. Carl, Pinnegar, Stefinee, & Teemant, Annela. (Spring 2005)The case for hypermedia video ethnographies: designing a new class of case studies that challenge teaching practice. *Journal of Technology and Teacher Education*, 13, p141(21). Retrieved October 13, 2005, from Expanded Academic ASAP via Thomson Gale:

Jeeheon, Ryu. (2004).*A Cognitive Model of Knowledge Transformation In Authoring Hypertext*. Unpublished PhD dissertation, Florida State University, Tallahassee, FL.

Jonassen D. & Hernandez-Serrano, J. (2002) Case-Based Reasoning and Instructional Design: Using Stories to Support Problem Solving *Educational Technology Research & Development* , Vol. 50, No. 2, 2002, pp. 65–77

Jonassen, D.H. Peck, K. Wilson, B.(2000). *Computers as mindtools for schools*. Upper Saddle River, NJ: Merrill.

Jonassen, David H. (undated)., *Technology as Cognitive Tools: Learners as Designers*, ITFORUM Paper 1. Retrieved 13 October 2005, from http://itech1.coe.uga.edu/itforum/paper1/paper1.html

Jonassen, D.H. (1998). Designing constructivist learning environments. In C.M. Reigeluth (Ed.), *Instructional design theories and models: Their current state of the art* (2nd Ed.). Mahwah, NJ: Lawrence Erlbaum

Jonassen, D.H. and Reeves, T.C., (1996). Learning with technology: using computers as cognitive tools. In:

Jonassen, D.H., Editor, , 1996. *Handbook of research for educational communications and technology*, Macmillan, NY, pp. 693–719.

Lehrer, R., Erickson, J., & Connell, T. (1994). Learning by designing hypermedia documents. *Computers in the Schools*, 10, 227 - 254.

Lehrer, R. (1993). Authors of knowledge: Patterns of hypermedia design. In S. P. LaJoie & S. J. Derry (Eds.), *Computers as cognitive tools* (pp. 197 - 227). Hillsdale, NJ: Lawrence Erlbaum.

Liu, M. (2004). Examining the performance and attitudes of sixth graders during their use of a problem-based hypermedia learning environment. *Computers in Human Behavior* Vol. 20 No. 3 (May 2004) p. 357-79

Liu, M., (1998). A study of engaging high-school students as multimedia designers in a cognitive apprenticeship-style learning environment. In *Computers in Human Behavior*, 14, p387(29). Retrieved 13 October 2005, from *Expanded Academic ASAP* via Thomson Gale:

Liu, M., & Rutledge, K. (1997). The effect of a "learner as multimedia designer" environment onat-risk high school students' motivation and learning of design knowledge. *Journal of Educational Computing Research*. 16(2), 145-177.

Lundeberg, M. A., Coballes-Vega, C., Standiford, S. N., Langer, L., & Dibble, K. (1997). We think they're learning: Beliefs, practices, and reflections of two teachers using project-based learning. *Journal of Computing in Childhood Education*, 8(1), 59-8.

Nicaise, M., & Crane, M. (1999). Knowledge constructing through hypermedia authoring. *Educational Technology* 47 (1), 29.

Oughton, J.M., & Reed, W.M. (Jan 1, 1999). The influence of learner differences on the construction of hypermedia concepts: a case study. *Computers in Human Behavior*, 15, p11(40). Retrieved October 13, 2005, from CPSN via Thomson Gale:

Reed, W.M., Oughton, J.M., Ayersman, D.J., Ervin, J.R., & Giessler, S.F. (Nov 1, 2000) Computer experience, learning style, and hypermedia navigation. *Computers in Human Behavior*, 16, p609 (20). Retrieved October 13, 2005, from Expanded Academic ASAP via Thomson Gale:

Reed, W.M., & Oughton, J.M. (Jan 1998). The Effects of Hypermedia Knowledge and Learning Style on the Construction of Group Concept Maps. *Computers in Human Behavior*, 14, p1(22). Retrieved October 13, 2005, from Expanded Academic ASAP via Thomson Gale:

Reeves, T. C. (1998). *The impact of media and technology in schools*. Georgia: The Bertelsmann Foundation. Retrieved January 26, 2004, from http://www.wired.com/wired/archive/11.09/ppt2.html

Resnick, M.(1998). Technologies for Lifelong Kindergarten. *Educational Technology Research & Development* (vol. 46, no. 4, 1998)

Resnick, M., & Ocko, S. (1991). *LEGO/Logo: Learning Through and About Design*. In Harel, I., & Papert, S. (eds.), Constructionism. Norwood, NJ: Ablex Publishing

Repman, J., Weller, H. G., & Lan, W. (1994). Impact of social context on learning in hypermedia-based instruction. *Journal of Educational Multimedia and Hypermedia*, 2(2), 283- 298.

Riddle, E. M. (1995). *Communication through multimedia in an elementary classroom* (Report # 143). Charlottesville: University of Virginia, Curry School of Education. (ERIC Documentation Reproduction Service No. ED384346)

Speaker, K. (2004) Student Perspectives: Expectations of Multimedia Technology in a College Literature Class. *Reading Improvement* Vol. 41 No 4 Winter 2004.

Spoehr, K.T. (1994). Enhancing the acquisition of conceptual structures through hypermedia. In Kate McGilly, ed., *Classroom lessons: Integrating Cognitive theory and classroom practice*, 75-101. Cambridge, Massachusetts: The MIT Press.

Thompson, C. (2003, December 14). PowerPoint makes you dumb. *The New York Times Magazine*, p. 88.

Tietje L. & Cresap S. (2005). Hegemonic Visualism. *Radical pedagogy* [1524-6345] Vol: 7 iss: 1 pg: 1

Thomas, M., K. (2003) Designers' Dilemmas: The Tripartheid Responsibility of the Instructional Designer. *Tech Trends* Vol 47 No. 6

Tufte, E. R. (2003a, September). *The cognitive style of PowerPoint* [Monograph]. Cheshire, CT: Graphics Press.

Tufte, E. (2003b, September). PowerPoint is evil. *Wired*. Retrieved October 12, 2005, from http://www.wired.com/wired/archive/11.09/ppt2.html

Turner, S. V., & Dipinto, V. M. (1992). Students as hypermedia authors: Themes emerging from a qualitative study. *Journal of Research on Computing in Education*, 25(2), 187-199.

# A Systems Approach to High-Quality Online Course Development Guidelines

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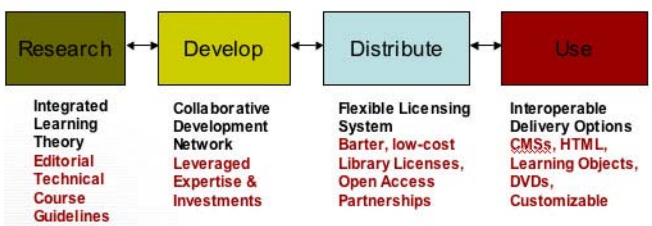
The National Repository of Online Courses (NROC) project supports the development and distribution of high-quality online courses to a *worldwide audience*. The goal of this project is to facilitate collaboration among a community of developers to create a library of online courses that are available to instructors in academic institutions everywhere. Supported by The William and Flora Hewlett Foundation, the library launched this summer offering courses for high school, Advanced Placement©, and higher education.

**A Sustainable Business Model**

NROC is being built upon an innovative business model that is prototyping a complete online learning "value chain." including editorial and technical guidelines, a collaborative development network, and options for flexible delivery and use by instructors. The model consists of pedagogical and technical guidelines for course development, a collaborative development network, options for flexible delivery, barter, and licensing, customization, and facilitation by instructors.

**Sustainable Online Course Value Chain**

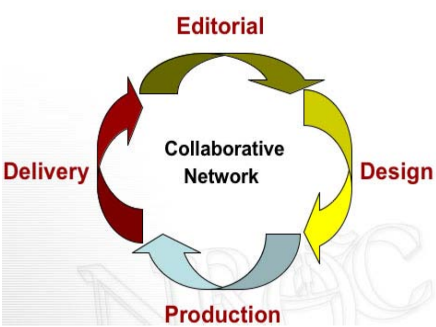
Figure 1

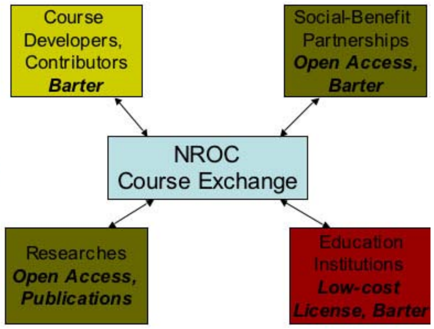



**Collaborative Development**

As the online education field takes off, tens millions of dollars are being spent on developing courses at the instructor and class level. It is safe to say that tens of thousands of courses are being made throughout the world. Yet when we survey the courses that are in use and in development, a tiny number of the courses employ innovative learning theory, high production value, or interoperable technical specifications. With this as our landscape, NROC has built a collaborative development model that allows course developers to share guidelines and expertise, advise on design and implementation, seek joint funding for collaborative development, match-make institutions with the same needs to leverage existing resources into sharing curriculum development.

**Collaborative Developer Network** **Flexible Barter and Licensing Model**




## Global Distribution

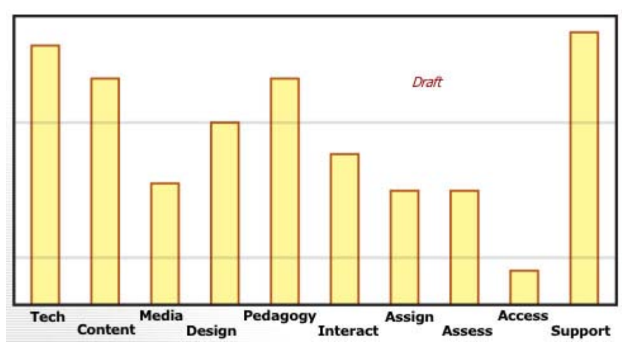
NROC partners with academic institutions, publishers, teaching organizations, state and federal agencies, international distributors, social benefit programs and others to create a global distribution network to provide courses to student, teacher, and the general public at little or no cost. There are a number of ways in which courses may be licensed for use, including barter (trading for contributing resources to the library), low-cost library licenses and open access licenses.

## NROC Guidelines

Our guidelines provide a comprehensive framework and set of principles that encompass what is known about effective online education, that have the flexibility to evolve as the marketplace of technologies, collaboration, investment, and learner and teacher experiences shift. The Guidelines are designed to help bridge the gap between what research tells us about learning, the current state of the online learning marketplace, and the existing technologies. The long-term goal of National Repository of Online Courses is to create a robust digital library of online course content, providing the best learning experiences possible for any institution, instructor or student who wants to use online courses to enhance learning and teaching. Our short-term goal is to disseminate the NROC guidelines to facilitate collaboration in the course development community, in order to navigate down a pathway of continual improvement in the quality, interoperability and availability of complete online courses.

## Pedagogy and Content

**Integrated Learning Theory and Development Guidelines**


## Learning Theory Framework

There are many approaches to defining learning theories, philosophies and best practices. The various philosophies of learning have tended to create silos and camps, inspiring debates over which is most effective or essential to learners' achievement. We have found it most productive for our purposes to take a **"systems approach"** to learning and teaching in which the theories and philosophies, with their relevant applications and data, are integrated and aligned into a unified framework of learning. NROC guidelines have therefore been designed within a comprehensive framework and set of principles that assume *alignment and reinforcement between theories of learning – as elements of an ecosystem that require reinforcing relationships between elements to succeed as a whole.*

The NROC systems approach is an integration of learning theories focused around 4 major themes: learner centered, knowledge centered, assessment centered and community-centered approaches. (ref. *How People Learn*, The National Research Council). We have derived a list of some of the significant attributes under each approach to inform our guidelines. We are asserting that the best online learning experiences involve a mix of these attributes, and that they should reinforce and harmonize with one another.

| | |
|---|---|
| **Learner Centered**<br>o multiple learning styles<br>o metacognition<br>o feedback<br>o interaction<br>o relevance | **Knowledge Centered**<br>o subject expertise<br>o concepts, principles<br>o subject pedagogy<br>o structure, scaffolding<br>o applied, connected |
| **Assessment Centered**<br>o multiple types<br>o understanding<br>o concepts, principles<br>o problem solving<br>o transfer | **Community Centered**<br>o social context<br>o cultural context<br>o real world connection<br>o relevance<br>o **interaction** |

**Significant Domains**

We have defined ten significant domains, or dimensions, within which principles for effective development and execution of online courses are organized. These domains were chosen by synthesizing the literature on learning theories, current practices and experiences, and vetting them with the real world issues of current available standard technologies, how education is managed and delivered, the experiences of teachers, and expectations of learners. These ten domains and their principles include the following.

**Technology**

*Description:* technology environment and tools proving student and instructor access to online course content and experience.

*Principles:* Uses standard technologies, bug free, runs perfectly. Interoperable with common learning management systems. Provides interaction options between learners content, peers, teacher, external information and examples. Clean navigational structure, pathways, organizational hierarchy and feedback functionality.

*Rating:* (1-4) 4 Interoperable, full featured, 3: Missing major feature, 2: Limited interoperability and limited features, 1: Does not take advantage of CMS interaction features/lacks good structure, and or limited in features, hard to use.

**Content**

*Description:* Breadth, depth, approach appropriate for course level and subject coverage.

*Principles*: Clear presentation of major principles, concepts, framework and thinking processes of subject. Incorporates real world examples, applications, additional sources and a variety of information types. Learning objectives reflect building knowledge, critical thinking, and transfer. Content organized in units with topics and subtopics. Transparent content framework that shows learning chunks, subject structure and associated activities. Coverage maps to depth and breadth of generally accepted standards for target course (such as established by AP guidelines & textbook contents). Includes current, socially and culturally relevant context and connections. Writing tone, level and style clear, informal and accessible to learners.

*Rating:* (1-4) 4: Complete course content online, 3: Majority of course content, linked supplemental content, 2: Areas of weak coverage, 1: Textbook dependent more than 1/2 content.

**Media**

*Description:* use of multiple media types to present content, provide activities and interactions.

*Principles:* Multi-modal media used to help present, and work with, key concepts, examples, applications. Provide for varied learning style and skill approaches: text, graphics, photos, animation, simulation, video, audio as appropriate for conveying subject. Engaging, motivating. Coherent arrangement of media types designed to link to and reinforce each other. Learner navigation and controls available and consistent.

*Rating:* (1-4) 4: Good design and pedagogical use of 4+ media types, 3: Good pedagogical use of 3 or fewer media types, 2: Weak use of media, 1: Limited media, and/or poor use.

**Design**

*Description:* Overall course construction, content presentation, navigation, use of visual elements, technical features.

*Principles:* Course navigation is intuitive, provides logical and varied paths through material. Helps to reveal context and connections of topics. Well-used mix of media for content presentation to scaffold new understanding, different learning modes and perspectives. Elements proportional, harmonious, uncluttered and restrained. Control of navigation and media consistent, clear and available to learner.

*Rating:* (1-4) 4: Well executed instructional, information, and media design, 3: Design weakness can be augmented by customization, 2. Contains design flaws/does not enhance experience, 1: Design hampers learner experience.

**Pedagogy**

*Description:* Application of universal and subject specific learning theories that enable effective learning and teacher.

*Principles:* Integration and alignment of 1) learner, 2) knowledge, 3) assessment and 4) community centered pedagogical approaches. Incorporation of subject specific pedagogy. Encourage learner metacognition – reflection on learning process and progress. Learner as driver, teacher as facilitator, guide, mentor. Multiple interaction types, safe and encouraging environment. Experience designed for learning subject framework and thinking processes.

*Rating:* (1-4) 4: Multiple approaches integrated and aligned to provide rich learning and teaching environment, 3: At least three well executed pedagogical approaches, 2: Lacking learner and community centered approaches, 1: Lacks coherent pedagogical approach.

**Interaction**

*Description*: Interaction types to include learners with content, other learners, teacher and outside experts/information through use of technology, course design and activities.

*Principles:* Interactions integrated throughout, providing multiple opportunities to construct meaning, reflect, examine assumptions, critique, question, and transfer knowledge, initially using own language, scaffolding to use of subject language and thought processes while advancing. Learning community of social interactions between peers, with teacher, (most motivational learning environment, best opportunities to construct understanding). Students and teachers create activities using communication tools. Performance expectations, and instructor availability explicit.

*Rating: (1-4)* 4: Learning activities provide multiple opportunities for reflection and critical thinking expressed in interactions with content, peers, instructor and external examples, flexible, adaptable by instructor 3: Some strong use of learner centered interactions with peers and instructor, 2: Weak opportunities for learner centered interactions, 1: No use of social interaction in learning activities or assessments.

**Assignments**

*Description:* A variety of activities provided for students to interact with, use, apply, reflect upon, and build content.

*Principles*: Active learning opportunities with varied assignments consistent with content presentation, learning objectives, and assessment. Provide motivation, encouragement and empowerment to work with content. Relevant and accurate. Clear instructions. Appropriate to course level and subject. Provide opportunities for practice, building conceptual frameworks, knowledge, critical thinking, reflection, understanding, transfer and exploring alternative approaches and perspectives. Different learning styles and skills required, using mixed media and communication tools. Expectations transparent to learners. Collaborative assignments available for peer teaching and assessment. Adaptable by learner and instructor.

*Rating:* (1-4) 4: Rich and varied use of individual and group activities to build subject framework, enhance practice and critical thinking, transfer, expression and reflection on learning process, 3: Individual and group modes for practice, application and critical thinking, 2: Requires enhancement of activities for learner centered experience, 1: Lacks assignments requiring reflecting on learning process, critical thinking and learner expression of content.

**Assessment**

*Description:* A variety of assessment types providing sufficient testing and feedback throughout the course to show knowledge acquisition, application and transfer.

*Principles:* Assessment strategies varied and consistent with content presentation, learning objectives and activities. Formative and summative. Relevant and accurate. Clear instructions. Feedback from quizzes and problems provided to learner throughout course to enable self-monitoring of progress. Appropriate to course level and subject. Show critical thinking, reflection, connections, understanding and transfer. Expectations and grading rubric transparent to learners.

*Rating:* (1-4) 4: Varied, well spaced assessment strategies, multiple learning, styles, immediate feedback on learning process and progress, reflects mastery of learning objectives, 3: Varied strategies, sufficient feedback, mapped to learning objectives, 2: Limited assessment options, need supplementing to be effective, 1: Lacks sufficient assessment to measure progress towards learning objectives.

**Access**

*Description:* Ability of students with some learning challenges to access content, including through alternative presentation methods and support.

*Principles*: Acknowledgement of need. Effort made for access to special needs learners. Alternatives to auditory and visual content are available. Consideration for navigation by motor challenged. Color conveying meaning is available without color.

*Rating:* (1-4) 4: Rich content and learning experience supplemented by alternative, parallel content mode accessible to auditory, visually, or motor challenged, 3: Content presentation accessible to visually *or* auditory *or* motor challenged 2: Some content not available, but can be supplemented, 1: Of limited value to learning challenged.

**Support**

*Description:* Information provided to learners and teachers to most effectively use, facilitate, support, and design the online course experience.

*Principles:* Student. Orientation to course and online learning, introduction to course structure, guide to "experiencing the subject," complete syllabus, participation expectations, assignments, grading policy, skills required, prerequisites. How to succeed online and work with peers, links to outside resources. Teacher. Guidelines for how to teach online, create and guide collaborative learning activities, group projects, peer-to-peer interactions. How to create a safe and encouraging experience, facilitate and guide students to construct, control and share their learning experiences. Complete instructors' manual with assignment and assessment suggestions. How to assess discussions and group projects. Link to tips and examples.

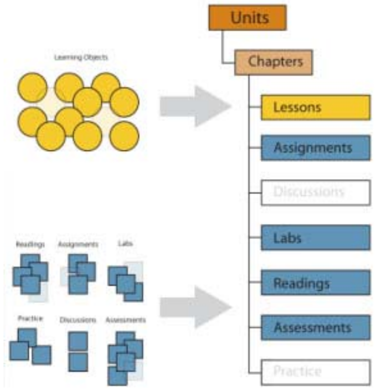
*Rating:* (1-4) 4: Complete set of learner and teacher support guidelines, orientation, examples and external resources for successful online learning and teaching experience, 3: Essential learner and teacher support materials: orientation and guidelines for interaction, 2: Support material needs supplementing, 1: insufficient support material for learning or teaching orientation and guidance on how to succeed in an online course environment.

**Design and Technology**

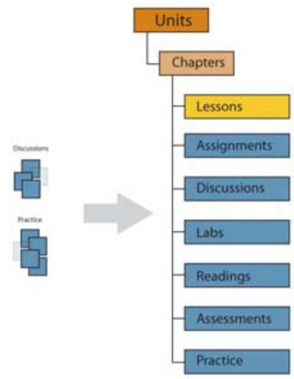
**Interoperability**

Our technical guidelines and execution have been designed to provide as much practical interoperability as is reasonably possible in the current digital environment. We (re)develop courses and learning objects to fit into a flexible schema that keeps file hierarchies, content, activities and assessments organized, to be most easily ported into various environments. NROC courses operate within most commonly used CMS tools and therefore require no new training. With a bit more effort and technical assistance, NROC course files can be loaded into proprietary and open source learning systems, or may be simply served as content without a CMS in an open, web-based environment. To support a wide variety of delivery options, NROC provides resources, training and consulting services to aid course library implementation.

**Interoperable Delivery Options**




**Customizable Courses**




**Customization**

To address some of the cultural and technical barriers to instructors and institutions adopting courses from other organizations, we have designed our courses and processes to make it as easy as possible for customization. Our content and technical guidelines promote a uniform presentation and organization of course learning objects so that it is transparent for instructors, or development partners to customize the courses within learning management systems by turning off or hiding any files not wanted, and augmenting the content presentations and activities by importing new files into the course. This schema also creates independent learning objects that can be taken out of the course sequence to build new modules or lessons around or enhance a course that has already been developed. We are also researching the cultural issues in the way of more substantial course exchanges between instructors and institutions. We will be providing training seminars and an online learning community to assist in learning about using third party online content, strategies for evaluating materials, and practical, hands-on techniques for integrating all of these resources to make courses more engaging and effective.

## NROC Technical Development Guidelines

The purpose of these guidelines is to provide course developers with an understanding of the values, characteristics and organization of the course content in the National Repository of Online Courses. Course developers can use this document to create courses that are consistent with the course architecture, distribution characteristics and end-user requirements of the NROC library.

**Background**

Our technical guidelines are meant for anyone interested in developing content for, or contributing content to, the NROC course library. The guidelines are not a strict set of technical specifications, but rather a set of characteristics and values that all courses in the NROC library should exhibit. As a set of guidelines that represents characteristics and values, the degree to which any course adheres to the guidelines can vary. Our goal in publishing the guidelines is to increase the degree of adherence for any NROC course candidate.

**NROC Course Characteristics**

The NROC course library has broad national and international distribution. Distribution typically includes sending courses on CDs or DVDs to be installed and hosted on a licensee’s server. Candidate NROC courses should be free of any licensing or technical restrictions that would prohibit this type of distribution.

Most NROC courses contain a great deal of multimedia content. Multimedia content can be instructionally effective, but it is very difficult to edit– it requires special software, skills or training, and is some cases, access to source code or source files. NROC courses break down the multimedia instructional content into discrete lessons (learning objects) that can be deleted, reorganized, or repurposed, giving an institution or instructor the greatest flexibility and degree of modification available without directly editing the content.

Multimedia content also requires a great deal of storage space on a web server. Because most institutions offer multiple sections or sessions of a single class, each requiring their own copy of a course within a CMS, the NROC course hosting model places all multimedia course assets on a single central content server. This allows the same multimedia learning objects to be referenced by each copy of a course without duplicating the content in each course. Since the multimedia learning objects are not directly edited by the instructor of each course session, only one copy of each learning object is required on the central content server.

NROC courses are designed for use with a Course Management System. Most NROC courses have been pre-loaded on WebCT, Blackboard and eCollege to facilitate installation on these Course Management Systems. All course content is provided in one or more formats that are compatible with most other Course Management Systems. In addition to interoperability, NROC courses seek to leverage the basic functionality provided by CMSs. NROC courses use the CMS system to provide the course organization, display the course menu, manage communication, manage collaboration activities, and deliver assessments. By relying on the CMS for this functionality and providing instructional and assessment content that is in a format that can be used by a CMS, NROC courses inherit the features of the CMS system. Instructors can use the interfaces provided by their CMS to edit the course structure, add content, change the scoring and weighting of assignments or edit assessment items.

The NROC course model relies on, and seeks to support, the role of the instructor in a course. In addition to the course modification support and flexibility described already, NROC courses include a Teacher's Guide, answer keys and grading rubrics. The Teacher's Guide for each course may include notes and teaching tips for each section of the course, alternate and supplemental assignments or assessments and correlations to multiple textbooks.

The following section provides more details on NROC course requirements, characteristics and guiding principles.

**Server Requirements**

NROC courses are typically hosted by licensees of the NROC library. NROC courses are delivered using a standard HTTP web server like Internet Information Server with no special port or firewall requirements. Courses should not rely on any proprietary server-side technologies or database connections. Note that NROC courses are designed for use with a Course Management System that will have its own list of server requirements. See *Appendix B: System Requirements* for more information on this topic.

**Client Requirements**

NROC courses use standard web technologies including HTML, FLASH, Java, JavaScript and PDF. They are designed to run in standard browsers including Internet Explorer, Safari, Netscape and Firefox on Windows and Macintosh operating systems. Courses should avoid reliance on non-standard browser plug-ins and extensions. In order to minimize the NROC client-side requirements, NROC recommends the use of QuickTime for delivery of web-based video content

**Licenses and Royalties**

Candidate courses should not require any software or media licenses or royalties associated with NROC distribution of the course. NROC courses should not rely on any proprietary software or technology that requires a software license and royalty payment. Course media elements including images, video, audio and animation should not require any re-licensing or special permissions by NROC library subscribers.

**Complete Courses**

NROC courses should be complete in their scope and coverage of the topic presented. While the course may require the use of a textbook, labs or other supplemental materials, these materials should not be the primary instructional resource for any section of the course. NROC courses are designed to support a distance learning education model where the course can be completed on-line, with moderation by an instructor. NROC courses can also be used as a collection of resources to support other use cases, including support of tradition classroom courses and teacher education programs.

**Reuse**

NROC courses employ an object-based architecture. The courses are built as a collection of lessons, assignments, labs and assessments that are organized within units and chapters. Each course element should be self-contained – it should not rely on the presence of other discreet elements to be technically or instructionally functional. Instructional objects, especially multimedia content that is not readily editable by an instructor, should be small enough to be viewed in one instructional period (about 45 minutes). However, to increase the potential for reuse, while maintaining instructional context and minimizing the complexity of the course map, learning objects will ideally represent 6 to 12 minutes of instruction. The object-based NROC course design allows course content to support a number of educational uses. Packaging a course as a collection of discreet elements allows an instructor to modify and augment a course by deleting, editing, reorganizing and adding content.

**CMS Friendly**

NROC courses consist of a collection of instructional and assessment elements that are represented in formats that are compatible with most other Course Management Systems. NROC courses use the CMS system to provide the course organization and display the course menu. NROC courses are designed to leverage the functionality provided by the CMS system. Course content including discussion questions and collaboration projects are designed to use the communication tools provided by most CMS systems.

**Assessment Delivery**

NROC course assessments are delivered with the assessment tools provided by the CMS. Assessment item types are limited to those commonly supported by CMS assessment tools and include multiple choice, short answer, and matching. The assessment content is provided in a number of formats to facilitate importing the content into the CMS. The available formats include RTF, XML (IMS QTI) and Respondus (a commercial assessment management and development tool - www.respondus.com). Answer keys and grading rubrics are provided for all course assessments.

**Role of the Instructor**

While NROC courses represent an organized, complete and in-depth treatment of the topic, the course instructor is the final arbiter of what is presented to the student. NROC courses can be used as is, edited, augmented, combined with an existing course or used as a learning object repository. To support the instructor, NROC courses include a Teacher's Guide. The Teacher's Guide should contain notes and teaching tips for each section of the course, a pacing guide, rubrics for grading assignments and assessments, alternate and supplemental assignments or assessments and correlations to multiple textbooks.

## NROC Course Structure

**Home**

The course Home serves as an introduction to the course. The Home section includes the course title, a brief description of the course content and course-level objective and outcomes.

**Syllabus**

Each NROC course has a Syllabus section that contains information about the course elements, course organization, and textbooks that may be used with the course. All of the textbooks listed in this section have been "mapped" to the course content. The syllabus section may also contain other resources such as web links or class discussion topics.

**Chapters**

NROC course content is organized by Chapter (in some NROC courses a collection of Chapters may be organized into a Unit). A typical semester course will have between 10 and 15 Chapters. Each Chapter contains the Readings, Lessons, Assignments and Assessments that make up the course content.

Additionally, each will typically contain a midterm and final exam. The diagram below shows the structure of a typical NROC course.

## REFERENCES


Advancing the Boundaries of Higher Education in Arizona Using the World Wide Web, Maryanne Fox & Paul Helford Northern, Office for Teaching and Learning Effectiveness, Arizona University, 1999

An Introduction to Quality Matters: Inter-Institutional Quality Assurance in Online Learning, a project of MarylandOnline, and the Fund for the Improvement of Postsecondary Education (FIPSE), Web: www.QualityMatters.org

Best Online Instructional Practices: Report of Phase I Ongoing Study, Morris T. Keeton Senior Scholar University of Maryland University College, JALN Volume 8, Issues 2 - April 2004, p 75

Canadian Recommended E-learning Guidelines (CanREGs) Prepared by Dr. K. Barker, FuturEd January 2002, FuturEd and CACE (Canadian Association for Community Education) All right reserved. No part of this work may be reproduced in any form by any means without permission in writing from FuturEd, 101 - 1001 W. Broadway, pod 190, Vancouver Canada, V6H 4E4.

Coherence and Continuity, Weaving the f2f and virtual together, Vicki Suter, Director, NLII Projects (vsuter@educause.edu) Collaborative Communities of Practice 2004 Conference, September 14 – 16, 2004

Connecting learning objects to instructional design theory: A definition, a metaphor, and a taxonomy, Utah State University, Digital Learning Environments Research Group, The Edumetrics Institute, Emma Eccles Jones Education 227

Criteria for Evaluating the Quality of Online Courses, Clayton R. Wright, wrightc@macewan.ca, Instructional Media and Design, Grant MacEwan College, Edmonton, Alberta T5J 4S2

Designing Courses, Instructional Design for Online Learning (links to articles), http://www.ibritt.com/resources/dc_instructionaldesign.htm, January 21, 2005

Developing e-learning content Australian Flexible Learning Framework projects and selected external literature, Backroad Connections Pty Ltd 2003, Version 1.00, 31 July 2003, http://flexiblelearning.net.au/guides/content.pdf

efmd Certification of e-Learning (CEL), Partnership b/w The European Foundation for Management Development (efmd), the Swiss Centre for Innovations in Learning (SCIL) at the University of St. Gallen, and Spirus Applied Learning Solutions AG. efmd, Gachard House, rue Gachard 88, Box 3 - 1050 Brussels, Belgium , website: http://efmd.be/cel

Elusive Vision: Challenges Impeding the Learning Object Economy by Laurence F. Johnson, Ph.D. New Media Consortium June 2003

Fink's Principles of Good Course Design, L. Dee Fink, University of Oklahoma Instructional Development Program, July 19, 1999. Taken from on Dec 04, http://honolulu.hawaii.edu/intranet/committees/FacDevCom/guidebk/teachtip/teachtip.htm

Guide to Rating Instructional Design, Gary Brown browng@wsu.edu, Learning Theory, Design & Implementation, Washington State University, 2004 (online)

Guidelines for Establishing Interactivity in Online Courses, Mark Mabrito, 2004, North Carolina State University, Innovate 1 (2). http://www.innovateonline.info/index.php?view=article&id=12.

How People Learn: Brian, Mind, Experience and School, Committee on Developments in the Science of Learning, Brandsford, John, D. et al Editors, National Research Council, National Academy Press, Washington,D.C. 2000

Improving Learning Through Understanding of Brain Science Research, Khaki Wunderlich, Annette Bell, and Lisa Ford, League for Innovation in the Community Colleges, January 2005 Volume 8, Number 1

Index of Learning Styles Questionnaire, Barbara A. Soloman, Richard M. Felder, North Carolina State University(http://www.engr.ncsu.edu/learningstyles/ilsweb.html)

Innovations in Online Learning Innovations in Online Learning Moving Beyond No Significant Difference, Carol A. Twigg © The Pew Learning and Technology Program 2001, http://www.center.rpi.edu

Introduction to Web Accessibility, Paul Bohman, October 2003, www.webaim.org, Copyright (c) 1998-2004 WebAIM (www.webaim.org). JALN Volume 8, Issue 2 — April 2004

Keeping Web Accessibility in Mind, ASD: Accomodating Students with Disabilities in Higher Education, http://asd.usu.edu

Learning Theories & Methodologies, http://www.elearnspace.org/Articles/lessonslearnedteaching.htm

Learning to Learn, Greg Gay, 1996-2004, Learning Disabilities Resource Communities, http://www.ldrc.ca (online course: http://snow.utoronto.ca/Learn2/introll.html)

Learning without Limits vol. 3 — Emerging Strategies for Effective E-Learning Solutions — Warren Longmire Gena Tuso Ellen D.Wagner, Ph.D. David Brightman, editor.INFORMANIA, INC. , www.infomania.com

Lessons Learned Teaching Online, George Siemens, 8/22/2002, http://www.elearnspace.org/Articles/lessonslearnedteaching.htm

Mulitple Intellegence Inventory, Greg Gay, 1996-2004, Learning Disabilities Resource Communities, http://www.ldrc.ca/projects/miinventory/mitest.html, http://www.ldrc.ca

My Three Principles of Effective Online Pedagogy, Bill Pelz, CAS Professor of Psychology Herkimer County Community College (2003 Sloan-C award for Excellence in Online Teaching, JALN Issue 8, Volume 3 — June 2004

Online Course Assessment Worksheet, ©2001 Rehberg, Stanton, McQuillan, Eneman. All rights reserved, http://www.uncc.edu/webcourse/sb/worksheet.htm

Power Users of Technology, Joyce Malyn-Smith, UN CHRONICLE No. 2, 2004 www.un.org/chronicle, p 58

Predicting Learning from Asynchronous Online Discussions, Dezhi Wu and Starr Roxanne Hiltz, Department of Information Systems, College of Computing Sciences, New Jersey Institute of Technology, http://web.njit.edu/

Progress towards a Unified E-Learning Strategy, Date Published: 8 April 2004 By: e-learning Strategy Unit, Department for Education and Skills

Rethinking Virtual Space as a Place for Sociability: Theory and Design Implications, Marisa Ponti and Thomas Ryberg, Göteborg University and Aalborg University, marisa.ponti@ped.gu.se, ryberg@hum.auc.dk, Proceedings Contents, NLC2004 /Proceedings/Symposia /Symposium 13, Networked Learning Conference 2

Seven principles for good practice in undergraduate education. The American Association of Higher Education's- Chickering &Gamson, 1987

Sternberg-Wagner Thinking Styles Inventory, 1997, http://www.ldrc.ca/projects/tscale/tsint.php (Dec 11. 2004)

Storyboarding to Success: How to Begin Building Your Online Course, Lorraine Stanton and Sam Eneman, University of North Carolina at Charlotte Stephen Rehberg and Jeanne McQuillan, Georgia State University.

Theory and Practice of Online Learning, Editors: Terry Anderson & Fathi Elloumi, CREATIVE COMMONS. Printed at Athabasca University, 2004 askau@athabascau.ca www.athabascau.ca

Theory and Practice of Online Learning, by Dean Caplan Bow Valley College, Editors: Terry Anderson & Fathi Elloumi, Athabasca University, Canada\

Thirty Things We Know for Sure About Adult Learning, By Ron and Susan Zemke, Innovation Abstracts Vol VI, No 8, March 9, 1984

Travelers Guide to Learning Object Landscape, Susan Alvarado-Boyd, NMC: The New Media Consortium 2499 S Capital of Texas Hwy Building A, Suite 202 Austin TX 78746-7762 tel: 512.445.4200 fax: 512.445.4205 nmc@nmc.net

Writing a Syllabus, By Howard B. Altman, University of Louisville, William E. Cashin, Kansas State University,http://honolulu.hawaii.edu/intranet/committees/FacDevCom/guidebk/teachtip/teachtip.htm

To access appendices and more details on the Technical and Content Guidelines, please visit montereyinstitute.org.

# Design of Educational Resources Integration under Grid Environment

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**Abstract**

*A grid is a new paradigm of distributed computing to share and collaborate with decentralized resources. A Web-Service-based OGSA approach for a grid can improve the extensibility and interoperability of a grid system. This paper emphasizes technical features, the architecture, and advantages of OGSA compared to distributed networks. It also analyzes educational resources of South China Normal University and describes a solution to resources integration according to the IBM product OGSA-based Service Domain.*

## Introduction

With the development of technology, Grid Computing has exceeded its original academic field and has greatly influenced other fields. In the field of Grid Computing, many forums, such as Global Grid Forum, have been founded, and lots of companies such as IBM, Sun, etc., are doing research on it. Moreover, new research institutes and industrial organizations have been investigating Grid Computing. Research on Grid Computing has become a hotspot nowadays.

Campus Grid is one of the main applications of Grid Computing to scientific computation. The university is the chief scientific and academic institute in our country, which has been greatly invested by the government. Grid Computing becomes an ideal technology for the campuses with rich computational resources and scientific research projects calling for large-scale computation. So far, researches have focused on some powerful research institutes of high performance computing, such as Tsinghua University, Peking University, etc. As one of the "Project 211" universities, South China Normal University is already on the initial stages of applying grid technology. The OGSA (Open Grid Services Architecture) Grid computing, based on the two mainstream technologies: Grid Computing and Web Service, has great effect on integrating existing educational resources properly.

## The Architecture and Features of OGSA

Technical theories of Grid Computing have not established formal standard. However, in the view of core technology, Globus Toolkit (GT) has been the virtual standard of Grid Computing. GT1 was built up in 1999, and the following GT2 is a paragraph of service set and software library for the grid and Grid Computing, which is based on community, open framework and open codes. In 2002, IBM and Globus announced OGSA, which drew the outline of GT3.0. OGSA has been implemented by GT3, some other open codes and commercial system. So far GT4 has been released to make a further improvement of OGSA.

### The Main Features and Key Technologies of Grid Computing

The main features [1] of Grid Computing include: heterogeneity, scalability, adaptability, unpredictability of structure and multi-level management domain, etc. The key technologies [2] include: (1) Nodes of a grid, the resource providers, including highend servers, clusters and so on. (2) Broad-band network, providing necessary means of high performance communication in Grid Computing. (3) Tools of resource management, task management and task dispatching, which actively dispatch tasks according to the current load status of the system to improve function efficiency. (4) Inspecting tools, helping users take full advantage of resources. (5) Visualization tools of Application Layer, providing intuitionistic visualized information and friendly user interfaces.

**OGSA**

OGSA is the latest and the most important grid architecture, which is put forward after the ‘five-layered Sandglass Structure’. It is called the Next Generation Grid Architecture.

So far, the three main components of OGSA are Open Grid Services Infrastructure (OGSI), OGSA Services and OGSA Modules. OGSA is based on Web Service, which is a standard-based and widely-disposed distributed computing pattern, providing a basic mechanism to describe and call on grid service. With the core interface set of OGSI, semantic meaning of Web service and other important services could be standardized, so that the service can be virtualized and manipulated with another. The Web Services in accord with the standard of OGSI are called Grid Service [1]. In OGSA, everything is considered as Grid Service. Grid Service can be congregated by different ways to meet the needs of the virtual organization, and can be defined by the virtual organization partly according to its manipulation and shared services.

OGSA is composed of four main layers, from the bottom to the top as follows: resources (physical resources and logical resources), Web Service and OGSI extensions which define the grid service, OGSA architected services, and grid applications.

Two backbone technologies of OGSA are Grid Technology (Globus Toolkits) and Web Service. Globus is the solution to gird technology which has been widely accepted by the fields of science and engineering; Web Service is a standard application framework for network storage. Globus is the collection of services based on community, open architecture and open codes, and it supports software library for network applications and grid applications, which solve the problems such as security, information detection, resource management, data management, communications, error detection and the transplantability, etc. Web Service is used to describe the interface of software components, the methods of accessing components through interactive protocols, and detective method of identifying the related service providers.

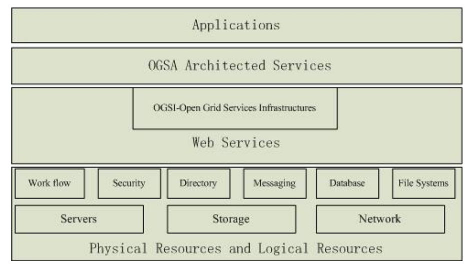

Fig. 1 Open Grid Services Architecture

**The Comparison between OGSA and Sandglass Structure [3]**

Two chief standards appear in the development of Grid-OGSA and Sandglass Structures, and they have their own features and advantages. OGSA develops on the basis of Sandglass Structure. Moreover, OGSA has its distinctive advantages of complicated distributed resources. The comparison between them shows as following, Table 1.

Table1 The comparison between OGSA and Sandglass Structure

| | OGSA | Sandglass Structure |
|---|---|---|
| Structure | Service-oriented Architecture | Protocol Architectu-re |
| Categories of Resources | Physical and Virtual Resources | Physical Resources |
| Sharing | Resources sharing | Services Sharing |
| Advantag-es | Easy to Transplant, Implement and Obtain Supports | Virtualizat-ion, Agility, Unified Interfaces etc. |
| Disadvan-tages | Lack of Virtualization, Bottlenecks of Core-protocol etc. | Resources of Simple Structure Cost Higher |

**The Comparison between OGSA and Web Service**

OGSA combines two mainstream technologies: Grid Computing and Web Service. It utilizes Grid Computing to extend the range of Web Service, and it carries out the mapping and the application from the service functions to the original platform, therefore, it makes the integration of the services and the resources perfectly. Although, OGSA is quite similar to Web Service not only on the technical concept, but also on the concrete implement. However, there are some differences between them, as shown in Table 2.

Table 2 The comparison between OGSA and Web Service [3]

| | OGSA | Web Service |
|---|---|---|
| Oriented Service | Temporary Services | Permanent Services |
| Protocol | Protocols superior to XML/SOAP | XML/SOAP |
| Naming and Binding Methods | DNS | Not limited to DNS |
| Security and Performan-ce | Higher Security and better Performan-ce | —— |

## 3. The Solution to Education Resources Integration

### The Introduction to Application and Development of Grid Computing in Education

Grid Computing has been used in the fields of education in China. The ChinaGrid project, carried out by the ministry of education in (the tenth five-year project) "Project 211", is one of the largest grid projects in the world. ChinaGrid is implemented by twelve universities, including Huazhong University of Science and Technology, Tsinghua University, Peking University, etc. It can obtain resources that have not been used completely, from different computer systems, and provide them to users when necessary so as to form a unified virtual system. When the grid network is finished, the resources of one hundred "Project 211" universities will be shared widely over the whole country. As one of the "Project 211" universities, South China Normal University does some researches and carries out some experiments and applications about grid computing according to practical situations.

South China Normal University has one local chief campus and two other districts (U-City and Nanhai College). The educational resources of the chief campus contain four parts: Network Center, IT Center, School of Distance Learning and the Library. Network Center is the access point to manage IT Center, the Library and School of distance learning. IT Center manages the teaching building, student dormitories and staff dormitories; School of Distance Learning manages the local institute and the education of distance. Each of these four main parts has several personal computers; both IT Center and School of Distance Learning have some equipment such as minicomputers, servers, etc.

### The Analysis of Resources Integration

When outer users access the educational resources from SCNU, they must get through a Network Portal. Identified by the firewall, the request from the users can be attached to the servers of Network Center or School of Distance Learning. The Web Server communicates with the Service Domain server, Virtualization Layer of Service Domain server transfers the requests of users into service requests that can be recognized by Service Layer via Web application programs. Then the Hubs of each level of Service Domain distribute the service requests to the grid nodes. Finally, the computational result will return to the users.

Generally speaking, the campus educational resources are idle most of the time and the rate of utilization is not high. When a great number of scientific computing must be done, we can use grid technology based on OGSA and its corresponding products to allocate the resources and to communicate. But some security problems occur. Hence, one of the components of OGSA: OGSI and its corresponding protocols are put forward to solve these problems.

### Service Domain [4]

Each part of the campus network of SCNU has its distinctive functions and responsibilities. Therefore, they provide different services to the users. Considering the situations, we choose Service Domain based on OGSA Architecture and Service-oriented, which is put forward by IBM Company in order to integrate the resources.

### Architecture

Service Domain [4] is a technology for Service Grid. It has an access point to integrate the relevant Web Service, and it adopts the theory of independent computing to combine Web Service and Service Grid together. It consists of two layers: Service Domain of Service Layer and On Demand Service Grid (ODSG) of Virtualization Layer that varies when necessary. These two layers constitute the perfect service-oriented architecture. Service Domain virtualizes service integration into the grid; whereas ODSG virtualizes

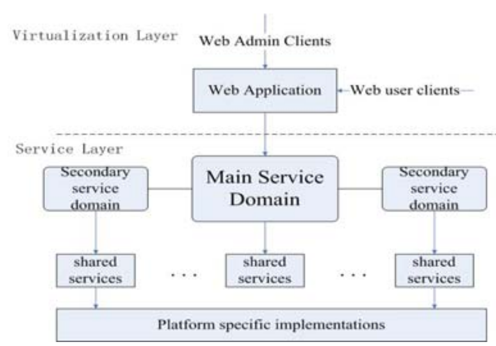

Fig. 2 SOA of Service Domain

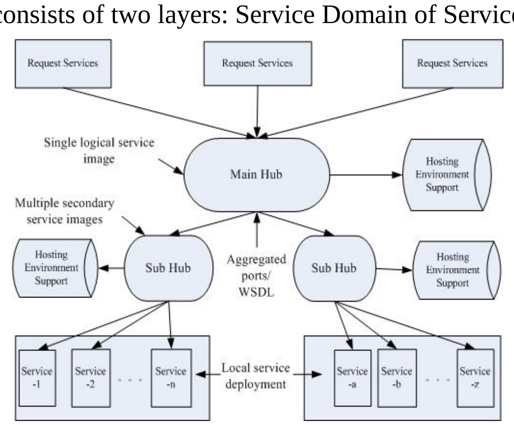

Fig. 3 ODSG Architecture

the grid. These functions offer a feasible service running and maintenance mechanism. Figure 2 shows Service Oriented Architecture (SOA) of Service Domain.

Being Virtualization Layer of Service Grid, ODSG integrates Service Domain with local Hosting technology, and provides the users with heterogeneous services integrated in different service groups (OGSI portType). The Hub provides its deputizing services with the single external logical interface. The Main Hub can also transmit the requests of the service to the Sub Hubs, which constitutes Tree Structure of Service Routing. Figure 3 shows ODSG Architecture.

ODSG has a feature of distributed dynamic service publication, thus the concrete service can be released on its affiliated Sub Hub which the service has been registered into, but the service can also be called by Main Hub. What's more, ODSG has called portals of public grid for service invocation sent by a unified interface, moreover, the portal is managed by Main Hub to monitor the status of system performance.

**Design and Implementation**

A Sub Hub can be set up in each part of the university. For example, SCNU could build up three Sub Hubs and register the resources of the university in the form of services to their own Sub Hub, respectively. General applications can be registered into Web Service, while computing resources can be registered into Grid Service. Inside each university, resources are utilized by gaining the services of the Sub Hubs. The services which have the same functions will be registered to the unified interface (portType), and then the Sub Hub will choose the best service provider for the users according to the current load and the customized management strategy.

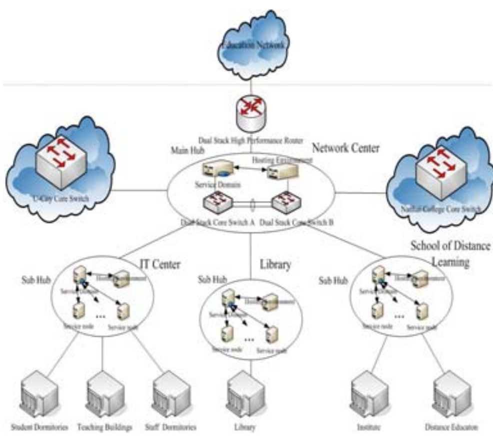

Fig. 4 Educational Resources Integration with Service Domain Technology

Each Sub Hub can also be registered to the Main Hub so that the resources of each Sub Hub can be recognized and employed by other parts of the Sub Hub. For example, a user wants to search an article, and IT Centre and School of Distance Learning provide this service. Both of their invocation interfaces are the same, but the quality of the services, such as the response time, is quite different. When the users log in Main Hub and request the course service, Main Hub will choose a best Sub Hub for them according to the privilege of them and the current load of the services. So the users can ignore the services from which of the nodes.

The applications of Service Domain are based on Web Service, so users need not spend lots of time to develop the application platform, but they can concentrate on the development of the business. What's more, scheduling and management can be implemented by registering services, configuring the strategy files, etc.

**Conclusion**

According to the design of educational resources integration of South China Normal University, Grid technology can be employed to integrate and optimize the educational resources, so that we are able to achieve the goals of maximum utilizing the resources in reason and scientific calculating in a great amount. Meanwhile, we come up with some ideas about the campus grid:

(1)The university has advantages of putting Grid Computing in practice, and it is in need of sharing various kinds of data, resources (such as sharing data, computational resources, storage resources, and application resources), and complicated computation. What's more, the university has a great technical power, so that they are sensitive to the new technology.

(2) Applying the grid to campus is a crucial measure to catch up with the development of the next-tide Internet technology.

(3) Applying the grid to campus is a proper method to upgrade digitized campus-information fundamental structure.

(4) At the beginning, we can build up several Sub Hubs to construct the grid, and then enlarge the size gradually to optimize the education resources.

(5) Wireless Network is the appropriate way for access.

With the development of the wireless technology, wireless network will become an indispensable part of network communications at campus, or even in the whole society. The wireless access equipments such as Bluetooth, notebook, moveable PC, multimedia information terminal, give new challenges and good opportunities to applications of Grid technology. A series of technologies, for example, the Wireless Grid, will have a bright and flourish prospect in the near future.

**References**


Xiao Lianbing, Huang Linpeng.(2002).Technology of Grid Computing. Computer Engineering. [J]. 28(3). 1-3,50.

Foster I., Kesselman C., Tsudik G., etc.(2001).The Anatomy of the Grid. International Journal of Supercomputer Applications. [J] 15(3),200-222.

Ning Kui.(2004).Study of Grid System Based on OGSA.Computer and Modernization. [J].10. 13-15.

Yih-Shin Tan etc. Apply Service Domain Technology to implement Service Grid. [J]. Refer to IBM Web Page.

Grid computing: first European Across Grids Conference, Santiago de Compostela, Spain : revised papers / Francisco Fernandez Rivera ... [et al.]. .(2004) Berlin; Springer.

Ian Foster,Carl Kesselman.(2004).Grid Computing, Edition 2.[M]. Beijing:Publishing House of Electronics Industry.

Chen Yaling, Gui Xiaolin,etc.(2003).Grid Computing Middleware based on Proxy.Computer Research and Development. [J]. 40(12).1806-1810.

Hu Chunming,Huai Jingpeng,etc.(2004).Grid Architecture based on Web Service and the Research on its Supporting Environment. Journal of Software.[J].7.

Liu Fangxiu.(2002).Features and Key Technology of Grid Computing .Journal of East China Shipping Industrial College:Science Edition.[J].16(6).

Sun Gongxing,Yu Chuansong.(2003).Research on the Design of Campus Grid Computing Environment of High Performance Physical Institute.Journal of Da Lian University of Technology.[J].43.

Zhang Hui, Huang Liusheng,etc.(2004).Design and Application of Information Integration Framework under Grid Environment. Computer Science.[J].31(7).98-100.

NET: http://www-900.ibm.com/cn/grid/index.shtml

# Seamless Technological Curriculum Pathways the Engage Curricula Redesign

Rayton Sianjina

As new technologies continue to emerge and students require more flexibility in course scheduling, institutions of higher education are striving to accommodate these students. As a result institutions of higher education have responded by implementing online learning system. However, for an academic program or course to successfully make the transition from the traditional to the online delivery methodology, there are many factors to be considered carefully. Accordingly, Levy (2003) faculty members are faced with a number of new challenges when teaching an online learning course as opposed to a traditional one. These challenges include: "the administration or management of online courses; the course layout and design; the best delivery method for the content, such as text, graphic, audio, or video; the various communication methods that the students will use such as email, discussion boards, and chats; ways to increase and maintain student involvement; appropriate student assessments for online learning; and, a working knowledge of all the technologies being implemented in the online course" (p. 22).

Additionally, college administrators are increasingly putting pressure on faculty to participate in distance learning and other technology related endeavors. Most faculty, however, have not responded as quickly and enthusiastically as administrators would like. For a variety of reasons, faculty members resist efforts to engage in distance learning. Specifically, faculty members have expressed the concern of a lack of institutional support, the change in interpersonal relations, and quality in program offerings via distance education technologies.

In an effort to reach non-traditional students, Delaware State University, just like other institutions of higher learning, through office the of Distance Education and Learning Technologies, is proactively providing its faculty with effective and meaningful professional development workshops in order to assist them in transitioning from "brick wall to click wall" learning and teaching community. This office has developed strategies that attract faculty to participate in course redesign and development activities. Faculty members are provided with incentives in order to engage them in this process. In the next sections, of this paper, discussions of various strategies are given in detail.

## Instructional Support

All humans operate and are motivated by positive reinforcement. Faculty members must be given incentives for their efforts and involvement with distance learning technologies. Institutional support is a critical part of course to course redesign for the new technology, especially distance education.

Certainly, in order to be successful as an online instructor, faculty members need to have some understanding of pedagogy as it relates to online instruction. These instructors need to know how to transition from traditional lectures to more interactive lessons that encourage students to be active participants. Furthermore, instructors must do more than develop new technical skills. Online development and delivery does require new redesigned pedagogical approaches. Certainly, at best, it necessitates for an institution to rethink its overall academic mission. Additionally, college administrators are increasingly putting pressure on faculty to participate in online learning and other technology related endeavors. Most faculty, however, have not responded as quickly and enthusiastically as administrators would like. Faculty members express serious concerns and reservations regarding the effectiveness of online learning. For example, the 1998-99 national study of faculty conducted by UCLA's Higher Education Research Institute (HERI) revealed that two-thirds of college and university faculty found keeping abreast of information technology stressful, rating it above research/publishing demands, teaching load, and the tenure/promotion as a significant stressor (HERI, 1999). Not only that, online delivery challenges traditional assessment practices and brings together teams of people, each with unique skills, into a course redesign and development team. Clearly, in order for online instruction delivery to be effective, it is inevitable for course redesign to take place. Certainly, online instruction calls for rethinking of the traditional instruction practices.

Furthermore, in this Internet era, institutions of higher learning have witnessed the exciting convergence of content, technology, and effective learning and teaching strategies. Today, the academe, faculty, and students benefit from access to the rich contents and treasured resources from various technologies. The old model of "owning" a collection or site has given way to "sharing," and the new emphases have shifted from a large physical classrooms to virtual classrooms.

Although college administrators are increasingly putting pressure on faculty to participate in online learning and other technology related endeavors, for a variety of reasons, faculty resistance to participate in this arena is high. While individual faculty members may have individual reasons to resist participating in the latest wave of online education, Bower points, "there are several reasons why faculty in general resist distance education.

The rapid development of digital communication technologies allows institutions of higher education to move beyond the "brick and mortar" restrictions of place and time to serve a larger, broader, and more diverse population. Although it is not a new idea, the implementation of distance learning in higher education has increased exponentially.

Certainly, the most common type of training needed by participants is the use of course management software (CMS). CMS systems provided by companies such as Blackboard and WebCT integrate responsive instructional functions. Typically, most CMS are characterized by user-friendly interface that facilitate access to online lectures, assignments, moderated discussions, quizzes, grades and synchronous and asynchronous chat sessions.

**Pedagogical Training**

Clearly, techniques that are effective in the traditional classroom are not necessarily effective in an online environment (White and Weight 2000). Online classroom provides the opportunity to establish a unique community of learners, but such a technique requires facilitating a development of a community very different from those that work in the traditional face-to-face classroom setting (Palloff and Pratt 2000). Faculty members who are experienced and successful in the traditional classroom cannot intuitively and automatically make the transition to the online environment (Harasim 1990). They need professional development in order to learn what works and what doesn't work online. Therefore, faculty members who do not want to "reinvent the wheel"; pedagogically will sooner or later learn the online environment techniques, in order for their students to succeed. Additionally, faculty members recognize that formal training can save them time in the long run, as well as allow them to become more effective and successful online teachers faster.

**Recommendations**

Training for faculty members to teach online should, at the minimum, contain four major components. Namely: Technical training, Pedagogical training, online coursework, and Incentives.

Technical training should include both the Course Management System (CMS) that will be used to deliver the online course and the use of other software that facilitates communicating through the Internet, such as Blackboard or WebCT. In the case of Delaware State University, Blackboard is the course management system that the university uses. Other types of software can also used, for example, interactive screen captioning software is invaluable in provided training. The captioned screens seem interactive even when one is working off-line.

A national Center for Education Statistics (NCES) 1997 report indicated that about 60 percent of higher education institutions provide training opportunities for distance learning faculty in this area. This means that 40 percent of the institutions offering distance-learning courses asked faculty to teach these courses without providing any special preparation for the experience. In addition to expertise in their content areas, faculty members need to attain a level of proficiency with the computer technologies needed to develop and deliver online instruction. Online educators need to be competent in using technology as a means for effective instruction (Floyd, 2003). Staff development is essential for the successful movement from the traditional classroom to a distance-learning environment.

**Online Course Work**

One incentive used by institutions to encourage the faculty to get involved in institutional initiatives is workload adjustment. However the NEA study (2000) indicated that course reduction was not provided to the large majority (84 percent) of the faculty in its national survey. Perhaps this is because one of the reasons for expanding distance learning and use of educational technology is its increased productivity. If institutions provide release time to faculty preparing distance learning courses, they may need to demonstrate increased productivity through other means such as increased student-faculty ratio in distance learning classes.

Compensation for online instruction is an area of concern for faculty. According to a survey conducted by the National Education Association (2000), 63% of distance learning faculty is compensated for a distance-learning course as if it were a normal course even though online instruction takes more preparation time. Sellani and Harring (2002) note that financial differential is necessary to attract and sustain effective online instructors as successful online faculty equate one online course as equivalent to two grounded-based courses in relation to resources needed to insure high quality and meaningful learning for students.

Pedagogical training should emphasize accepted best practices for online education. Specifically, faculty should receive training in:

- Facilitating interaction and discussion in online courses;
- Facilitating active learning and collaborative online; and
- Assessment and evaluation for online courses.

Some portion of either the technical or pedagogical training for faculty to teach online should be delivered online so that faculty experience online education from the student point of view. Finally, faculty mentoring is critical to online teaching. Without assistance for colleagues and/or the department of Distance Learning, it is doubtful for successful online education.

## References


Bower, B. L. (2001). Distance education: Facing the faculty challenge. The Online of Distance Learning Administration IV (II).

Floyd, D. (2003). Distance learning in community colleges: leadership challenges for change and development. Community College Journal of Research and Practice, 27 337-347.

Harasim, L., ed. (1990). Online Education: Perspectives on a New Environment. New York, NY: Praeger.

Levy, S. (2003). Six factors to consider when planning online distance learning programs in higher education. Online Journal of Distance Learning Administration VI (I) Spring 2003.

National Education Association. (2000). A survey of traditional and distance learning higher education members. Retrieved September 10, 2005, from http://www.nea.org/he/abouthe/dlstudy.pdf.

Palloff, R. & Pratt, K. (2003). The virtual student: a profile and guide to working with online learners. San Francisco, CA: Jossey-Bass

Sellani, R., & Harring, W. (2002). Addressing administrator/faculty conflict in an academic online environment. The Internet and Higher Education 5. 131-145.

White, K., & Weight, B.(1994). The online teaching guide. Needham Heights, MA: Allyn & Bacon.

# Evolution in the Classroom: What Teachers Need to Know about the Video Game Generation

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Research driving the mandates of the current education reform law, No Child Left Behind, indicates a 300% increase during the last 10 years in students being labeled with specific learning disabilities. In addition there has been a dramatic increase in the number of minority students labeled as having learning and emotional disabilities (U.S. Department of Education, 2002). One possible reason for this disturbing evidence is that our teachers and schools are not prepared to assess the skills or meet the needs of a "new" generation of learners entering their classrooms. The new generation I am referring to are those students who have daily access to interactive 3D environments, spend a significant amount of time exploring that environment and who have the skills to maneuver and problem solve within it. That environment is the 3D world of video games. There is evidence indicating the same students who are most at risk for failure in the traditional classroom setting, spend an average of twenty-seven minutes per day more than their counterparts using video games (National Center for Educational Statistics, 2002: Woodward, 2002). David Sousa, author of the book, "How the Special Needs Brain Learns", feels the way our schools are currently set up could, in fact, be disabling for some students who, given a different learning environment, might otherwise thrive. Although research on the subject is still in its formative years, the research led by Henry Jenkins, Kurt Squire, Marc Prensky and James Gee, lends strong support to Sousa's beliefs.

**The students**

Kids today spend more time outside the classroom--exploring, questioning and problem solving than they do "learning" in school. They make decisions based on their every day experiences, their interests, their strengths, and their desires. Their world expects them to interact with it and when they do so, they are in command. They welcome a challenge and the opportunity to test new boundaries. They are in control of their own destiny and the heroes of their own adventures. They support and guide the direction of a billion dollar industry. These are the gamers, the video game generation (Beck & Wade, 2004). Most are bright and inquisitive and can do things with a computer that the average teacher would never even attempt. Yet, many of the gamers in school today are at risk for failure. The risk is not predominantly for the reasons commonly sited, i.e., socio-economic status, cultural difference, disability or lack of opportunity. The gamers are not formally labeled. Instead they are referred to as lazy, apathetic, behavior problems, truant, disengaged or suffering from a bad attitude. Simply put, they are not happy in school. They are bored. They aren't challenged. They see no relevance in the subject matter. Some are dropping out and many just are waiting it out, apathetic and unengaged. I believe it is because of the video game.

Like it or not, video games play a daily part in the lives of almost every child, either through actual game play or through having friends and family who are gamers. Therefore, understanding how this new generation perceives the world, interacts and problem solves within it can have a serious impact on how well the video game generation performs in school. "Once the child reaches the age of six or seven, the influence of the culture--whether or not it is manifested in a school setting--has become so pervasive that one has difficulty envisioning what development could be like in the absence of such cultural supports and constraints." (Gardner, 1991, p.105). The basis for the gamers' cultural and social connections is often a shared gaming experience. Video games cross all cultural and ethnic boundaries. Not recognizing that these shared experiences exist can deeply affect the way this generation responds to public education. Teachers, who have never shared these experiences, face a deep chasm when trying to communicate with this increasing segment of their classroom population.

**The facts**

- 92% of children, ages 2-17 play video and computer games (National Institute on Media and the Family, 2001).
- Video games are most prevalent among children who are of elementary school age and older (Woodward & Gridina, 2000).

- The average American child grows up in a home with two televisions, three tape players, three radios, two VCRs, two CD players, one video game player and one computer (Kaiser Family Foundation, 2005).
- 60% of all Americans, or about 145 million people, play interactive games on a regular basis (Entertainment Software Association, 2004).
- From 1997 to 2001, computer ownership has increased 37% for Whites, 53% for Blacks, 53% for Hispanics, 38% for Asian/Pacific Islanders, and 46% for Native Americans (National Center for Educational Statistics, 2003).
- According to parents, children between the ages of 2 and 17 spend almost 6 ½ hours a day in front of electronic screens either television, video games or a computer (Woodward & Gridina, 2000).
- Approximately 80% of American families own a computer and 78% have video game equipment in their homes. (National Center for Educational Statistics, 2003; National Institute on Media and the Family, 2001).
- Households with more than one child are more likely to have a video game system than those with only one child. Homes with at least one boy are more likely to have a video game system (76% of homes with at least one boy vs. 58% of homes with only girls) (Woodward & Gridina, 2000).
- 100% of the college students polled in a recent survey conducted at 27 campuses have played a video game either on a console or on the computer (Wilkens, 2004).
- Parents are the driving force behind the video game industry. In 2004, over 50% of parents polled said they were going to buy their child a videogame for Christmas. 90% of all videogames are purchased by individuals 18 years or older (Entertainment Software Association, 2004).

**The teacher's world—who is in the driver's seat?**

The majority of today's teachers are women (79%) with an average age of 46. In some states, 60% of the teachers are over 50 (National Center for Educational Statistics, 2003). Most of the experience these teachers have had with technology is limited to word processing, data bases, presentation software, and perhaps some multimedia such as video and digital cameras. When these teachers bring technology into the classroom, they bring what they are familiar with, which, although is a step in the right direction, it is not in itself engaging for the students. Teachers do not typically see the videogame as a learning tool. The teachers are working within an environment where change tends to be slow, money scarce, and bureaucracy plentiful. Unfortunately their students are living in an environment where change is rapid, constant, and anticipated. This generation of learner wants to be challenged. They want to have some control over the choices they make and the direction they take. The students are ready to be in the driver's seat and in the fast lane.

The problem facing teachers is that they do not want to give up the wheel. Their lack of understanding of this new generation leads them to believe that if they give up the wheel, the car will crash. The opposite may be true. The number one request by teachers for professional development revolves around behavior management/control issues. Teachers are encouraged to embrace differentiated instruction, a method of meeting the needs of the individual learner, yet many teachers are unsure how to achieve differentiation while still maintaining control, thus differentiation is slow to be integrated into the system. Differentiation is inherent in the video game generation's world. They make choices on a daily basis in every venue from food choices, information to be gathered, games to play, products to buy, shows to watch to cell phone rings, music, friends, styles, the list is endless. If they want something they don't have all they have to do is "Google" it and they are presented with a menu of choices of where to get it, and how much it will cost, the history of the item and related subjects and sites. The environment is always individualized for them. This is the "have it your way" generation. The "do it my way" philosophy of the traditional old school does not work for this generation.

**The gamer's world—Move over, I'm driving, buckle up!**

The game generation is in charge and ready to lead**.** Beck and Wade (2004) point out in their timely book, *Got Game: How the Gamer Generation Is Reshaping Business Forever,* that there are several distinct influences the experience of playing video games has on the on the way the game generation learns and organizes information. Prensky (2004) has likened the skills of the gamer to that of the highly effective workers of Stephen Covey's era. Gamers believe, for example:

*There is always an answer*

Video Games are basically fair. There is always a problem(s) that has a solution(s) which lead to an end result--the object of the game. There can be many different routes to reach the solution, all of which count equally if you achieve the goal. The answer is rarely obvious. A correct answer will give you information which will be useful in reaching the goal, thus you must persevere to find a correct answer. The answer is always relevant. You might be frustrated for a while and you may need help in finding it, but it is always there. Cheats (hints) are built into the program and are part of the resources available to you. Cheats are OK because you are learning (gaining valuable information) as you move forward toward the goal. In schools, the answer is given to you, it is often not linked to anything relevant, there is only one right answer and one right way to get there and cheats are not to be tolerated! Students rarely if ever associate fairness with schools.

*Nothing is impossible*

In any game, you have the tools and the talent to be successful on your own or you may connect with someone who has the information you need in order to move forward (collaboration). You see yourself and your friends do amazing things such as save the world from terrorists or alien invasions, beat the best team in the NFL, create thriving civilizations and manage a successful small business. You have the power to control your destiny. You can accomplish anything you want, and therefore, you are motivated.

*Trial and error*

It is proven through game experience that this is the fastest, most efficient way to learn. If trial and error does not work, you know where to find the necessary resources and you can access them at will. You are in control of your own success or failure. If you persevere, you will achieve your goal. If you do not win, restart and try again. You will not make the same mistakes twice. Failure is a learning experience, not an end result as it is so often in schools.

*Competition and collaboration*

Competition is inherent in game structure. Gamers are always competing. Competition is the motivating factor. Competition does not eclipse collaboration; in fact, collaboration is often an integral part of furthering your success. Competition and collaboration are symbiotic rather than mutually exclusive concepts.

*Roles are clear*

In games, roles are clearly defined. You are the droid or the Jedi, the good guy or the bad guy, an employee or the boss. You choose your role and understand its limitations. You understand the rules, the tools at your disposal and you are willing to take the risks. In schools, the roles are not as clear.

*Gamers are autonomous*

Merriam-Webster Online Dictionary (http://www.m-w.com/) defines autonomous as the quality or state of being self-governing, especially the right of self-government. The culture of gamers is very much a culture of personal and professional autonomy. Gamers play well with others but accept responsibility and consequences for their actions, both positive and negative, within the game. Gamers feel they have the right to choose their own path and are confident in exercising that right.

Gamers dominate their culture

There is little or no attention paid to elders. Most elders are non-gamers. Non-gamers don’t have a clue what you are doing and therefore, they can’t be of any help. Most gamers have come to this conclusion through trial and error. Edginess and attitude are dominating elements of the culture. Gamers are risk takers. They move fast and play hard. They are the stars in their own adventure. They are responsible for their own success. Their experience tells them that with patience and perseverance, they will succeed.

*Do your own thing:*

Within the game generation, leaders are irrelevant and often evil; ignore them. This is the attitude of the dot.com generation. They created and built the eBusiness concept that dominated the economic landscape during the 1990’s. At the time, there were no leaders to follow in this field. They carved their own niche and the payoff was huge. They did their own thing. When many of the dot.com’s collapsed, they pressed “RESTART.” They learned from their mistakes and most have become rising executives in new endeavors.

**The games vs. school**

So, what is it about video games that make gamers respond to the world differently from the way they respond in the classroom? Compared to the classroom, games are empowering, motivating, individualized differentiated learning environments with set rules which value the efforts of the individual child. Games are challenging and motivating. They offer the child a shared experience with their peers in a collaborative environment. They are a platform for problem solving. The structure is apparent, the rules are clear and unambiguous, and your role in the game is well defined. The goal is always attainable.

*Video games are rule-based*

The rules are applied equally to each player. The rules of the game have to be sufficiently well defined so there is no room for individual interpretation. Consequences of player behavior are clearly either positive or negative. If there is a disagreement about the rules of the game the game is stopped until the disagreement has been resolved. In schools we tend to consider our classrooms rules based. However, the teacher is the keeper and the interpreter of the rules. The teacher chooses the game. The teacher makes the rules and can change the rules at will, either for the class or for the individual. The game continues even when rules are broken. Gamers, who are confronted with rules that are arbitrary and subjective, will often "shut down" and refuse to play the teacher's game.

*Video games offer various routes to success*

School has a set outcome with one acceptable route. If you stay in school for 12 or more years, you will get out. Schools are currently set up to sort students by age, skill is secondary. For example, a student who is very successful at his/her grade level will stay at that grade level and not move up. However, if you are not successful in your grade level, you will fall back a level. Regardless of your success in the lower level, you will not be able to move back up.

*Skill is not relevant to upward movement.*

In a video game, success at one level catapults you to the next, more challenging level. Usually, there are several different routes available to reach the next level. These routes are based on individual skill. You may fall back temporarily, but there is always a route that will allow you to move back up to the next level and beyond.

*Player effort influences the game outcome*

The amount of energy the player puts into the game invests the player with the outcome. Teachers are frustrated with the lack of effort students are putting into their assignments and coursework. Yet these are the same students who spend hours playing games which they find relevant, challenging and fun.

*The player is attached to the outcome*

The player has an emotional attachment to the outcome, meaning the player is happy if they win or unhappy if they loose. Juul (2003) calls this the "game contract," which the player agrees to when they play the game. The spoilsport is one who refuses to seek enjoyment in winning, or refuses to become unhappy by loosing in which case, the gamer is not attached to the goal. Many gamers are not sure what the goal is in school or how they can help accomplish that goal. For this generation of learner, that is a serious problem. Gamers often fail to see relevance in the information presented in the classroom. In games, the objective is clear--build an empire, save the world, kill the zombies. The gamer sees value in killing zombies and saving the world. The gamer often does not see value in filling out their spelling notebook, completing another math worksheet or reading a 15$^{th}$-century author. Teachers have to understand how gamers learn in order to make the content relevant.

*Video games simulate real-life consequences*

Medical colleges use video games to train surgeons, the Air Force uses "virtual flight simulators" to train its fighter pilots and many major corporations are using "virtual models" to train their junior executives. If you screw up, you're patient dies, you crash or you're fired. These are real-life consequences. Games can often mirror the complexities of real life. Gamers view the world from multiple viewpoints. They play games from the first, second and third person perspective, opening different routes to problem solving. They can literally get into a character's skin and see the world from the character's point of view. They understand that problems are complex but given a relevant goal, clear expectations and the autonomy to utilize a variety of resources, they can and do find the solution.

**The bad news**

*Game over*

Educators have been slow to pick up on this fundamental shift in the way the video game generation learns. They know something is very different in the classroom, they just can't pin point what it is. Teachers are frustrated by their inability to connect with students. This dissatisfaction is evidenced by the **63,000** open teaching positions across the nation in 2003. The current majority of teachers is over the age of 46 and began teaching before the video game was such a big part of the youth culture. The average teacher rarely shares the same daily experiences or have the same interests as their students whose native experience with technology is so different from their own. Students and teachers are in a constant battle for control and influence based on opposing expectations. There is a huge cultural divide between the video game generation and the teachers and that divide is taking its toll on both students and teachers alike.

Students are telling teachers loud and clear that they don't want to play the teacher's game anymore--game over. We are dealing with a new, rapidly growing culture that refuses to be force fed a "canned education." Apathetic students are willing to be in school, perhaps, but motivated only by their parents, their friends or the law. Even though they are physically in attendance, they are not engaged in the "game" we call school. This attitude is a slap in the face to our traditional educational system, but it is a fact and it is not going to go away. It should be a wake up call--the rules have changed.

Given that 100% of college students polled on 27 campuses indicated they had played a videogame in the last 12 months, we can assume that gamers are not a rarity in the classroom. Today's dominant emerging culture is the culture of gamers. Thirty-nine percent are women (Entertainment Software Association, 2004). The students of the gamer generation are our future CEO's, doctors, lawyers, scientists and world leaders. Beck and Wade (2004) conducted a large scale study of 2,500 business professionals to determine whether the experience of gaming and growing up surrounded by games, changes attitudes, expectations, and abilities related to how the video game generation performs in the business world (p.21). The results indicate that gamers see the world very differently than do their parents, teachers or other non-gamers. The structure of the game molds the gamers' experiences, leading to a different way of looking at the world and given a certain situation, determining how to best interact. Teachers who are not gamers do not live in the same world and therefore cannot see the possibilities. The gamers are trying to send a message to their teachers and to the educational system as a whole. Clearly, teachers are going to have to rethink how they present material in the classroom.

**Embrace the video game**

Many commercially available video games can be used as learning tools in the classroom. Current research has identified the main features of video games that teachers need to be aware of when using them in the classroom (Juul, 2003; McFarlane, Sparrowhawk and Herald, (2002). Lesson plans using existing video games as the learning platform are rapidly emerging. Squire has created teaching materials to support the learning in Sid Meir's game, *Civilization* (Squire, 2003). Teaching with video games can open new avenues of communication between teachers and students. They offer the student a familiar environment in which to demonstrate their skills, to move to the next level (Hostetter, 2002 Prensky, 2004). Teachers who are familiar with the covert learning found in video games can create win-win opportunities in the classroom. Ninety percent of all elementary and secondary students polled use their home computers for videogames, while only eighty-three percent use them for school assignments (National Center for Educational Statistics, 2003.) Why not merge the two. I am not saying that the video game should completely replace the traditional methods of teaching. There are certain foundations that should stay intact. I am, however, saying that the use of video games as a teaching tool deserves serious consideration as a means of presenting information and bridging learning concepts. We must give teachers permission meet the unique learning needs of the gamer generation. Today's teachers, and especially those just entering the profession, need to partner with the students and get on board –the students are already there.

**References**


Beck, J., & Wade, M. (2004). *Got game: How the gamer generation is reshaping business forever.* Boston, MA: Harvard Business School Press.

Entertainment Software Association. (2004). *Essential facts about the computer and video game industry.* Retrieved December 22, 2004, from http://www.esa.com

Gardner, H. (1991). *The unschooled mind: How children think and how schools should teach.* New York: Basic Books.

Gee, J. (2003). *What video games have to teach us about learning and literacy*. New York: Palgrave McMillan.

Hostetter, O. (2002). *Video games--The necessity of incorporating video games as part of constructivist learning*. Retrieved December 22, 2004, from http://www.game-research.com/art_games_contructivist.asp

Juul, J. (2003). *The game, the player, the world: Looking for a heart of gameness*. In the Level Up: Digital Games Research Conference Proceedings. Ultrecht, the Netherlands: Universiteit Utrecht.

Kaiser Family Foundation. (2005). *Generation M: Media in the lives of 8-18 year olds*. Retrieved March 9, 2005, from http://www.kff.org/entmedia/entmedia030905pkg.cfm

National Center for Educational Statistics. (2003). *Computer and internet use by children and adolescences.* Retrieved December 2, 2004, from http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2004014

National Institute on Media and the Family. (2001). *Fact sheet*. Retrieved October 21, 2004, from http://www.mediafamily.org/facts/facts_mediause_print.shtml

McFarlane, A. Sparrowhawk, A., Heald, Y. (2002) *Report on the educational use of games: An exploration by TEEM of the contribution video games can make to the educational process.* Retrieved January 15, 2005, from http://www.teem.org.uk/publications/teem_gamesined_full.pdf

Prensky, M. (2002). *The motivation of gameplay: The real 21st century learning revolution*. *On The Horizon, 10*(1). Retrieved October 12, 2004, from http://www.marcprensky.com/writing/Prensky%20-%20The%20Motivation%20of%20Gameplay-OTH%2010-1.pdf

Prensky, M. (2004). *The seven games of highly effective people: How playing computer games helps you succeed in school, work and life*. Retrieved October 12, 2004 from http://www.marcprensky.com

Sousa, D. (2001). *How the special needs brain works*. Thousand Oaks, CA: Corwin Press.

Squire, K. (2003). Video games in education. *International Journal of Intelligent Simulations and Gaming, (2)*1. Retrieved November 28, 2004, from http://www.educationarcade.org/gtt/pubs/IJIS.doc

Squire, K., & Jenkins, H. (2004). Harnessing the power of games in education. *Insight (3)*1, 5-33.

U. S. Department of Education. (2002). *No child left behind, PL 107-110: Elementary and secondary education act*. Retrieved September 30, 2004, from http://www.ed.gov/legislation/ESEA02

U. S. Department of Education, Office of Special Education and Rehabilitative Services. (2002). *A new era: Revitalizing special education for children and their families*. Retrieved November 28, 2004, from http://www.ed.gov/inits/commissionsboards/whspecialeducation/reports/index.html

Wilkens, J. (2004). *Video games play a positive role in modern culture: University researchers are exploring the impact video games have on learning dexterity and social commentary*. Retrieved November 28, 2004, from http://www.dailybreeze.com/today/1083706.html

Woodward, E. H., & Gridina, N. (2000). *Media in the home: The fifth annual survey of parents and children.* Retrieved January 12, 2005, from http://www.annenbergpublicpolicycenter.org/05_media_developing_child/mediasurvey/survey7.pdf .

**Websites for further research and game reviews**

www.Eopinion.com
www.Smartkids.com
www.mediafamily.org

# Why do I need to learn this if I can get it all online? Current issues in the education of teacher-librarians.

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There have long been arguments in the library community over the necessity of retaining courses such as cataloging in library science degrees. The arguments for doing away with such courses appear to be even stronger in the school library media community. With the ever-increasing availability of cataloging records from "one-stop" vendors there are seemingly fewer and fewer opportunities for media specialists to put their cataloging expertise into practice. In addition, cataloging has traditionally been the "statistics" class of all library programs – with the reputation of being difficult, unapproachable, and consequently feared by students. Online vendors now offer not only instant cataloging, but instant collection analysis, instant collection development, instant weeding, and so on. Now that students, apparently, do not need to have these skills, they are asking how these courses are still relevant to them.

Other traditional foundational courses are also being questioned, including courses in reference services. Students are again questioning the usefulness of reference, especially as it relates to print based resources, when so much information is available quicker on the Internet.

To what extent does this questioning reflect a real need for change within preparation programs for school library media specialists? Are we simply clinging on to content because this is what has always been done and we are loath to sacrifice any content, as this will in some way diminish our stature as a field? Can we justify the continued study of these subjects? Are they foundational to everything we do as library media specialists or must we reappraise our whole philosophy of what a library media specialist is? A good way to clarify the issue is to examine the case of cataloging, as this is the course where faculty often experience the most resistance.

## The necessity of teaching cataloging

"Cataloging is hard. As a library media specialist, I'll never do cataloging: Why I do need to learn this stuff?" – overheard during a class break

"Cataloging is the intellectual foundation of librarianship—it is the way in which good librarians, in all fields, think." – Michael Gorman

There are a number of reasons why budding library media specialists would find a cataloging course useful in the professional work they are being educated and trained to do. Although school libraries are sometimes seen as simply a repository for books, in fact they are fast becoming storehouses of increasingly complex information packages that are multimodal in their orientation, organization, and use. Often these resources feature a number of authors associated with these works and these resources are frequently multidisciplinary in nature. Another trend in American schools that has a direct impact on the school library, is the increasing cultural and ethnic diversity of the learning community. Each of these groups comes into the school library and its information resources with a unique perspective that has been formed by its culture, intellectual ability, and educational level. The increasing diversity of information resources, particularly networked information resources, and information technologies that enable access to these resources require that we media specialists and our learning communities be conversant in both the design and capabilities of these resources in order to make the best use of these resources. As media specialists, if our aim is to provide the best service to our learning communities, we need to be knowledgeable of the way that information is created, manipulated, displayed, and used (Carpenter et al, 1991; Intner, 2002).

## Cataloging education and its role in school librarianship

The library exists as a repository for recorded knowledge, as a knowledge portal, and, particularly in the school setting, as an access point to networked information resources. In a recent opinion on the subject of the core competencies required of the librarian, the Task Force on Core Competencies of the American Library Association (2005) made the following statement of principle:

The ability to organize collections of informational materials in order that desired items can be retrieved quickly and easily is a librarian's unique competency. Well-organized collections are the foundation for all library service. Competence in organizing collections involves thorough knowledge of bibliographic and intellectual control principles and standards, understanding of how to apply these principles and standards in practical, cost-effective operations; and, the ability to collaborate with those who provide systems for managing organizational functions such as library vendors and institutional computer center staff members. (American Library Association, 2005, p. 1)

Cataloging and indexing are two of the principal means of organizing information in a way that is useful for information seekers (Holley, 2002). As Gorman (2002) suggests, "cataloging is not just for catalogers" (p. 10). For those prospective library media specialists and others who believe that knowledge of bibliographic control has no place in the education of the library media specialist, they should be mindful that the key to the effective use of the online public access catalog, a fixture in their media center, online databases, and Google, is an understanding of "the way in which recorded knowledge and information is organized for retrieval…." (Gorman, 2002, p. 2). Gorman also argues that librarians have a thorough knowledge of cataloging standards and principles are essential to all aspects of library work (e.g., Reference, Library Instruction, Circulation, Collection Development, and Cataloging) and in order for them to be effective librarians. "Librarians will be more effective in finding information both for themselves and for their patrons if they understand the structure of records in the online catalog, the principles of authority control including cross references, and the MARC format insofar as it affects indexing (Holley, 2002, p. 45). Given that school library users employ online public access catalogs and online databases independently in their search form information in lieu of the face-to-face interview with the reference librarian, school librarians can employ this greater understanding to their advantage by creating more accurate cataloging records and indexed databases to support their learning communities in their quest for useful information and knowledge.

**Why do we need to learn this stuff?**

Although the arrival of the Internet and the cornucopia of networked information resources available using this medium and its many information services has changed the face of knowledge creation and information retrieval forever, the mission of the school librarian remains the same: to organize information for the benefit of the learning community; to develop a collection of useful information resources for this community, and to provide effective instruction and instructional services that have the potential to benefit this community from cradle to grave. As Gorman (2002) states, "I believe that cataloging is a central part of that mission in ways both obvious and subtle, and that we must devise ways in which education for our profession understands and communicates that centrality" (p. 13). Cataloging is not merely a peripheral activity, one that we must do in order to get materials on the shelves so that the real work can get done. Rather it is (or should be) the very foundation of all our efforts to support learning and to build an information literate population.

**The fault of the profession?**

Perhaps one answer is that we are doing a poor job in educating our students as to the power and foundational nature of these courses. While the internet is indeed a rich resource of information, it has now reached a stage where the lack of organizational elements within it have resulted in the ready acceptance of poor-quality or inaccurate information, simply because it is easy to find. Older Internet users come to on-line resources with a thorough training in the searching and evaluation techniques they honed in the print world. In other words they have a thorough understanding of the practice and principles of information literacy. In particular they understand the importance of various organizational devices: of cataloging, of indexing and of headings, summaries and tables of contents. The students in today's K-12 environment may be technologically knowledgeable, but they are often lacking these basic information processing tools. If our cataloging and reference courses are truly foundational to information literacy, then we should have little problem in justifying them to our students. However, we must not only make the case for this, but communicate this effectively to our students. We must also ensure that our courses themselves support the new information technologies, and that they are relevant, not in the sense that they throw out the old and embrace only the new, but in that they are truly comprehensive and are taught in enough depth and breadth to include the new technologies. It may be prudent to reexamine our basic library courses to ensure we are not promoting suboptimal skills.

### The need for balancing our preparation programs

A second major topic concerns those areas that are currently lacking in library media preparation programs. As we move away from the idea of the "book warehouse keeper" to the "teacher-librarian" there is increasing pressure put upon programs to give their students adequate preparation in the teaching aspects of the job. While some states require that school library media specialists be certified teachers before they become media specialists, this is by no means a universal requirement. In many ways preparation programs that accept non-teachers have a tough assignment, in that they still have a similar number of credit hours, but those must be divided between teaching courses and library courses. Even those courses that only accept teachers may find that teachers who were trained some years before are not as well prepared in areas such as technology as could be desired. Over ten years ago various authorities raised the issue of the teaching component of the teacher-librarian post (Amey, 1993: Amey & Reesa, 1993). Concern was raised about the nature of our preparation programs, as to whether we were truly educating teacher librarians, or simply training them. As Altmann (quoted in Amey, 1993, ¶ 2) states:

> Teacher-librarians too often see themselves simply as conduits of information, or perhaps even for knowledge, identifying and passing on useful materials to their students and fellow teachers. We have not taught them to recognize complexity, to assess themselves as factors in their teaching, to reflect critically on the materials and techniques they work with. How to educate, rather than train, teacher-librarians is a major problem in an environment in which too little time is available for professional education in this field.

However, Hamilton (2001) raises an interesting counter argument to this from the Canadian perspective where he suggests that it is the emphasis on teacher-librarian that has diminished the role of the teacher-librarian in the schools and has marginalized the librarianship aspects of the job. He also laments the fact that

### Overwhelming technology

A third area of concern regarding the preparation of library media specialists is the growth in general technology within schools and the need for technology support. Increasing demands are being placed on media specialists to act as technology coordinators. Many schools are no longer retaining full-time technical support staff for computer labs and equipment, but are shifting these duties to the media specialists. This has the effect of giving the media specialists three major tasks: maintaining and administering the media center and its collections, teaching information literacy skills and collaborating with other teaching faculty, and providing technical support, training and expertise.

There are two disturbing aspects to this. Firstly we are not preparing our students to be technical support in the way that schools now require it. Our teacher-librarians are being trained in the infusion of technology into the curriculum. Technology classes focus on the use of technology as a tool for learning, and give students basic knowledge of a wide range of software programs that can be of great value to both students and teachers. These courses do not generally cover software or hardware trouble shooting, network administration, or the kind of data gathering and administration that are properly the responsibility of technical support personnel and data professionals.

Secondly our teacher-librarians are being required to spend increasing amounts of time away from the educational and library duties they are trained to perform, to work as technical troubleshooters and support personnel. Obviously the more time spent in basic technology support and service, the less time is available for information literacy instruction, collaboration with teachers, and therefore poorer educational services from the media center, at least in quantity if not quality. It is easy to see how this could quickly result in dissatisfaction with the media center program, its decline in importance and the subsequent allocation of more technical support duties to the media specialist.

### A call for communication

One answer to these problems may be increased communication. Firstly we must agree amongst ourselves as to the usefulness of the various components of our preparation programs. We should encourage communication between library schools and colleges of education so that we may present a united front on what a teacher-librarian should be. If both teaching and librarian skill sets are truly needed, then we must work together to promote this, rather than allowing each profession to devalue the work of the other.

Secondly we must communicate effectively with our students. They must not only be told the value of the skills and education they receive, but we must provide courses and experiences that demonstrate this, so they may have the opportunity to value their preparation and understand how each part works to support the others.

Thirdly we must educate the educators: teachers, principals, and superintendents. We know the valuable contribution our teacher-librarians can make to encouraging and ensuring student success, but obviously large numbers of teachers and school administrators do not. We must also prepare our students to educate their schools as to the significant enhancements they can offer to every learning environment. They must be their own advocates but they must be given the tools and skills necessary to do this.

The field of teacher-librarianship offers essential components to the creation of effective learning environments. However, it can only do so if its practitioners are allowed to do participate in a meaningful way. It is our responsibility to promote this by equipping our students to the best of our ability. This will require all of us, whether in traditional library schools or colleges of education, to agree on the necessity of both traditional library and education curricula and to advocate strongly for the continuation of the library media specialist within our schools.

**References**

American Library Association (2005). First congress: Task force on core competencies draft statement. Chicago: American Library Association.

Amey, L. (1993). What are the major issues that must be addressed in the nineties in regard to education for teacher- librarians? Emergency Librarian, 21(1), 78. Retrieved September 22, 2005, from Academic Search Premiere database.

Amey, L., & Cohen, R. (1993) Issues: What are the major issues that must be addressed in the nineties in regard to education for teacher-librarians? Emergency Librarian, 21(2), 32. Retrieved September 22, 2005, from Academic Search Premiere database.

Carpenter, M., Frost., C. O., Hildenbrand, S., Inter, S. S., Kovacs, B., Matthews, J. R., et al. (1991). The education of cataloging librarians. In S. S. Intner & J. S. Hill (Eds.), Cataloging: The professional development cycle (pp. 63-91). Westport, CT: Greenwood Press.

Gorman, M. (2002). Why teach cataloging and classification? In J. S. Hill (Ed.), Education for cataloging and the organization of information: Pitfalls and the pendulum (pp. 1-13. Binghamton, NY: The Haworth Information Press.

Hamilton, D. (2001). Educating the teacher-librarian. School Libraries in Canada, 21(2), 15.

Holley, R. P. (2002). Cataloging: An exciting subject for exciting times. In J. S. Hill (Ed.), Education for cataloging and the organization of information: Pitfalls and the pendulum (pp. 43-52). Binghamton, NY: The Haworth Information Press.

Intner, S. S. (2002). Persistent issues in cataloging education: Considering the past and looking toward the future. In J. S. Hill (Ed.), Education for cataloging and the organization of information: Pitfalls and the pendulum (pp. 15-29). Binghamton, NY: The Haworth Information Press.

# Don't tell them to read the instructions -Tell them what to do! How low reading adult learners have a better chance to "get it" when their instructional software narrates to them.

H. Solomon

**Abstract**

*Once a weakness in text-enablement has been identified in a student, giving him or her a multimedia software package that starts off with a demand to read immediately identifies the software to the user as reading-based. This often means to the user that it is an opportunity to work in an area of a learning modality weakness. The multimedia capacity of today's desktop computers makes possible design opportunities that are no longer restricted to text as the principle learning modality. Narration of instructions can greatly enrich the learning experience for low text-enabled users, making it more likely that desired learning outcomes will occur. This presentation reports on a research project that tracked user proficiency in applying a learned procedure after instruction in text and narrated modes. A post-hoc analysis of student performance indicated that providing only the reading modality significantly increases the likelihood of failure to learn the procedure well enough to complete it.*

Creating instructional software that includes narration takes more development time, as sound clips need to be created, synched to the onscreen visual information, and brought under user control. This is clearly more effort than is often put into text-based products. Including narration would slow the rate at which software products could be produced and increase the cost of producing the software. So, the question arises about whether the benefits of including narration outweigh the additional costs.

Rose and Meyer (2002), in advocating standards of universal design for learning (UDL), suggest that instructional media needs to be flexible because the learners have different needs and capabilities in different areas. What works for one doesn't necessarily work for another. They go on to elaborate that text is the dominant modality in schools, which is only beneficial for the students who are good at using text. For those who don't use text very well, however, software should compensate and accommodate. The accommodations, while they may be more costly to create, are often used in unanticipated ways that add value to the software beyond what was expected at the time of the original design. They liken this to the architectural principle of Universal Design which calls for architectural accommodations for universal access that wind up being used extensively by those who were not thought to be the immediate beneficiaries.

Shih and Alessi (1996), in the light of an experimental finding showing no learning effect among college senior undergraduate students, cautioned against the development of fancy multimedia programs that don't have any learning effect. They noted that it was possible that voice may have some benefits including increased realism and naturalness, better comprehension by poor readers, less distraction of visual attention, increased engagement, and better synching to temporal events. In working with their chosen experimental population however, advantages of text over voice, such as greater flexibility of processing rate, more than compensated for these differences.

Some experimental evidence supports combining sound with other media. Lai, (2000) for instance, found a learning effect resulting from the combination of audio and animation where the observed learning effect was explained as the audio drawing student attention to the dynamic graphic and explaining the visual image step by step. Nocente (1996), found an effect in favor of audio-enhanced instruction for 12$^{th}$ grade trigonometry students in spite of the audio being a redundant repetition of onscreen text Along the way, she also noted that students appreciated the option of being able to turn the audio off.

A study (Solomon, 2005) was conducted at a community college in the southeast United States that investigated the effectiveness of different modalities for presenting information by randomly assigning students to learn a procedure from a multimedia software tutorial in three different versions. One version favored a reading presentation modality, one a spoken presentation modality, and one a choice between the two modes. The outcome measured was the proficiency of student performance of a PowerPoint procedure shown in the tutorial. Except for the mode of presentation, all information contained in all versions was identical. Students who volunteered for the study were recruited from a population enrolled in a special program for students who had been admitted despite low entrance exam scores under the college's open admissions policy.

Although no significant difference between the proficiency of student performances could be attributed to the treatments, analysis of the collected data revealed that a much higher than anticipated number of the students who were unable to complete the procedure successfully had been assigned to complete the reading modality software. This indicates that for a poorly text-enabled population, presentation of instructions for a procedure in text mode is likely to result in failure to learn the procedure.

Introduction:

Cognitively complex procedural skills could be described as those that require a learner to follow a multi-step path beyond the threshold of tasks with which they are previously familiar. This is a relativistic definition of such skills, and encompasses the notion that tasks diminish in cognitive complexity after many repetitions. Consider, for instance, the creation of a presentation in Microsoft's PowerPoint software. For many people attending the AECT convention, this task is often preceded by the word "just" as in "just make up your PowerPoint". For many other persons, the thought of undertaking this task rouses trembling and severe fear of failure.

If we think back to the time when mastering this task was a challenge to us, we probably relied extensively on printed manuals, tutorial programs, in-program help features, and other ways to find out what we needed to do to get over completing the task a first or second time. A fortunate few of us were coached through our first few times by some other person who had previously mastered the task, and was well practiced at its procedure. Those of us without the service of a coach were very likely to have encountered text-based media like the words printed on pages of manuals or appearing on computer screens. For most of us, the use of text-based media posed no strenuous challenge because reading these words was a skill so regularly practiced that it offered no difficulty. We were able, because of the extent to which we automate the task of reading, to concentrate our attention on mastering the tasks involved with using the program.

For persons who have had difficulty with reading, and who have not automated reading tasks to the same extent as have the professors and graduate students attending this conference, the ability to concentrate on a task may be reduced by a need to concentrate on successful reading. This makes the task of learning the procedure more difficult. In such cases, it is reasonable to suggest that replicating the services of the coach by providing narrated directions for performing the procedure might increase the likelihood that the learners will not only learn but also become more fluent with the procedure.

Many different phenomena have been given the name "technology gap," ranging from the inability of the American urban poor to access computer networks to third world lack of information infrastructure to parents not understanding the appropriate technological innovations to supply for their children at the beginning of a school term. Recent experiences of this author in working with firefighter training indicate a gap of substantial nature in the training methods and tools used by instructors from different types of organizations. Training organizations that work with persons in traditionally blue-collar trades are periodically expected to update training materials to meet new goals and standards. While training produced may rely on traditional classroom settings, even here, high tech presentation is increasingly expected. Training is expected to be delivered in ways in which the trainees have a greater chance to "get it".

While it is possible to ask trainees to read through instructions, reading is only one, and certainly not the only, means to acquire procedural knowledge. The most commonly used alternative means is listening. In numerous studies (Rehaag and Szabo (1995), Holmes, (1985)) acquisition of knowledge by reading is shown to be more rapid than the acquisition of knowledge by listening. Yet it stands to reason that listening would have advantages for those who read slowly. If learning software is designed without allowing the slow readers to hear instead of read, that software potentially widens the academic achievement gap between good and poor readers. For instance, if students are able to calculate the answers to math problems but have difficulty reading the directions for proceeding through more complex problem forms, they are likely to be considered poor in math. The design of the learning experience gives reading difficulties the potential to mask ability in other areas.

Although technological enhancements of learning materials are common, the inclusion of narrated directions is far less widespread. There is a relative lack of research documenting any gains made by learners when listening is offered as an alternative to reading. Researchers attempting to conduct such research encounter a number of difficulties. Included in the difficulties are such factors as difficulty with recruiting appropriate populations and with standardizing the instruction received so that identical learning content is presented in all experimental conditions. To illustrate the first of these, consider that the strong preponderance of studies conducted in college classrooms results in much research that uses populations pre-selected on the basis of the abilities tested as part of admissions standards – including reading.

An advantage of printed as compared with narrated presentation is that the printed material lingers in front of the reader over time and can be approached at a pace dictated by the reader rather than the narrator. Passages, or parts of passages, may be reviewed by the reader as required to insure confidence in understanding the content. Narration is not as natural as reading when it is repeated. While reading allows the reader to select the amount of redundancy that will produce the best available learning experience for himself or herself, no equivalent selection method is available to support listening.

In a sense, any study comparing learning that results from printed instead of audited presentation is bound to be confounded by the modes representing different bundles of affordances. Consider that the following characteristics inhere in each of the two learning modalities.

Table 2. Comparison of Affordances of Reading and Listening

| Afforded by reading | Afforded by listening |
|---|---|
| Faster maximum rate of acquisition | Reduced load of visual acquisition |
| Learner is in control of presentation pace | Available in more lighting conditions |
| Faster access to different parts | Sense of hearing is always on |
| No limits on reviewing | Eyes free to concentrate on visual information |

While table 1 is incomplete, it is sufficient to demonstrate that the question of which modality is better for learning is not likely to be settled in any one study. For a study to reasonably compare narrated and textual presentation modalities for learning, it must make an attempt to offset the natural advantage of either learning mode, and be conducted with a population for whom reading acquisition and listening acquisition rates could be presumed to be approximately equal.

One reason that a comparison study makes sense now is that by mixing the technological capacity of computers with carefully created instructional design, it becomes possible to offset the inherent advantages of these learning modalities. For instance, the faster maximum rate of acquisition advantage for reading might be offset with the presentation of reading material as a sequence of one-sentence units displayed with a sequence of mouse. This would impose a series of physical clicking actions between sentences and slow down the rate of reading. The action of exposing the next sentence would take about as much time as a narrator’s natural pauses for commas and periods. Table 2 below indicates a set of compensations that could equalize a study for the natural advantages appearing in table 1.

Table 3. Methods for offsetting the Affordances of Reading and Listening

| Advantage | Favors | Offset by: |
|---|---|---|
| Faster maximum rate | Reading | Triggered sequential presentation of text |
| Control of presentation pace | Reading | Introduce learner triggers to control pace in both modes |
| Faster access to different parts | Reading | Segment presentation and tightly index segments for review |
| No limits on reviewing | Reading | Allow unlimited audio replay of segments under learner control. |
| Reduced load of visual acquisition | Listening | Increase percentage of screen space that is visual representation of the procedure being learned. |
| Immunity to poor lighting conditions | Listening | Keep all visual attention on a monitor in light-controlled conditions |
| No earlids | Listening | Conduct studies during normal waking hours |
| Freedom from visual distraction | Listening | Remove irrelevant visual information. |

Of those items in table 2 that are supposed to compensate for the advantages of listening, most of them require little more than attention to detail. The only exception is increasing the percentage of screen space that is visual representation of the procedure being learned. By choosing a procedure performed on a computer as the task to be learned, the learning environment provided by the computer can be made to look like the actual environment in which the task will be performed. This strategy reduces the number of potential visual distractions by reducing the number of visual items on the screen.

In addition to the triggered sequential presentation of text described earlier, other design characteristics that tend to reduce the advantage of reading do so by enhancing the flexibility of the listening modality to make it more the equivalent of reading. Introducing triggers to control the pace of presentation is already a familiar tool that characterizes just about all PowerPoint demonstrations. Being able to replay specific short sequences of narrated clips on demand is a design feature that adds to the narrated modality without decreasing the ability to repeat a section. This is like being able to turn to a selected page of an audio book. Shih and Alessi (1996) proposed this type of audio repeatability as a way to better synch audio presentations with any visuals being described. By now, such commonplace technologies as DVDs have built similar capabilities into products widely distributed in home entertainment systems. As a result, learners do not have to learn to use this capacity. They just need to be made aware that it is available.

**The Study**

The study that provides the basis for this paper was conducted by its author to measure procedural task fluency increases for low-reading community college students when narration replaced text as the medium in which directions were made available. The study was conducted at a community college in the Southeast United States in October of 2004. Participants in the study came from two student populations. The first and larger group (n = 69) was identified by the institution as “low reading” on the basis of low entry examination scores on the CPT test. The second group (n = 18) served the function of being an experimental control, and was recruited from individuals enrolled in an introductory educational technology class. Both groups volunteered to participate in the study and were induced to do so by a promise of extra credit in one class in which they were enrolled.

A task was selected that would be new to the participants so that there was no previous familiarity with it. The selected task involved the use of a procedure in PowerPoint of adding narrated audio clips to different zones of a background illustration. A multimedia computerized tutorial was devised that demonstrated the procedure. The tutorial concluded with a question asking the participants whether they had grasped the procedure. If a positive response was received, the program opened a specially prepared PowerPoint file that was ready to have the procedure implemented as many times as possible within fifteen minutes. The maximum number of times that the task could have been completed was thirteen. None of the participants successfully completed the task the maximum available number of times.

The tutorial was developed in two different forms. In each, the participants advanced at their own pace through a series of 14 screens in which the procedure to be used was discussed and demonstrated. As different parts of the procedure were shown, the screens used were taken from screen shots of PowerPoint as it would appear at the currently demonstrated stage of the procedure. The areas of the screen that would be used by the actual program were activated to produce what looked like the same result that the actual program would give in response to the same user action. The difference between the two versions of the tutorial was limited as far as possible to the presentation of directions for doing the steps of the tutorial. In the text-based version, the directions were presented as text appearing in a consistent location on the screen, informing the user how to proceed. In the narrated version, the directions were presented as a series of spoken audio clips while no text appeared on the screen. The same words were used in both versions.

Strategies discussed above for reducing the inherent advantage of reading as a presentation modality were incorporated in the design of the tutorial software. Although a direct comparison was the goal of the study, a third version of the tutorial software in which the choice between modalities was made available to students as a menu item was also included. For this version, a portion of the introduction to the software was enlarged by the inclusion of a timed screen (10 seconds) showing the program user how to switch between modes if he or she felt a need to change from one mode to another. This version was developed to allow this study to provide potential confirmation of previous studies (Nocente, 1996) that indicated that choice of modality resulted in superior learning performance. It also facilitated a potential comparison between randomly selected and self-selected participant groups on other performance parameters.

For the study, the research questions were:

1) What is the effect on performance of a procedure when students learn from narrated rather than textually presented multimedia software?

2) Is there a differential learning effect for low reading ability learners of learning a procedure from narration rather than text?

3) If narration is optional and under user control, will learners with low reading ability choose to use it?

Based on a review of literature concerned with similar studies, the hypothetical positions adopted for investigation were:

1) Students who learn a procedure from narrated rather than textually presented multimedia software will perform the procedure correctly at a higher rate.
2) Among low reading ability learners, the effect of learning from narration will be more pronounced than it will be for high reading ability learners.
3) If narration is optional and under user control, learners with low reading ability will choose to use it for most learning situations.

**The Study's Results**

The results of the study showed no significant difference in the fluency with which the learned procedure was performed in favor of any of the treatment conditions. While the observed rank order of mean performance fluencies was

1) offering a choice of modality
2) offering instruction in only the listening modality and
3) offering instruction in only the reading modality,

no significant advantage was found in favor of the listening modality treatment on the ability to perform procedures by students whose reading scores were either above or below the median reading level.

Even in the light of further analysis that included a post hoc breakdown of the participants by CPT score quartile, there remained no significant advantage of the listening modality. Low reading students who participated in the study did not show a significant tendency to choose the listening modality version of the software. While they might have been able to avoid the potential for reading difficulty associated with a choice of the reading modality version, low reading students in this study exhibited no clear desire to take advantage of the choice offered.

**The Study's Post-Hoc Result**

While the study failed to confirm its hypotheses, post hoc statistical analysis of its results led to this paper. Collected data may sometimes be used in ways that go beyond its support of the original research hypotheses of a study. In this case, the search for explanations of why the hypotheses were not supported by the data was as revealing as the results of the actual study.

If learners going through a learned procedure accomplish it a greater number of times in a fixed interval, they may be said to be more fluent with the procedure. The difference between completing the procedure 3 times or 6 times in a 15-minute period could be attributed to greater fluency. A fluency score of 0, on the other hand, indicates that the learner "didn't get it." Embarrassing as it is for designers of tutorial software to admit, sometimes student will fail to learn. And failure to learn, instead of being treated as an aberration, ought to be of interest to us if it is associated with any one particular treatment.

Analysis of the data revealed that students offered only the reading version of the tutorial software scored a larger than expected number of zeroes. This meant that there was a high likelihood that students were more likely to fail to learn to perform the procedure demonstrated when they had been assigned to a text-based presentation. Of the seventeen students who completed the study but were unable to complete any labels, ten were from the "reading only" treatment group. A binomial test of this phenomenon against the expected value of .33 (28 of 85) showed that the possibility of this distribution of zero scores occurring by chance was less than .05. It seems then, that for the population of this study, assigning instruction only available as text significantly increases the likelihood of failure. Table 3 shows the results of the binomial analysis.

Table 3: Binomial Analysis of Distribution of Zero Scores by treatment

| Treatment | Number of Zeroes | Proportion of Total | Proportion of Zeroes | Sig. |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Reading Modality | 10 | .33 | .61 | .025 |
| Listening Modality | 3 | .39 | .18 | .055 |
| Choice Modality | 4 | .28 | .21 | .460 |
| Total | 17 | 1.00 | 1.00 | |

This distribution of zero scores strongly suggests that among low reading community college students, greater than average difficulty will be encountered learning procedures when the structure of the lesson mandates that they learn from reading. Given the dominance of low reading levels in the population tested, an alternative interpretation of this phenomenon is that the listening modality helps students learn the procedure well enough to complete it.

**Implications**

Presuming the veracity of the study reported about in this paper, the conclusion may be reached that, of community college students with previously noted low reading ability, providing text based instruction in procedures involving computer programs increases the chance of their failure to master the procedures described. This conclusion is clearly limited in its power by the low number of study participants whose score was zero. Because tutorial software isn't designed to produce failures, conclusions drawn on the way a limited number of failures line up can only be supported by studies with very small samples. In a low reading population, where failure to duplicate the shown procedure is more likely to occur than average, only 17 of the 89 participants could be included in a sample of "zero" scores. Because only around 20% of a trait-selected population would meet the criteria for being included in the sampled group, studies of this sampled group require much larger base populations than the one mentioned here.

On first glance, it would appear that only a small number of persons fall into the category of those who may avoid failure in procedural learning by being exposed to tutorials as narration rather than as text. And because the result is only related to procedures performed using a computer, it may be tempting to suggest that not many low-reading adults are likely to be involved in computer usage, thus minimizing the extent of the problem. However, a US Bureau of Labor Statistics report from October, 2003, on the type of computer activity at work by selected characteristics claims that workers with less than a high school education were likely to be using a computer in 43% of available jobs. In addition, the Alliance for Excellent Education (2003) makes reference to a report by the National Association of Manufacturers that in 2001, more than $60 billion was spent on training, and that much of that was on remedial reading, writing, and mathematics. (Alliance for Excellent Education, 2003) The combination of the two reports provide a strong indication that failure to learn procedures on a computer because the presentation of information is in a mode that leads to some learner failures is a problem worthy of solution.

When people undertake new tasks, their success with the tasks can depend on the instruction they receive about doing them. If we want to challenge low readers to new accomplishments in non-reading related areas, it makes sense to provide an alternative to reading text in the form of listening to narration. Making this option available decreases the chances of failure.

The time that this study can have an impact on how instruction is designed is rapidly approaching. High bandwidth internet delivery, which is becoming increasingly widespread, is making the transfer of recorded spoken instruction a reality. File formats for the transfer of sound-related recordings are already in place and popular. Podcasting is within a few years of becoming as ubiquitous as radio. It is easy to visualize the transfer of the instructions for steel cellar door assembly, for instance, into an iPod-like device worn at the point of assembly. The cost to produce sound-based instructional devices is dropping dramatically. Users will have already absorbed the costs of playback units. The time spent in the production of a narration of instructions is little more than the time it takes to have a proofreader speak them aloud.

One advantage audio has over text is that it is weightless and not bound to any particular place. It is easy to summon up another scene in which you have brought your car to your local auto dealer's service department to replace the disk brake pads of your front wheels. The service writer has looked up the year and model of your vehicle and typed in the kind of job to be done. A computer in the service office has downloaded a set of audio files, each a narrated subroutine of the overall brake pad replacement procedure. The mechanic, equipped with a set of ear buds connected by a wireless connection to a miniature receiver unit in a specially made shirtsleeve pocket, removes the device and touches a stylus to the "getting ready" menu. This contains a submenu of items including preparing the work area, tools you'll need, etc. The touch of the stylus to the "tools you'll need" area brings up the sound of a master mechanic's voice telling her that in addition to the toolbox of conventional hand tools, she will also need a brake adjustment wrench and a spring tension gauge.

The mechanic selects the "performing the work" menu, which reveals a choice of several sub-procedures arranged in the order in which they are normally performed. She selects the "removing the calipers" item and the master mechanic tells her about the special caliper removal edge built into the wrench she brought with her earlier. She holds the tool in the position described, moves it to the location described, pushes in the direction described, and confirms visually that the proper clearance for caliper release is achieved.

Once she has the caliper removed, she sees a few parts whose removal procedure is obvious. Having replaced brake pads many times, she doesn't need to approach the menu sequentially. Instead, she quickly works through the parts of the procedure she remembers until she gets to the "pad guide slot for removal" item. At this point, she picks up on the master mechanic's narration again. Overall, she spends about 10 minutes on the procedure for this wheel. The "standard jobs" credit she is getting for it is 20 minutes. Similar savings occur on the other side of the car as well.

Key to her success is the presence of just-in-time instruction structured in a way that lets her concentrate on what she sees and what to do with the tools and parts on which she is working. Key to the just-in-time instruction is a smattering of off-the-shelf computer connected products and the network of dealerships sponsored by the manufacturer. The scenario in question costs little more to put into place beyond the already existing high bandwidth network than the will to put the files into the right databases.

With the imaginary mechanic in this scenario, menu reading was used, but the bulk of the delivered instruction took the form of narration. If the instruction had been in the form of text, the number of words or pages of instruction that would have to be carried would have been enormous. To this day, service manuals are heavy, inaccessible, sloppy attention hogs. They rarely deliver exactly the information desired, and in the few cases that they do, font sizes become small enough to result in eyestrain.

One implication of the results of the study at hand is that, in circumstances where technology facilitates narratively-delivered instruction about procedures, that it is worthwhile to do so. Consider for a moment the main result of this study – that there was no significant difference in fluency of procedure performance that could be attributed to any of the modalities in which the instruction was delivered. This, in effect, says that text-based procedural instruction did not enable readers to become any more fluent with procedures than did listening. The delivery of exclusively text-based instruction cannot be supported on grounds of learning efficiency, cost, or convenience. The only reason left for its dominance is that "we've always done it this way."

The study at hand cannot say that a menu of audio files is the most effective method of bringing instruction to the point of need. The procedure for which the "concentration of failures" phenomenon was observed was limited to one done on computers. This has not been shown here to translate into workshop or pencil and paper settings. But there is good reason to expect that similar results can be obtained. One reason for this expectation is the match between procedures and audio of their both being extended into time. Text cannot claim the same match because it locates information at a place. In doing so, it creates a need on the part of learners to alternately focus visual attention to multiple places. The service manual and the textbook both match on-screen text fields in adding visual clutter to the learner's area of visual concentration. The results of the study at hand simply indicate that additional research about the value of narratively delivered instruction needs to be done.

The imaginary mechanic scenario is one of the possible areas in which auditory delivery of information makes sense. It depicts a combination of a workplace, a motivated adult learner, and sequential procedures. The study at hand dealt with a school setting, a computer-based task, cooperative adult learners with varying levels of motivation, and a sequential procedure. Room for research exists in changing the settings, changing the ages of the learners, and changing the task to one where multiple paths to successful completion exist. It should be clear from the scenario described that there will be places where auditory delivery of instruction reduces errors, improves advance preparation, and increases efficiency. It is reasonable to expect that procedural learning is an arena in which auditory instruction can be expected to be of benefit.

There will be some areas where learning through narration is cumbersome and inefficient. Although "talking books" are enjoyed by many listeners at many different reading levels, they typically take longer to complete because the speaker's rate of delivery is less than a reader's rate of reading.

Literature, then, seems to be most efficiently delivered in text-based media forms. History may be another area where auditory presentation of information is slower and less flexible than reading. In areas like this, little of what is expected of a learner is to be able to perform a procedure. Often, the expectation is that the learner be able to perform the act of test-taking in the aftermath of his or her learning. Because the usual form of "test-taking" places the test taker in front of visually presented text and then results in a performance of creating or modifying a visually presented document, textual presentation is closer to the way the task is assessed than is auditory presentation. This is a better alignment of the assessment to the presentation method, which is likely to appear as "better learning." The study mentions that performances of procedures are poorly measured by assessments measuring some verbal skill.

The area of math involves measures of visually oriented manipulation as well as application of learned procedures. Because it contains both a need to visually focus on a document and a sequential procedure, it is difficult to anticipate whether any failures in learning in this area can be avoided by narrating rather than asking students to read the procedural instructions involved. It is certainly possible that listening to the procedure described while it is being done may be more likely to lead to accurate problem solving than reading the procedure from a textbook. On the other hand, the large number of visually based symbols required may make a case for reading being the better choice of learning medium. This is another area where comparison studies may prove useful.

The study's result was obtained only in a low-reading adult population. But one important detail that must be considered is that children, up until approximately the sixth grade, are on the same track as low-reading adults. The two groups share a characteristic of being able to acquire information more quickly from listening than from reading. Research needs to be done about the benefits of narrated presentation for learning of skills other than reading. The study at hand provided one answer about the value of narration over text and opens the door to many new questions.

## Conclusion:

The value of auditory presentation is not as much that students learn "better" but that failure to learn at all is diminished. This was shown only for low reading adult learners using a computer to learn a computer-based procedure. The possibility exists that the result could extend to other environments and other populations, with learning of something other than procedures. More research into the value of narration in areas not touched by this study needs to be done.

## References:


Hassen, P., (2004), GED Testing Program Participation Drops 43.6 Percent in First Year of New Exam Series. Retrieved September 25, 2005 from http://www.acenet.edu/AM/Template.cfm?Section=Home&TEMPLATE=/CM/ContentDisplay.cfm&CONTENTID=3708

Holmes, B. C., (1985), The effect of 4 different modes of reading on comprehension. Reading Research Quarterly, 20(5), 575-585

Lai, S., (2000), Influence of Audio Visual Illustration on learning abstract concepts. Journal of Instructional Media, 27(2), 199-206

Nocente, N. M., (1996), The effects of digitized voice and learner characteristics on learning trigonometry with CAI. Dissertation: University of Toronto. AAT: NN11974

Rehaag D. M. & Szabo, M. (1995, February), An experiment on effects of redundant audio in computer based instruction on achievement, attitude, and learning time in 10th grade math. A paper presented at the annual meeting of the Association for Educational Communication Technology, Anaheim, CA

Rose, D. H. & Meyer, A., (2002), Teaching Every Student in the Digital Age: Universal Design for Learning. ASCD, 2002. Retrieved 6/30/2004 from: http://www.cast.org/teachingeverystudent/ideas/tes/

Shih, Y. & Alessi, S. M., (1996), Effects of text versus voice on learning in multimedia courseware. Journal of Educational Multimedia and Hypermedia, 5(2), 203-216

Solomon, H., (2005), The effect of audio narration in computer mediated instruction on procedural fluency by students of varying reading levels. Retrieved 10/9/2005 from http://etd.lib.fsu.edu/theses/available/etd- 04072005-161927/unrestricted/dissertation_final.pdf

US Bureau of Labor Statistics, Type of computer activity at work by selected characteristics, October 2003. Retrieved 9/25/2005 from http://bls.gov/news.release/ciuaw.t03.htm

# Technology Tools for the Middle School Classroom

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**Abstract**

*The purpose of this study is to examine the extent on how middle school teachers use the technology in the classroom and to what degree their students are using technology and the facilities, equipment provided by their schools. To answer many questions surrounding technology in schools, a study was conducted with randomly selected one thousand schools in ten states and the data was collected at the end of April 2004.*

**Introduction**

Technology continues to touch the lives of all Americans. From computers and cell phones to video games and on-line bill paying, technology is everywhere in American society. In education, especially, uses of technology in schools have exploded in recent years. For example, the number of computers in schools continues to rise with more than six million in our nations elementary and secondary schools (Fulton, 1999). Also, a recent survey of the National Center for Educational Statistics has reported 99% of full-time public teachers have access to computers or to the Internet somewhere in their school (Roward, 2002). In another major report on technology and readiness in schools, it was concluded that all students should graduate with the technology skills needed for today's world and all teachers should be equipped to use technology as a tool to achieve high academic standards in their classrooms (CEO Forum, 1999). In addition, integrating technology in the classroom has been proven to have positive effects on student learning. In their longitudinal study on the effects of integrating computer based leaning centers in elementary schools, Kromhout & Buzin (1993) pointed out that the use of technology in the classroom resulted in positive and statistically significantly high test scores, across grades and schools, for the areas of reading and mathematics. In a similar study by Lemke, Quinn, Zucker, and Cahill (1998), it was reported that students who used computers in the classroom did significantly better on standardized tests than students who used computers in a lab and that teachers were more likely to integrate computers into their instructional plans when the computers were in their classrooms.

In spite of the rapid growth of technology in our nation's schools, problems have arisen. First, there is evidence that many teachers still do not use technology in their classrooms (Education Week, 1999). Second, according to a survey (2002) of teachers conducted by Center for Educational Statistics, only 22% felt well prepared to use computers in their classrooms (Essex, 2002). Third, according to Mouza (2003) quality professional development in technology for teachers has been lacking because school districts have been using funds to purchase equipment rather than train their teachers. There are also other questions regarding technology in schools. Are teachers adequately prepared to use technology in their teaching? Are schools providing enough technology tools for their teachers and students? Do teachers really value technology in their teaching? In spite of these concerns, most educators continue to believe that technology is essential for quality education in the United States. Middle schools, in particular, can play an important role in helping middle schoolers learn more effectively, and in improving their technology skills.

To answer some of the questions surrounding technology use in middle schools, a survey was sent to 1000 middle schools in eleven states (New Hampshire, Vermont, West Virginia, Kentucky, Oklahoma, Texas, South Dakota, Massachusetts, Montana, Nevada, and Iowa). This study explored the types of technology used by middle schools teachers, their value, and the training and equipment provided them by their schools. One thousand questionnaires were sent to these teachers and three hundred sixty-three were returned.

The questionnaire consisted of two parts. In part one the teachers marked how often they used particular types of technology (never, rarely, sometimes and often) and how valuable these types of technology were in their teaching (very valuable, valuable, no valuable, no opinion, little value and no value). In part two the teachers indicated the availability of different types of technology in their schools and the training provided for them and their students by their schools. The results were analyzed using percentages of uses and of value. The majority of those responding were female with one to ten years of experience. Moreover, most of the respondents were mathematics and science teachers followed by those teaching social studies and English. This article will report only those findings dealing with the uses of technology tools in middle schools.

## Results

The results of this study indicate several important findings concerning technology in middle schools. Table A shows that the most often used types of technology were: word processing for teaching (83.9%), computers in preparing lessons (73.3%), e-mail for discussing teaching with other educators (68.6%), and the overhead projector (57.9%). The next most often used forms of technology were: the Internet (53.9%), computer assisted instruction (46%), computer graphics (40.7%), and Microsoft PowerPoint (40.0%). Table A also reveals that there were other types of technology used less often by the teachers: VCR's (33.7%), spreadsheets for assisting teaching (30.5%), CD-ROM disks (30%), television (26.5%), web pages (25.9%), video projectors (LCD projectors) (28.1%), databases to assist teaching (27.6%), digital cameras (26.4%), and films (12.7%). Additional evidence found in Table A indicates that the least often used types of technology were: the tape recorder (6.7%), digital camcorder (7.1%), laser disc player (4.1%), radio (1.7%), film strips (2.0%), slide projector (1.1%), and record player (.8%).

Table A: Technology Used by Teachers

| | Often | Sometimes | Rarely | Never |
|---|---|---|---|---|
| Use of word processing for teaching | 83.9% | 13.6% | 1.9% | 0.6 |
| Use of computer to prepare lessons | 73.3% | 21.2% | 3.6% | 1.9% |
| Use of overhead projector in teaching | 57.9% | 21.8% | 10.7% | 9.6% |
| Use of Internet for teaching | 53.9% | 39.1% | 5.0% | 2.0% |
| Using e-mail to discuss teaching with other educators | 68.6% | 19.8% | 6.6% | 5.0% |
| Use of computer assisted instruction | 46.0% | 40.7% | 10.0% | 3.3% |
| Use of computer graphics for teaching | 40.7% | 37.1% | 13.5% | 8.7% |
| Use of VCR in Teaching | 33.7% | 47.0% | 16.6% | 2.7% |
| Use of Microsoft Power Point and other computer programs for teaching | 40.0 | 31.9% | 17.2% | 10.9% |
| Use of spreadsheets for assisting teaching | 30.5% | 38.0% | 23.3% | 8.3% |
| Use of CD-ROM in teaching | 30.0% | 39.4% | 26.6% | 6.0% |
| Use of television in teaching | 26.5% | 45.6% | 20.4% | 7.5% |
| Create web pages for teaching | 25.9% | 20.4% | 12.9% | 40.8% |
| Use of video projector in teaching | 28.1% | 28.7% | 17.1% | 26.1% |
| Use of database to assist teaching | 27.6% | 29.3% | 24.0% | 19.1% |
| Use of digital camera in teaching | 26.4% | 32.1% | 23.1% | 18.4% |
| Use of films in teaching | 12.7% | 32.5% | 24.2% | 30.6% |
| Use of tape recorder in teaching | 6.7% | 20.8% | 31.1% | 31.4% |
| Use of digital camcorder in teaching | 7.1% | 23.4% | 28.0% | 41.5% |
| Use of laser disc player in teaching | 4.1% | 14.9% | 16.5% | 64.5% |
| **Use of radio in teaching** | 1.7% | 14.9% | 24.9% | 58.5% |
| Use of film strips in teaching | 2.0% | 7.0% | 18.8% | 72.2% |
| Use of slide projector in teaching | 1.1% | 7.7% | 22.4% | 68.8% |
| Use of record player in teaching | 0.8% | 4.4% | 13.3% | 81.5% |

Results reported in Table B show the different types of technology required or encouraged by teachers for their students. These were: encourage student use of Internet for work (56%), require computers for learning or assignments (49.3%), require students to use word processing for assignments (37.8%), require the use of Internet for work (32.1%), encourage power point use by students (27.5%), encourage students to use computer graphics (29.6%), encourage e-mail use by students (28.2%), encourage use of different types of media in work (22.8%), and encourage students to use CD-ROM for work (18.8%). Further results in Table B show that other lesser-used types of technology recommended for students were: spreadsheets (8.2%), database (7.8%), VCR (7.5%), digital camcorder (5.4%), and laser disc players (1.4%).

Table B: Technology Encouraged or Required for Students

| | Often | Sometimes | Rarely | Never |
|---|---|---|---|---|
| Encourage student use of Internet for work | 56.0% | 38.2% | 4.7% | 1.1% |
| Require computers for learning or assignments | 49.3% | 36.2% | 10.0% | 4.5% |
| Require students to use word processing | 37.8% | 39.4% | 15.3% | 7.5% |
| Require use of Internet for work | 32.1% | 46.3% | 13.3% | 8.3% |
| Encourage power point use by students | 27.5% | 36.4% | 19.3% | 16.8% |
| Encourage students to use computer graphics | 29.6% | 40.6% | 17.1% | 12.7% |
| Encourage use of different types of media in work | 22.8% | 37.8% | 26.1% | 13.3% |
| Encourage student to use CD-ROM for work | 18.8% | 33.4% | 31.2% | 16.6% |
| Encourage student to use electronic portfolio | 10.5% | 17.1% | 16.9% | 55.5% |
| Encourage e-Mail use by students | 9.7% | 25.8% | 25.5% | 39% |
| Encourage student use of spreadsheets | 8.2% | 25.9% | 36.1% | 29.8% |
| Encourage student use of database | 7.8% | 24.5% | 28.4% | 39.3% |
| Encourage student use of VCR | 7.5% | 26.9% | 34.3% | 31.3% |
| Encourage student use of digital camera | 15.2% | 28.7% | 28.1% | 28.0% |
| Encourage student use of digital camcorder | 5.4% | 18.9% | 29.3% | 46.4% |
| Encourage student use of laser disc players | 1.4% | 5.6% | 16.2% | 76.8% |

Findings in Table C indicate that schools are providing many types of technology tools for their teachers. VCR's are provided for a majority of teachers (93.3%) and Internet access is available in most classrooms (95%). CD-ROM equipment is present in over eighty percent of the classrooms (89.1%) and computers are provided for students in more than seventy percent of classrooms (72.2%). Digital cameras (73.3%) and e-mail facilities (86.9%) are also being found in over 85% of the schools. Video (LCD) projectors are available in over 60% of the schools (65.6%), while technology training for teachers (91.9%) and special technology instruction for students (91.1%) are provided by most schools.

Table C: Technology Provided for Teachers and Students

| | Yes | No |
|---|---|---|
| VCR's provided in classroom | 93.3% | 6.7% |
| Internet access in classroom | 95.0% | 5.0% |
| CD-ROM equipment provided in classroom | 89.1% | 10.9% |
| Computers provided in classroom | 72.2% | 27.8% |
| Digital cameras provided in classroom | 73.3% | 26.7% |
| **Distance learning is provided** | 48.3% | 51.7 |
| E-Mail in classroom | 86.9% | 13.1% |
| Video (LCD) projectors provided in classroom | 65.6% | 34.4% |
| Training for teachers in uses of technology | 91.9% | 8.1% |
| **Instruction for students in using technology** | 93.1% | 6.9% |

## Conclusions

Evidence from this study indicates several important findings. First, middle school teachers are using several types of technology tools in their teaching. Word processing and computers seem to be the most popular with over 70% of the teachers reporting that they often use them. E-mail, the overhead projector and the Internet are also popular with more than half of the teachers using them often in their classes. Other tools such as computer assisted instruction, computer graphics, VCR's, spreadsheets, CD-ROM, television, web pages, databases, and digital camera, are being frequently used but by only 25 to 34% of the teachers. The fact that the teachers are employing several types of technology tools in their teaching is important because it now shows that technology means more than just using computers to enhance instruction. Second, today's middle school teachers are rarely employing some traditionally used of technology tools: films, film strips, slide projectors and tape recorders. Third, middle school teachers are clearly encouraging (at times requiring) their students to utilize technology tools in their work. For example, nearly one half of the teachers in the study required their students to use computers for their assignments and over 50% encouraged them to utilize the Internet. Word processing, power point, and computer graphics are further being encouraged by 22 to 37% of the teachers. By encouraging their students to utilize technology tools, it seems clear that middle school teachers are recognizing the value of technology tools in helping students learn. Fourth, middle school teachers are receiving technology training, and students are been provided with instruction in using technology tools. In addition, both are being provided with a variety of technology tools by their schools. These facts are important because they appears to refute prior research showing a lack of technology training for teachers and insufficient amount of equipment being provided by schools.

Although the study indicates that many middle school teachers are integrating technology tools in to their teaching, encouraging their students to use them and are being provided with essential equipment and training, it seems clear that middle school teachers need to integrate other types of technology tools into their teaching instead of relying so much on word processing and the computer. Web pages, digital cameras, video projectors, power point presentations, computer graphics, and videos are being used but infrequently. Students, too, are being encouraged to use certain types technology tools for their work but need to use other tools (such as e-mail) to enhance their learning.

In summary, the use of technology tools in middle schools continues to grow each year. Nevertheless, more teachers need to use more technology tools in their everyday teaching. Lastly, more and more middle school teachers are understanding that integrating a variety of technology tools into their teaching is essential for improving the achievement of students and that using many types of technology tools will help students to develop technology skills needed for success in later life.

**References**

CEO Forum, (1999). *The CEO forum school technology and readiness report. Professional development: A link to better learning*. Washington, DC: CEO Forum

Education Week. (1998, Oct. 1). Technology Counts '98 [Special issue]. *Education Week*. 28 (5).

Fulton, D. (1999). *How teachers' belief about teaching and learning are reflected in their use of technology: Case studies from urban middle schools*. Thesis. College Park, MD: University of Maryland.

Kromhout, O. M. & Butzin, S. M. (1993). *Integrating computers into the elementary schools curriculum: an evaluation of nine project child model schools*. Journal of Research on Computing in Education, (26, 1-15).

Lemke, C., Queen, B., Zucker, A., & Cahill (1998). *Report to the Commonwealth of Virginia: An analysis of educational technology availability and usage in the public schools of Virginia.* Santa Monica, CA: Milken Family Foundation.

Mouza, C. (2002-2003). *Learning to teach with new technology: implications for professional development*. Journal of Research on Technology in Education. 35 (2), 272-287.

Roward, C. (2000). *Teachers use of computers and the Internet in public schools.* Stats in brief (on-line). Retrieved August 10, 2000 from http://nces.ed.gove/pbus2002/2000090.pdf.

# How Video Games Can Be Used As An Effective Learning Environment for Cognitive Apprenticeship Theory-Based Learning

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## Introduction

Cognitive science and its theories have been used in designing learning environments and many researchers have suggested that technology can assist in the implementation of these theories (Spiro et al, 1991; CTGV, 1993; Jonassen, 2004). Video games have become one of the most influential forms of technology in the world. This paper examines the potentials of video game technology as a cognitive apprenticeship-based learning environment by exploring the principles of Collins-Brown's (1989) model of cognitive apprenticeship with current video games and how the principles are applied effectively using the unique characteristics of video games.

## Cognitive Apprenticeship

### Situated Cognition

Cognitive apprenticeship is situated within the social constructivist paradigm (Brown et al., 1989; Resnick, 1989).

The theory of situated cognition claims that every human thought is adapted to the environment (Clancey, 1997). Moreover, what people perceive, think, and do develops in a fundamentally social context (Driscoll, 2000). The cultural context, the co-constitutive nature of individual-action-environment, and multiple knowledge communities have all become elements of situated cognition theory. Wenger (1998) summarized the basic premises of situated cognition theory: (1) We are social beings, which is a central aspect of learning; (2) Knowledge is a matter of competence with respect to valued enterprises, such as singing in tune, discovering scientific facts, fixing machines, and so on; (3) Knowing is a matter of participating in the pursuit of such enterprises, that is, active engagement in the world.

### Cognitive Apprenticeship theory

Based on the limitation they perceived of in today's formal schooling, Collins and his colleagues (1989) proposed an alternative method of instruction – cognitive apprenticeship, a synthesis of formal schooling and traditional apprenticeship. The goal of cognitive apprenticeship is to make the thinking process of a learning activity visible to both the students and the teacher. The teacher employs the methods of traditional apprenticeship (modeling, coaching, scaffolding, and fading) to effectively guide student learning. Collins, Brown, and Newman (1989) and Collins (1991) identified four aspects of cognitive apprenticeship-based learning: content, instructional methods, sequencing of instruction, and sociology.

Content refers to the different types of knowledge required for expertise and includes domain knowledge of concepts, facts, and procedures and strategic knowledge of an expert's ability to make use of concepts, facts, and procedures to solve problems.

Instructional methods are the learning activities used during instruction to help students construct, use, manage, and acquire new knowledge. They recommended seven instructional methods: "modeling," "coaching," "scaffolding," "fading," "articulating," "reflecting" and "exploring."

### Application of Cognitive Apprenticeship

The basic methods of cognitive apprenticeship have been successfully applied to teaching in the domains of reading, writing, and mathematics (Palincsar & Brown, 1984; Scardamalia & al. 1984; Scardamalia & Bereiter, 1985; Schoenfeld, 1985). In these domains, they emphasize two things. First, the method is aimed primarily at teaching the processes that experts use to handle complex tasks. Where conceptual and factual knowledge are addressed, cognitive apprenticeship emphasizes their use in problem solving and carrying out tasks. Conceptual and factual knowledge are exemplified and situated in the contexts of their use. There is a dual focus on expert processes and situated learning. Second, it focuses on the learning-through-guided-experience of the cognitive and metacognitive, rather than physical, skills and processes.

Most of the studies in these domains incorporate the basic elements of cognitive apprenticeship, using the methods of modeling, coaching and fading and of encouraging student reflection on their own learning. Especially in Scardamalia and Bereiter's 'Procedural facilitation of writing' case (1984, 1985), they applied tenets of cognitive apprenticeship by providing explicit procedural supports based on contrasting models of novice and expert writing strategies. Their approach was designed to give students a grasp of the complex activities involved in expertise by explicating modeling of expert processes, gradually reducing support or scaffolding for students attempting to engage in the processes, and providing opportunities for students to reflect on their own and others' efforts.

Cognitive apprenticeship has been supported by media, mainly via the computer and the Internet.

Lesgold and his colleagues (1992) developed 'Sherlock,' a computer-coached practice environment, to develop the troubleshooting skills of Air Force electronics technicians. The system is based on the cognitive apprenticeship theory of modeling, scaffolding and coaching using a schematic diagram that demonstrates expert understanding to the trainees.

Jarvela (1995) and Snyder et al. (2000) demonstrated the effectiveness of cognitive apprenticeship as an instructional design approach for teaching technical skills in an online environment by incorporating the use of discussion databases, e-mail and multimedia. They used cognitive apprenticeship techniques such as expert modeling, coaching, scaffolds, articulation, reflection, and exploration.

## Video Game Technology

Video games have become one of the most influential forms of entertainment in the world. Video games are a form of popular culture very similar to film or television in their impact. Generally, video games' characteristics such as competition, interactivity and realism are presumed to be the main factors that affect users by providing continuous and engaging visceral and behavioral thrills (Norman, 2004; Squire, 2004). Educators have not researched video games as much as other media (computers, the Internet, film and television, for example), but as video games have recently advanced both technologically and in popularity, there has been a movement to study the cognitive potential of games and how human interaction and the design of learning environments can be supported through game study (Squire, 2004).

### Research on Video Games and Learning

The most significant attempt at researching video games in a learning context was done in Gee's "What Video Games Have to Teach Us About Learning and Literacy" (2003) in which he outlined several learning principles by analyzing the various strengths and patterns used in popular video games. These principles can be taken into consideration when we design learning environments.

Other educators see video games as powerfully motivating digital environments and study them in order to determine how motivational components of popular video games might be integrated into instructional design (Bowman, 1982; Driskell & Dwyer, 1984; Bracey, 1992).

The "Games to Teach" Project (Jenkins, 2002), a collaborative effort between Microsoft and MIT's Comparative Media Studies Program, conducted a series of elaborate "thought experiments," and developed several conceptual prototypes exploring different models for how games might enrich the instruction of science, engineering and math at the advanced placement high school and early college levels. Their studies suggest that games do offer teachers enormous resources they can use to make their subject matter come alive for their students, motivate learning, offer rich and compelling problems, model the scientific process and engineering contexts, and enable more sophisticated assessment mechanisms.

## Video Games as a Cognitive Apprenticeship-based Learning Environment

Good video games immerse users in rich interactive digital micro-worlds. Bowman (1982) suggests that educators could use video games as a model for improving learning environments by providing clear goals, challenging students, allowing for collaboration, using criterion-based assessments, giving students more control over the learning process and incorporating novelty into the environment.

Many other game researchers have implied that video games could be used to create a cognitive apprenticeship-based learning environment (Jenkins, 2002; Prensky, 2002; Squire, 2004). However, none of them deeply studied how video games can support certain learning theories.

The following are specific implications of game technology and how and why it can be used in learning according to the principles of Collins-Brown's (1989) model of cognitive apprenticeship.

**Content: Teach tacit, heuristic knowledge as well as textbook knowledge.**

Collins et al. (1989) refer to four kinds of knowledge: domain knowledge, heuristic strategies, control strategies and learning strategies. Domain knowledge is the conceptual and procedural knowledge typically found in textbooks and other instructional materials. Heuristic strategies are 'tricks of the trade' or 'rules of thumb' in which people use narrow solution paths to solve a problem. Control strategies are for students to monitor and regulate their problem-solving activity.

Video games' high interactivity and rich multimedia elements are almost unlimited in presenting different knowledge or strategies. In video games, domain knowledge can be easily presented by providing a tutorial or presentation using media such as text, narration, graphics, video and animation.

Heuristic, control and learning strategies can be fostered through repeated problem-solving practice (Squire, 2004). In the virtual environment of video games, learners can repeat actions without the anxiety of failure. Also, by taking part in simulations, learners can easily observe the natural uses of domain knowledge and later apply it in an authentic context.

Most video games first present domain knowledge and require players to apply this knowledge in problem-solving activities. Domain knowledge is especially necessary in role-playing and simulation games; without it users often cannot succeed in the game. By solving problems and achieving incremental goals, game players also learn other strategies. For example, in the PC game 'Monopoly Tycoon,' users first go through an interactive tutorial and static text to learn the basic words, concepts and strategies of buying and managing real estate properties. When the actual game starts, players use the basic knowledge and strategies and domain knowledge from the tutorial in order to experiment with more advanced and less explicit strategies for completing objectives; they ultimately learn complex and contextualized real estate management skills.

Situated Learning: Teach knowledge and skills in contexts that reflect the way the knowledge will be useful in real life.

Sociology is one of the building blocks of the cognitive apprenticeship model, in which, all instruction is placed within 'authentic' contexts that mirror real-life problem solving situations. The learning environment should reproduce the technological, social, temporal and motivational characteristics of real-world situations where what is being learned will be used (Collins, Brown & Newman, 1989).

Games have a great potential to support this principle by providing a realistic environment in which learners can practice and apply newly acquired knowledge and problem solving abilities. In 'CSI: Dark Motives,' the player is a new trainee at the Las Vegas crime lab, and must gather and analyze evidence, interview suspects, and work with other lab members in order to solve the crimes and be hired by the team. The gameplay takes place in a true-to-life environment: the player has a believable incentive for solving the crimes (employment), the various suspects and characters assert themselves in realistic ways, and authentic forensic tools must be mastered in order to solve the cases.

Role-playing and simulation games can also give learners the experience of contextualized learning, in particular when interaction and collaboration are integral success strategies. Video game consoles with multi-player online or wireless gaming capabilities appear to be an increasingly important part of the video game environment supporting the principle of situated learning (Squire, 2004). In many Massively Multiplayer Online Role Playing Games (MMORPGs), character class skill sets and areas are designed so that no one player can survive without bonding with others. Even in MUDs (Multiple User Dungeons), text-based online environments, users can collaborate in groups to complete quests and solve puzzles.

Modeling and explaining: Show how a process unfolds and give reasons why it happens that way.

In a video game, the modeling of processes and the demonstration of expert performances can be easily visualized. Squire (2004) suggests that computerized simulations or 'edutainment' video games can be powerful tools for learning for four reasons: (1) learners can manipulate otherwise unalterable variables, (2) students can view phenomena from new perspectives, (3) learners can observe a system's behavior over time and (4) students can visualize a system in three dimensions.

Most video games contain features that model and explain gameplay using visual aids, allowing a player to observe a process and understand its underlying factors. In the first battle of 'Final Fantasy Tactics,' you do not have control over all the members of your party. Rather, you only control the main character and can watch how your computer-controlled allies move, attack and use items in the battle. You are free to engage in the battle or stay at the rear of your party and merely observe (you can rotate the battleground in order to view the battle from four different directions). After this battle, you gain control of all the members of your party. The unique initiation to gameplay in 'Final Fantasy Tactics' allows the player to understand the methods and strategies necessary for successful future battles.

Coaching: Observe students as they try to complete tasks and provide hints and help when needed.

In the learner-centered environments of video games, the player often requires guidance on what to do next. Gee (2003) mentioned that good video games deal with overt information and guidance on one hand and immersion in practice on the other.

Coaching in an apprenticeship-based video game environment can be accomplished through a variety of forms of guidance: from programmed feedback for certain inputs to virtual coaches as Gee (2003) described using the example of Professor Von Croy (a character in the 'Tomb Raider' game series) who guides Lara, the heroine, over a variety of obstacles. In driving simulation games such as 'Crazy Taxi' or 'Grand Theft Auto III', a navigating map with marks indicating safe houses or mission locations is another form of a hint. In the 'Sonic the Hedgehog' games, memo-style notices suggest what the user should do to finish a game stage. In the 'Monster Rancher' series, an in-game assistant gives continuous information on how your virtual-pet monster is feeling, how well it may do in competitions, and what the result of certain training methods may be (spoiling may lead to a lazy monster; attempting a difficult task may frustrate a monster). By following the assistant's advice, a player learns the most appropriate methods for raising a healthy and victorious monster.

In MMORPGs, less experienced players often ask higher-level players advice about where to find a particular shop in a city, which weapons or spells are the most effective, or how to defeat a certain enemy. 'A Tale in the Desert,' however, makes coaching an integral element of gameplay. In this social experiment of sorts, players start with nothing and learn to gather materials and construct objects in order to progress in an Ancient Egyptian society. Various skills can be learned in the game, ranging from art or architecture to leadership or the human body. One of the requirements of a player who decides to train in leadership is to become a 'mentor' for less experienced players. Mentors are 'on-call,' and there are mentors specifically devoted to speakers of languages besides English. A player can contact her mentor as often or as seldom as it is necessary, placing gameplay and learning directly in her Zone of Proximal Development (Vygotsky, 1978).

Virtual coaches or masters who help players use some functions of a game, hint at some goals, tactics, or strategies can be easily integrated into games.

Articulation and Reflection: Have students think about their actions and give reasons for their decisions and strategies, thus making their tacit knowledge more explicit; Have students look back over their efforts to complete a task and analyze their own performance.

Cognitive apprenticeship also requires extended techniques to encourage the development of self-correction and monitoring skills. It encourages reflection by noticing differences between novice and expert performance and by using techniques such as abstracted replay (Collins & Brown, 1998).

In video games, the replaying of learners' actions and strategies and giving feedback can facilitate articulation and reflection. Malone (1981) also suggested that multiple goal structures and scoring can give students feedback on their progress. Video games can provide multiple sources or dimensions of feedback based on users' performance in authentic contexts. One example of how video games can prompt reflection is through the slow-motion replaying and reviewing of learners' actions like in many martial arts fighting games such as 'Tekken', 'Street Fighter', and 'Soul Caliber.' More advanced methods of prompting reflection are evidenced in 'Mario Kart 64,' in which a player can race around the track against a 'ghost' kart (the driving data of his best lap), and 'ESPN NFL 2K5,' in which the computer can analyze every aspect of a player's play style, save this profile to a memory card, and allow that person or a friend to practice against her play style and learn her strengths and weaknesses. These latter two examples demonstrate how video games can support prediction, hypothesizing and experimentation, which focus a student's attention directly on her own thought processes (Herrington & Oliver, 1995).

Articulation is seen less frequently in 'stand-alone' video games, although some games, like 'Myst IV: Revelations' do contain 'journal' and 'photography' systems that allow a player to focus more attention on her cognitive processes while playing the game. However, MMORPGs such as 'World of Warcraft' or 'Everquest,' because of their collaborative nature, foster a player's frequent articulation of his knowledge when negotiating with his group mates about which dungeon to enter, the method of attack or how to complete a particular quest. A player often needs to not only suggest a course of action to the group, but also to be able to give several reasons why and how it should take place, or why it should happen one way and not another.

Exploration: Encourage students to try out different strategies and hypotheses and observe their effects.

In the real world, exploration costs money, time, and sometimes has risks in various situations. In virtual environments, especially in simulation and role-playing games, learners can apply as many different strategies and hypotheses as they want.

Gee (2003) suggested a multiple routes principle from this point of view: there are multiple ways to make progress or move ahead. This allows learners to make choices, rely on their own strengths and styles of learning and problem solving while also exploring alternative styles (p.108).

In designing video games, we can allow students to choose different ways to solve problems, and this design strategy is easily found in many strategic simulation games. For example, in first-person World War II simulations such as 'Battlefield 1942,' and 'Medal of Honor,' players can choose different types of soldiers and apply different strategies to defend or attack territories. A novice player might choose to fight as a sniper and find himself very ineffective against a battalion of tanks. Players can experiment with different troop types and combinations, vehicles and offensive and defensive strategies. These games allow a player countless opportunities to plan, act, and adjust strategies in order to become a more effective team member. Also, in 'Star Craft', players can use different strategies to fight back against two other enemies; exploration of strategies also takes place when dealing with more and varied enemies. By observing the effect of the strategies they choose, players can learn different perspectives.

Sequence: Present instruction in an order from simple to complex, with increasing diversity, and global before local skills.

Sequencing involves the staging of learning whereby tasks are presented in increasing complexity and diversity so that students develop a broad understanding of the domain of expertise. One of the common characteristic features of video games are their increasing complexity and diversity as students build certain skills and knowledge of strategies. In games, multiple difficulty levels can be provided to adjust the game difficulty as learner's individual skills develop (Malone, 1981). In addition, reducing the amount of help from virtual guidance or coaches as the game progresses can be easily included in a game's design.

Several skill-related games employ this strategy, usually providing some rewards as a motivational factor as the learner gains more expertise. A good example is the game 'SSX Tricky', the snow boarding role-playing simulation game. In the beginning of the game, the character can only snowboard on easier slopes. After viewing demonstrations of new tricks, then practicing and mastering these techniques, the game allows the player to advance to more difficult slopes. As a reward for mastering both tricks and slopes, a player is allowed to customize her character with more fashionable outfits and boards.

**Conclusion**

The cognitive apprenticeship theory and its effective implementation strategy have been built through an analysis of traditional apprenticeship and the extensive body of cognitive science research.

As discussed above, video game technology has a great deal of potential in designing learning environments. Besides its great effect on learners' motivation, video games have many features that can be strong advantages, when compared to other media, in designing cognitive apprenticeship-based learning: it provides realistic virtual worlds; it is effective in visualizing and modeling processes and strategies; it allows for high levels of interaction; and it is effective in giving feedback and opportunities for practice. Applied properly, these features can make cognitive apprenticeship-based environments more engaging for both students and teachers.

**References**

Bowman, R.F. (1982). A Pac-Man theory of motivation: Tactical implications for classroom instruction. *Educational Technology, 22*(9), 14-17.

Bracey, G.W. (1992). The bright future of integrated learning system. *Educational Technology, 32*(9), 60-62.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18, 32-42.
Clancey, W.J. (1997). *Situated Cognition: On human knowledge and computer representations.* New York: Cambridge University Press.
Cognition and Technology Group at Vanderbilt (CTGV) (1993). Anchored instruction and situated cognition revisited. *Educational Technology, 33* (3), 52-70.
Collins, A., & Brown, J.S. (1988). The computer as a tool for learning through reflection. In H. Mandl & A. Lesgold (Eds.), *Learning issues for intelligent tutoring system* (pp.1-18). New York: Springer-Verlag.
Collins, A., Brown, J.S., & Newman, S.E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In L. B. Resnick (Ed.), *Knowing, learning, and instruction: Essays in honor of Robert Glaser* (pp. 453-494). Hillsdale, NJ: Lawrence Erlbaum Associates.
Collins, A., Brown, J.S., & Holum, A. (1991). Cognitive apprenticeship: Making thinking visible. *American Educator*, *6*(11), 38-46.
Driscoll, M. P. (2000). *Psychology of learning for instruction* (2nd ed.). Boston: Allyn & Bacon.
Driskell, J.E. & Dwyer, D.J. (1984). Microcomputer videogame based training. *Educational Technology, 24*(2), 11-15.
Gee, J.P. (2003). *What video games have to teach us about learning and literacy.* New York: Palgrave.
Herrington, J. & Oliver, R. (1995). Critical characteristics of situated learning: Implications for the instructional design of multimedia. In J. Pearce & A. Ellis (Eds.), *Learning with technology*, pp. 253-262. Parkville, Vic: University of Melbourne.
Jarvela, S. (1995). The cognitive apprenticeship model in a technologically rich learning environment: Interpreting the learning interaction. *Learning & Instruction, 5*(3), 237-259.
Jenkins, H. (2002). *Game Theory: How should we teach kids Newtonian physics? Simple, play computer games. Technology weekly.* Retrieved November 2, 2004, from http://www.technologyreview.com/article/02/03/wo_jenkins0302902.asp?p= 0
Jonassen, D. (2004). *Design of constructivist learning environment.* Retrieved March 2, 2004, from http://www.coe.missouri.edu/~jonassen/courses/CLE/.
Lesgold, A., Lajoie, S., Bunzon, M., & Eggan, G. (1992). A coached practice environment for an electronics troubleshooting job. In J. Larkin & R. Chabay (Eds.), *Computer assisted instruction and intelligent tutoring systems: Establishing communications and collaboration.* (pp.202-238). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
Malone, T.W. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive Science*, (4), 333-369. MediaScope.
Norman, D. (2004). *Emotional Design.* New York: Basic Books.
Palincsar, A.S., & Brown, A.L. (1984). Reciprocal teaching of comprehension-fostering and monitoring activities. *Cognition and Instruction, 1*, 117-175.
Prensky, M. (2002). *Digital Game-based learning.* New York: McGraw-Hill Trade.
Renkl, A., Atkinson, R.K., & Maier, U.H. (2000). From studying examples to solving problems: Fading worked-out solution steps helps learning. In L. Gleitman & A. K. Joshi (Eds.), *Proceeding of the 22nd Annual Conference of the Cognitive Science Society* (p. 393-398). Mahwah, NJ: Erlbaum.
Resnick, L. B. (1989). Introduction. In L. B. Resnick (Ed.), *Knowing, learning and instruction: essays in honor of Robert Glaser* (pp.l-24). Hillsdale, NJ: Lawrence Erlbaum.
Spiro, R.J., Feltovich, P.J., Jacobson, M.J., & Coulson, R.L. (1991). Cognitive Flexibility, Constructivism, and Hypertext: Random Access Instruction for Advanced Knowledge Acquisition in Ill-Structured Domains, *Educational Technology*, 24-33.
Squire, K. (2004). *Video Games in Education.* Retrieved November 2, 2004, from http://www.educationarcade.org/gtt/pubs/IJIS.doc
Scardamalia, M., & Bereiter, C. (1985). Fostering the development of self-regulation in children's knowledge processing. In S.F. Chipman, J.W. Segal, & R. Glaser (Eds.), *Thinking and learning skills: Research and open questions* (pp. 563-577). Hillsdale, NJ: Lawrence Erlbaum Associates.
Scardamalia, M., Bereiter, C., & Steinbach, R. (1984). Teachability of reflective processes in written composition. *Cognitive Science, 8,* 173-190.
Shoenfeld, A.H. (1983). Problem solving in the mathematics curriculum: A report, recommendations and an annotated bibliography. The Mathematical Association of America, MAA Notes, No. 1.
Schoenfeld, A.H. (1985). *Mathematical problem solving*. New York: Academic Press.

Snyder, K., Farrell, R. & Baker, N. (2000) Online Mentoring: A case study involving cognitive apprenticeship and a technology-enabled learning environment. *Proceedings of the ED-MEDIA 2000, USA.*

Snyder, K. (2000). Asynchronous learning networks and cognitive apprenticeship. *A model for teaching complex problem solving skills in corporate environments.* Unpublished doctoral dissertation.

Vygotsky, L. (1978). *Mind in Society: The Development of Higher Psychological Processes.* Cambridge, MA: Harvard University Press.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity.* New York: Cambridge University Press.

**Video Game References**

2015. (2002). *Medal of Honor*. EA Games.

Acclaim Studios Cheltenham. (2001). *Crazy Taxi*. Acclaim.

Blizzard Entertainment. (1998). *Star Craft*. Blizzard Entertainment.

Blizzard Entertainment. (2004). *World of Warcraft*. Blizzard Entertainment.

Capcom. (1987). *Street Fighter*. Capcom.

Core Design Ltd. (1996). *Tomb Raider*. Eidos Interactive.

Deep Red. (2001). *Monopoly Tycoon*. Atari.

Digital Illusions. (2002). *Battlefield 1942*. EA Games.

EA Sports Big. (2001). *SSX Tricky*. EA Sports Big.

eGenesis. (2003). *A Tale in the Desert.* eGenesis.

Namco. (1995). *Tekken*. Namco.

Namco. (1999). *Soul Caliber*. Namco.

Nintendo. (1996). *Mario Kart 64*. Nintendo.

Rockstar North. (2001). *Grand Theft Auto III*. Rockstar Games.

Sonic Team. (1990). *Sonic the Hedgehog*. Sega.

Sony Online Entertainment. (1999). *EverQuest*. Sony Online Entertainment.

Square Enix. (2003). *Final Fantasy Tactics*. Nintendo.

Tecmo. (1997). *Monster Rancher*. Tecmo.

Ubisoft Montreal. (2004). *Myst IV: Revelations*. Ubisoft.

Ubisoft. (2004). *CSI: Dark Motives.* Ubisoft.

Visual Concepts. (2004). *ESPN NFL 2K5*. Sega.

# Mathematical Software and Young Children

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## Introduction

According to the National Council of Teachers of Mathematics [NCTM], educators' goals should be to "create a coherent vision of what it means to be mathematically literate both in a world that relies on calculators and computers to carry out mathematical procedures and in a world where mathematics is rapidly growing and is extensively being applied in diverse fields" (1995, ¶2). Emphasizing the importance of understanding and using mathematics, the NCTM also notes that "in this changing world, those who understand and can do mathematics will have significantly enhanced opportunities and options for shaping their futures. Mathematical competence opens doors to productive futures. A lack of mathematical competence keeps those doors closed" (2000, p.5). Likewise, the National Association for the Education of Young Children (NAEYC) (2002) states that young children need mathematical understanding and skills not only in mathematics classes but also in science, social studies, and other subjects. Regarding this changing world where mathematics has never been more important in our life, workplace, and the scientific and technical community, the International Society for Technology in Education [ISTE] draws attention to the potential of technology to change education and improve students' learning and suggests educators "design developmentally appropriate learning opportunities that apply technology-enhanced instructional strategies to support the learners" in order to maximize their learning (2000, p.9). Today, a number of different technologies are being used in mathematics' classrooms. Computers and computer programs are one of them and have become increasingly visible in early childhood education settings since the end of the 1980's (Char, 1990; Clements, 1999, 2002; Haugland, 1997).

Although, children today have access to computers in libraries, day care centers, preschool programs, elementary schools, community centers, and after-school programs, educators still continue to debate the potential benefits and possible harm resulting from computer use by young children. The most important concern researchers raise is that computer use might replace other activities that are essential for children's development (Barnes & Hill, 1983; Brouwer-Janse, Suri, Yawitz, Vries, Fozard & Coleman, 1997; Healy, 1998, 2004; The Alliance for Childhood, 2000). The scholars argue that children may spend more time using computers than, for instance, playing with blocks or playing with other children. In other words, computers would take children "away from the real development tests of the young child" (Turner, 1992, p.33). In addition to the concern above, researchers draw attention to other potential negative results of computer use: Computers may prevent children from building the social skills that are important for their overall growth and development; and computers may cause health problems, such as repetitive stress injuries, eyestrain, and obesity (Attewell, Suazo-Garcia & Battle, 2003; Barnes & Hill, 1983; Healy, 1998; Scoter, Ellis & Railsback, 2001; Shields & Behrman, 2000; Subrahmanyam, Kraut, Greenfield & Gross, 2000; The Alliance for Childhood, 2000).

On the other hand, other researchers have identified potential benefits of computer use for children's development (Clements, 1994, 1999, 2002; Clements, Nastasi & Swaminathan, 1993; Haugland, 1992, 2000; Haugland, Bailey & Ruiz, 2002; Liu, 1996; NAEYC, 2002). Appropriate use of computers may advance children's socialization and language development (Clement, 1994, 1999; Clements, Nastasi & Swaminathan, 1993; Haugland & Wright, 1997; Liu, 1996; NAEYC, 1996; Wright & Shade, 1994). For instance, at school, home or at childcare centers, a child can be asked to use a computer with a partner, which provides opportunities for them to work, share, and communicate with each other. In addition, developmentally appropriate software may encourage children to use their imagination and solve problems (Haugland & Wright, 1997; Johanson, 1997; NAEYC, 1996). Moreover, technological tools may increase children's motivation (Guthrie & Richardson, 1995; Haugland & Wright, 1997, Papert, 1993). For example, Guthrie and Richardson conclude that children were intrinsically motivated to use computers and spent more time at the computer than they did in other activities. According to Haugland and Wright, children are more motivated while using computers since the computer provides children "a world they want to explore, experiment and discover" (1997, p.13).

Children with special needs may also benefit from technology in terms of minimizing the effects of disability, improving quality of life, and enhancing social participation (Brett, 1997; Johanson, 1997; McComas, Pivik & Laflamme, 1998; Schery & O'Connor, 1992). Children who have physical disabilities can use computers with special input devices, such as alternative keyboards, including programmable, miniature, chording and on-screen keyboards (Kincaid, 1999; Lyman & Mather, 1998). In addition, as software that has auditory information can serve acoustic learners, software that includes visual information can provide greater usability for visual learners (McComas, Pivik & Laflamme, 1998).

In order to ensure the desirable effects of the computer uses mentioned above, children should be provided with technology-enriched learning experiences that are developmentally appropriate. Haugland and her associates stress the importance of effective software selection and note that developmentally appropriate software facilitates children's learning, empowers them to become active participants in their own learning, and sparks their curiosity (Haugland, Ruiz, 2002; Haugland, Bailey & Ruiz, 2002). "Market researchers tracking software trends have identified that the largest software growth recently has been in titles and companies serving the early childhood market" (NAEYC, 1996, p.11). In addition, according to the Software Publisher Association (SPA) consumer market report (1996), of families who have young children and their own home computer, 70 percent have purchased educational software for their children (SPA, 1996).

The purpose of this study is to determine whether computer programs that are identified as bestsellers are developmentally appropriate for the targeted age group by investigating the critical attributes of mathematical software intended for use by young children. Also, this study may assist software designers, teachers, and parents in designing and selecting developmentally appropriate educational software. For the purposes of this study, three "bestseller" mathematical programs designated for children between the ages of 4 and 7 were identified: Reader Rabbit's Math, Jump Start Numbers, and Math Mission: The Race to Spectacle City Arcade. The selected programs were evaluated against the following six criteria: the degree of child control, clear instruction, violence prevention, technical features, connections to the real world, and process orientation.

### The Degree of Child Control

Scholars agree that educational software should enable learners to individualize all activities in software (DeLaurentiis, 1993; Haugland & Shade, 1990; Khalifa, Bloor, Middelton & Jones, 2000; Mandel, 1997; Shade, 1999; Spencer, 1986) in order to help them build their self-esteem (Haugland & Shade, 1990) and increase their engagement and motivation (Campbell & Chapman, 1967; Fisher, Blackwell, Garcia & Greene, 1975). Likewise, Mandel argues that "the best interface is the one that lets users do what they want to do, when they want and how they want to do it" (1997, p. xi). In addition, researchers found that children get annoyed if the animated characters keep telling them what to do instead of giving them an opportunity to choose what they want to do (Druin, Bederson, Hourcade, Sherman, Revelle, Platner &Weng, 2001). Child control is also essential because there are simply not enough people in schools and child care centers to assist children one-on-one when they use software (Shade, 1999); thus, children should be encouraged to discover a variety of ways to solve problems by themselves (Haugland & Shade, 1990).

Haugland and Shade (1990) stress that children be active participants who initiate and determine the series of events instead of responding to programmed activities, and they argue that children should have an opportunity to set the pace of the software. For instance, there should be a feature that enables students to terminate animations and interrupt audio with mouse clicks, since students are not always patient enough to sit through lengthy instructions and will not be able to absorb much of the information at any one time (Deubel, 2002; Hanna, Risden, Czerwinski & Alexander, 1999). Animations and audio may distract and reduce students' ability to concentrate on the subject. Providing for greater student control of software features may eliminate those factors that negatively affect students' learning.

Not surprisingly, while solving some potential problems, granting children more control may conversely cause problems. Studies have indicated that including too much freedom of choice might decrease learning effectiveness, especially for novice users (Large, 1996; Niemiec, Sikorski & Walberg, 1996). According to Niemiec and colleagues (1996), very young children may not be able to make educational decisions since they do not have adequate knowledge. In addition, Steinberg concluded that "studies of learner control in the last decade support earlier findings that students who have little prior knowledge about a subject are likely to perform poorly under learner control" (1989, p.117). Thus, software should be designed to allow children to control the software; however, this freedom should not affect users' learning negatively. Niemiec et. al. (1996) suggest developers add a feature that "advises students of their progress and suggests courses of action but leaves the choice to the learner" (p.159).

Large, Beheshti and Breuleux (1998) conducted a study in order to identify primary school students' information seeking in a multimedia environment. Three multimedia CD-ROMs were placed in two classrooms for the duration of a class project and students were asked to find information about a specific topic. In one multimedia environment, the opening page offers users an opportunity to start a new game or open a saved game. The scenario of this game begin "…a dangerous secret mission inside the stone walls of Baron Mortimer's castle in 14th century Europe" (p.355) and the authors note:

> Not surprisingly, all student groups, on their first encounter with [the multimedia CD-ROM]**,** chose to undertake the game rather than delve deeper into the interface in order to discover the other search options. Some groups became engrossed in the game and spent more than 45 minutes on it without explicitly identifying relevant information for their project…(1998, p.355).

Regarding the literature, fortunately, all of the reviewed programs provide children with an opportunity to have control as children, where they can manage the flow and direction of activities. Specifically, on the first screen of Reader Rabbit's Math, children can either play a game or practice counting, adding, and subtracting. As noted in the result section, the opportunity to choose a game over practice might decrease learning effectiveness, especially for novice users (Large, 1996; Large, Beheshti & Breuleux, 1998; Niemiec, Sikorski & Walberg, 1996). Math Mission also includes games for children to play. The difference between the two programs is that children who use Math Mission need to first develop and improve their mathematical knowledge in order to be allowed to play the games. In short, in order to enhance learning effectiveness, designers could provide children with games as rewards for their progress.

### Use of Language

Language provides a means for expressing ideas and asking questions, the categories and concepts for thinking, and the links between the past and the future (Aldrich, 2002; Das, 1995; Piaget, 1962), which means that the use of language is an important issue with regard to making software more readily understandable to children. Salisbury (1990) emphasizes the importance of language by contending, "... speedy and efficient word-recognition and word understanding is a critical prerequisite for successful reading..." (p. 25). Basically, we know that most children who are three to five years of age are not reading and writing, at least not conventionally. Also, children who are six to eight years of age may read and write independently but they are not typically proficient. Briefly, language should be suitable for the target age group. The NCTE (2001) stresses that the language level of the software should be assessed in order to see whether it is too advanced or too technical for the targeted age group. Also, Haugland and Shade (1990) state that the software should include clearly written instructions and verbal directions. Thus, it might be said that clear language and suitable vocabulary are essential for developers to consider since they influence students' initial understanding as well as ongoing learning. In addition, children need simple and direct statements about what is expected from them in order to exhibit desired behaviors (Greenberg, 1992; Haugland & Shade, 1990).

Designers of children's software may identify particular words related to a subject for learners to master so that learners may have an opportunity to enhance their vocabulary knowledge on a specific subject. For instance, studies (Adams, 1990; Chun & Plass, 1997; Stahl & Fairbanks, 1986; Woof, 2001) showed that some elementary grade students who were provided direct instruction in a specific body of vocabulary words not only acquired the definitions but also applied these words to raise their "text intellectual" capacity. Woof (2001) states that technology can provide opportunities for children to encounter new words in multiple contexts by allowing them to access text or graphics. Also, she also draws attention to the devices and notes "devices that allow users to click on words to hear them pronounced (and sometimes defined), can enhance understandings about new words. Such "hot spots" can be a powerful learning tool, particularly when used in combination with other modalities" (Woof, 2001, p.173) that allow children to click on words to hear them pronounced and notes that those devices can enhance understanding about new words, as they click on words to hear them pronounced.

The programs reviewed are educational programs that have clear and understandable oral instructions that children can listen to repeatedly. And yet, these programs lack written instructions. Children can see the written instruction only when they quit from the programs. This may have the effect of decreasing the motivation of students who have hearing problems, or who prefer to read rather than hearing instructions. Therefore, in order to serve more children, software should include clear written and oral instructions with direct statements about what is expected from children in order to demonstrate desired behaviors.

## Absence of Violence

Quality software should provide a safe environment that engages the learner in experiences that promote intellectual, physical, social, spiritual, emotional, and moral growth and development (Bushman & Anderson, 2002; Haugland & Wright, 1997; Heath, Bresolin & Rinaldi, 1989; Huesmann & Skoric, 2003; NAEYC, 1994). However, today violence is often used in software and on web sites to attract children's attention and, unfortunately, some children may find violence entertaining. According to the NAEYC statement position (1994), children who are under seven or eight years old have great difficulty distinguishing "fantasy from reality and their ability to comprehend nuances of behavior, motivation, or moral complexity is limited" (p. 19); thus, children may think that violence is fun. In addition, the presence of violence may cause children to become less sensitive to the pain and suffering of others; to become more fearful of the world around them; and to be more likely to act in aggressive or harmful ways toward others (NAEYC, 1994). In order to emphasize the negative effects of violence, Haugland (n.d.) provides the following example:

> What do we communicate to children when bombs are used to destroy pictures rather than an eraser? In one classroom, children quickly placed objects on the screen using a drawing program for the sole purpose of watching a bomb explode the objects on the screen. Children bombed the screen over and over. In software and web sites it is critical to recognize that children never experience the consequences of their violent behavior. They just quit and start over again as if they had never done the violent act. These communicates to children that violence is harmless. Yet in reality when something is bombed, it is destroyed. It is not possible to click a button and have objects and or people restored (Selecting Developmentally Appropriate Software, ¶20).

Also, Haugland and Wright (1997) stress that software should not include any objects that children could use to perform violent actions, such as guns, swords, bombs or poison. There are also several studies that sought to identify the effects on young children of playing an "aggressive" versus "nonaggressive" video game (Calvert & Tan, 1994; Irwin & Gross, 1995). Based on these studies, children who played an aggressive video game displayed more verbal and physical aggression, had a higher heart rate, reported more dizziness and nausea than did other children who did not play the aggressive video game. These studies did not measure children's willingness to hurt anyone else; nonetheless, the data presented raises concerns about children's mental and psychological development that designers should consider.

Jump Start Numbers includes swords and skulls in one of the games. Although they do not attempt to use the swords to indicate a violent act, the presence of these icons may cause children to begin associating violent objects with fun. Also, in the program there is a character called Alien Mutt who while flying in her spaceship shoots the asteroids that Frankie needs and children have to knock her off the screen. NAEYC states that young children may not be capable of distinguishing reality from fantasy. Children who use Jump Start Numbers may think that shooting something or knocking someone off is fun. As mentioned before, in order to provide children with experiences that promote their intellectual, physical, social, spiritual, emotional, and moral growth and development, designers should create software that is free of violent characters and actions.

## Technical Features

The process of installation of software should be easy for children (Boivie, 1998; Haugland & Wright, 1997). Directions for loading the software must be concise, specific and easy to follow. Directions should include graphics and/or verbal instructions whenever necessary to make it easy to follow each step of the installation. Also, directions should include a trouble shooting guide for difficulties that may emerge during installation and while operating the system (Haugland & Wright, 1997; Shade, 1999).

Once installed, software should run quickly throughout the activities (Chafe, 1998; Cottrell & Eisenberg, 1997; Haugland & Shade, 1990; Haugland & Wright, 1997; Khalifa, Bloor, Middelton & Jones, 2000; Shade, 1999). In other words, there should not be long pauses during processing time that are due to either hardware capabilities or the inclusion of too many graphics or animations (Chafe, 1998). If software runs slowly children may get confused and wonder: Did I click the right spot? Should I have clicked twice instead of once? (Haugland & Wright, 1997, p.50). Also children may get bored and start checking what is happening on the screen, walk over to another activity, look around to see what is happening in other areas of the room and wonder why another child is using their computer (Haugland & Shade, 1990; Haugland & Wright, 1997).

Another important technical feature is "saving" children's progress within the program (Haugland & Wright, 1997; Khalifa, Bloor, Middelton & Jones, 2000; NCTE, 2001; Shade, 1999). Khalifa, Bloor, Middelton and Jones (2000) consider saving as an opportunity that makes children know they can stop and revisit the software at any time and that is given to students to reflect over time on an activity, make changes and enhance the learning experience. There are several reasons children may be interrupted during their computer experiences. For instance, it might be time for lunch or dinner, or they may have to leave from the place that they were using the software (Haugland & Wright, 1997; Shade, 1999). Also, according to the NCTE, software should allow learners to choose the place where the saved file goes. Software that provides a feature that enables children to save what they do might prevent children from having to start over repeatedly.

In addition to saving, a capacity for printing is also an important component of the software's technical quality. Khalifa, Bloor, Middelton and Jones state that a printing capacity is a feature that quality software has and the authors note that "printing gives children more opportunities to integrate their computer experience with concrete activities" (2000, p.5). Children, parents or teachers can easily record what children have done by printing so that they may have an opportunity to talk later with children about what they did helping children to improve their verbal and recall skills (Haugland & Wright, 1997).

Additionally, "help" features that include tutorials, hints, sample problems, and reference libraries might assist students in working independently with software (Boivie, 1998; Bush, 1992; Deubel, 2002). According to Squires and Preece (1999), "any information [in help section] should be easy to search, focused on the user's task, list concrete steps to be carried out…" (p.473), since learners might become easily disoriented without clear guidance and consistency. Likewise, Bush (1992) suggests that software manuals should provide step-by step training focused on a particular activity.

The five important technical features that quality software should have are listed above. The first feature is its installation process. Except for Reader Rabbit's Math, the software's opening screen appears automatically after the program's CD is inserted into the drive. Users can install the programs by clicking the "install" button on the opening page and it takes between 25 seconds and 90 seconds for each program. It is unlikely that users will face a problem as long as the software's system requirements meet the capacity of computer's system. Briefly, designers should identify the software's requirements clearly and explain them to users in the users' guide. The second one is that, once installed, software should run quickly. With the exception of Reader Rabbit's Math, all programs run without any pauses between activities. Where long pauses do exist in programs, children may become bored or confused.

Third, software should have a feature that saves children's work in order to prevent them from having to start over repeatedly. More specifically, software should remember all users who have used the software previously, as well as the challenge level each user has completed. This feature may increase children's sense of importance and stimulate their engagement. The next feature is its printing capacity. This feature enables children, parents, and teachers to record children's works and to talk about them, which may increase children's verbal and recall skills. Surprisingly, none of the reviewed programs includes a printing capacity. The final feature is the help section that includes tutorials, sample problems, and reference libraries.

### Screen Design

Characters or icons appearing on the screen should be chosen carefully to help users recognize them immediately so that they can make a connection between software and the real world (Large, Beheshti & Rahman, 2002, p. 90). For instance, designers may use doors that refer users to go *outside*, or *exit*. In addition to the previous example, designers may use green buttons that enable children to *continue* navigation, and red buttons to tell children to *wait* (Haugland & Wright, 1997; Jacso, 2003). In addition to these examples, developers may use a trash can to signal that if you want to delete something just drag and drop it into the trash can. Furthermore, it is suggested that icons should represent children's everyday world as well as the context of the learning task (Deubel, 2002; Large, Beheshti & Rahman, 2002; Squires & Preece, 1999). For instance, developers may use "side" for the length of the square rather than "x". Also, in order that students know what an icon means, software designers may add verbal cues that appear when the cursor is dragged across the icon (Houser, 1996).

We know that still and animated images can enhance the presentation of information and have a great impact on students' learning (Darves, Oviatt & Coulston, 2002; Large, Beheshti, Breuleux & Renaud, 1996; Levin, Anglin & Carney, 1987; Rieber, 1990; Spencer, 1986; Swenson & Anderson, 1982). Darves, Oviatt and Coulston (2002) carried out a study to explore whether conversational interaction with animated characters may influence learners' motivation, students' learning-oriented behavior and the quantity of impulsive question asking. The authors worked with twenty four elementary school children using a program called "I See!" that taught children about 24 different marine animals. In the wizard, the marine animals were animated and could answer questions about themselves using text-to-speech (TTS) output. Based on the outcome of this study, Darves, Oviatt and Coulston concluded that animated characters with extroverted voice have a positive influence on children's motivation. Also, they found that the interface was highly engaging for children and they were excited about talking to animals. However, the authors point out that the voice the animated character used should be matched to the character in order to ensure a desirable impact on users' performance.

In contrast, we now recognize that still or animated images can also have a deleterious effect. Khalifa, Bloor, Middelton and Jones draw attention to the response that follows the learner's answer. Khalifa and colleagues state that reinforcements given for correct answer should be more attractive than that given for incorrect answer; otherwise, learners "purposely answer incorrectly, hoping to see an attractive display that would not see for correct answers" (2000, p.4). As supportive of Khalifa and colleagues, Swenson and Anderson (1982) provide an example that emphasizes the importance of the potential for unintentional negative reinforcement. The authors note that

> …the student made an incorrect response, Snoopy made his appearance by walking upside down across the top of the video screen, dropping his sign about halfway across. Not too surprisingly, many students deliberately choose wrong answers so they could see Snoopy upside down on the screen, which was much more interesting than the intended reinforcer (p.134).

Rusthon and Larkin (2001) have reviewed the literature about connecting developmentally appropriate practices to brain research. They found that there is a need for educators to provide more opportunity for children to use "music, bodily-kinesthetic, visual-spatial, and interpersonal domains to learn and express understanding" (p.31). Also, they note that music, rhyme and rhythm are directly connected with the other basic functions of the brain, such as emotion, perception, memory and even language. In addition to music, rhyme and rhythm, Rusthon and Larkin state that pictures, symbols, and strong simple images have powerful influences on students' learning. In other words, pictures, symbols and images can help children keep information in memory for a long time. In brief, they concluded that art should hold an important place in the curriculum. In addition, colorful graphics and interesting animations keep children more focused on the subject. Wileman (1993) stresses the importance of graphics and stills and says children may encode and keep content in memory longer as well as retrieve it more easily through the use of well-designed visuals. Researchers found that graphics and animation improve students' success (Caputo, 1981; Eiser, 1988; Forgan & Weber, 2001; Hammond, 1971; Singleton, 2001).

In conclusion, all characters in the programs are easy for children to recognize since their appearances are similar to what can be found in their daily life. For instance, in Reader Rabbit's Math, the size of animals corresponds to their size in the real world. For instance, a hippo appears much smaller than an elephant. In addition to the previous example, Math Mission teaches children about a cent, a nickel, a dime, and a quarter and each one is sized correctly. However, some icons in the programs are not meaningful for children. For instance, in order to quit from the program, children need to click on a clock or a red oval button with the word "EXIT" on it. The clock and the button do not have a verbal or oral cue appearing when the curser is dragged across them. Children may not be aware that those icons will allow them to quit from the program if they click them. Instead of using a clock or a button, designers may use doors to indicate that children can quit the software (Haugland & Wright, 1997; Jacso, 2003). In addition, as noted above, software should have colorful, realistic graphics, and sound effects to improve students' learning opportunity in terms of helping children keep information in their memory for a long time. Math Mission and Jump Start Numbers have attractive and colorful animations. For instance, in Math Mission, characters dance, walk in the city, deliver the daily newspaper or drive a bus. Although Reader Rabbit's Math does have colorful graphics, children can easily anticipate what will happen next. This may cause children to experience a decrease or even a loss in motivation. Thus, while it might be concluded that software should include colorful graphics, sounds and interesting animations, they should also be supportive of children's curiosity to discover.

### Process Orientation

It is important for quality software to enable children to persist at a task for a longer time, to be eager to learn, and to pay more attention to the subject matter (Bransford, Brown & Cocking, 2000; Haugland & Wright, 1997; Haugland & Shade, 1990; Kinzie, Sullivan & Burdel, 1992; Papert, 1980; Seymour, Sullivan, Story & Mosley, 1987; Singleton, 2001; Swenson & Anderson, 1982). In Reader Rabbit's Math, animations repeat themselves, and this may cause children to become bored and thus decrease their motivation to continue with the software. At the beginning of Jump Start Numbers, children may persist at collecting biscuits for Frankie since they do not know what will happen if they collect all the biscuits and then wake Frankie up. However, the software does not include the icon that enables children to print out their certificate that is given as a children's reward after they find or earn all the biscuits. This may cause a decrease in motivation as well as the development of distrust in the software.

On the other hand, Math Mission includes all the icons that are mentioned in the user's guide. Children earn money as they help each clerk in each store. However, they are not allowed to spend this money until they help all the clerks in the Spectacle City. After children help all clerks and earn enough money, they are able to play games. Also, as children play the games, they have to pay money for each game so that if they spend all the money they have, then they need to help more people. This may increase their eagerness to help more people to earn more money. In other words, the software provides children with games that serve to positively reinforce their progress. Therefore, software should have an appropriate flow that keeps children's motivation level high. Returning to a prior recommendation, designers may provide children games with different scenarios, increasing children's curiosity and enabling them to discover and learn

Reader Rabbit's Math provides two options for children on the beginning page: The first option enables children to practice numbers, addition, and subtraction in the circus. Surprisingly, in this section, children are just expected to respond to questions asked by the rabbit. The second option allows children to play three different games. One game called the Log Ride asks children to build a ladder to help the rabbit reach his boat. Depending on the selected level, the ladder should be 10, 20, 30 or 40 rungs tall. Children are provided several ladder pieces that have different heights. For instance, children can use two 5-rung-tall ladder pieces or one 5-rung-tall, one 2-rung-tall and one 3-rung-tall ladder to make a 10 rung-tall ladder. In short, this may increase children's curiosity about discovering new ways to build a right height ladder so that they may spend longer time on playing this game.

### Conclusion

As noted in the introductory, although computers and computer programs are one of the technologies that are being used in mathematics classrooms, the most important challenge is to provide children developmentally appropriate programs that meet children's unique needs. In order to assist designers in designing developmentally appropriate software, the focus of this study was based on an investigation of critical attributes of mathematical software intended for use by young children. In addition, parents and teachers may find this study beneficial as they purchase software for their children or students.

Although this study was effective in evaluating the "bestseller" educational programs to determine whether they are developmentally appropriate or not for the targeted age group, there are two important limitations of this study to consider. First, during the design process as well as evaluation process, designers and educators should listen, observe and work with children in order to address children's unique needs. However, in this study children's preferences were considered based only on information reviewed in the literature, not from actual observations of children using the software. For future research, it might be suggested that designers and investigators consider children as learners, critics, inventors and technology design partners during the process of educational software design. Second, although it has been identified that the largest software growth recently has been in titles and companies serving the early childhood market (NAEYC, 1996), this study evaluated only three educational programs. For future research, investigators may evaluate more educational programs in order to better inform designers in their development of developmentally appropriate software.

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**References**

Adams, M.J. (1990). Beginning to read: Thinking and learning about print. Cambridge, MA: MIT Press.

Aldrich, J. (2002). Early childhood teacher candidates evaluate computer software for young children. Information Technology in Childhood Education Annual, 295-301. Retrieved January 23, 2004, from http://www.aace.org /dl/files/ ITCE/ITCE20021295.pdf.

Alliance for Childhood (2000). Fool’s gold: A critical look at children and computers. Retrieved on January, 15, 2004 from http://www.allianceforchildhood.net/projects/computers/ computers_reports.htm.

Attewell, P., Suazo-Garcia, B., & Battle, J. (2003). Computers and young children: Social benefits or social problem? Social Forces, 82(1), 277-296.

Barnes, B.J. & Hill, S. (1983). Should young children work with microcomputers—Logo before Lego? The Computing Teacher, 10(9), 11-14.

Boivie, C. A. (Jan 26, 1998). Rated E for ‘easy to use.’ Information Week, n666, p. 156(1).

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2002). How People Learn: Brain, Mind, Experience, and School. Washington: National Academy Press.

Brett, A. (1997). Assistive and adaptive technology: Supporting competence and independence in young children with disabilities. Dimensions of Early Childhood, 25(3), 14-15, 18-20.

Brouwer-Janse, M.D., Suri, J.F., Yawitz, M., Vries, G., Fozard, J.L., & Coleman, R. (1997). User interfaces for young and old. Interactions, 4(2), pp.34- 46

Bush, D. (1992, Nov). Software Manuals. Technical Communication, 39(4), 683-685.

Bushman, B.J. & Anderson, C.A. (2002). Violent video games and hostile expectations: A test of the general aggression model. Personality and Social Psychology Bulletin, 28 (12), 1679-1686.

Campbell, V.N., & Chapman, M.A. (1967). Learner control vs. program control of instruction. Psychology in the Schools, 4, 121-130.

Caputo, D. J. (1981). An analysis of the relative effectiveness of a graphic enhanced microcomputer-based remedial system in a university basis mathematical skill deficiency removal plan. Unpublished doctorial dissertation, University of Pittsburgh.

Chafe, A. (1998). Second language software and evaluative criteria. Retrieved on January 14, 2004 from electronic resource: http://www.stemnet.nf.ca/~achafe/softan_ html.htm

Char, C.A. (1990). Interactive technology and the young child. (Reports and Papers in Progress, Report No.90-2). Newton, MA: Center for Learning, Teaching, and Technology, Education Development Center.

Chun, D., & Plass, J. (1997). Research on text comprehension in multimedia environments. Language Learning & Technology, 1(1), 60-81

Clements, D.H. (1994). The uniqueness of the computer as a learning tool: Insights from research and practice. In June Wright and Daniel Shade (Eds.). Young Children: Active Learners in a Technological Age. Washington, D.C.: NAEYC.

Clements, D. H. (1999). Young children and technology. In G. D. Nelson (Ed.), Dialogue on early childhood science, mathematics, and technology education (pp. 92-105). Washington, DC: American Association for the Advancement of Science.

Clements, D.H. (2002). Computers in early childhood mathematics. Contemporary Issues in Early Childhood, 3(2), p.160-181.

Clements, D.H., Nastasi, B.K., & Swaminathan, S. (1993). Young children and computers: Crossroads and directions form research. Young Children, 48(2), 56-64.

Cottrell, J., & Eisenberg, M.B. (May, 1997). Web design for information problem-solving: Maximizing value of for users. Computers in Libraries, 17(5), 52-57.

Darves, C., Oviatt, S., & Coulston, R. (2002). The Impact of Auditory Embodiment on Animated Character Design. Proceedings of the First International Joint Conference on Autonomous Agents and Multiagent Systems (AAMAS '02). Bologna, Italy. Retrieved from http://www.cse.ogi.edu/CHCC/Publications/impact_auditory_embodiment ani mated darves.pdf .

Das, J.P. (1995). Some thoughts on two aspects of Vygotsky's work. Educational Psychologist, 30(2), 93-97.

DeLaurentiis, E.C. (Mar, 1993). How to recognize excellent educational software. Eric Clearinghouse document (ED 355 932).

Deubel, P. (February 2002). Selecting curriculum-based software: valuable educational software can help students rise to the challenge of standardized testing and assessment. Learning and Leading with Technology, 29(5), 10-17.

Druin, A., Bederson, B., Hourcade, J.P., Sherman, L., Revelle, G., Platner, M., &Weng, S. (2001). Designing a digital library for young children: An intergenerational Partnership. In Proceedings of Joint Conference on Digital Libraries (JCDL 2001) ACM Press, pp. 398-405.

Eiser, L. (1988). What makes a good tutorial? Technology and Learning, 8(4), 44-51.

Fisher, M.D., Blackwell, L.R., Garcia, A.B., & Greene, J.C. (1975). Effects of student control and choice on engagement in a CAI arithmetic task in a low-income school. Journal of Educational Psychology, 67(6), 776-783.

Greenberg, P. (1992). Ideas that work with young children: How to institute some simple democratic practices pertaining to respect, rights, responsibilities and roots in any classroom. Young Children, 47(5), 10-18.

Guthrie, L.F., & Richardson, S. (1995). Language arts: Computer literacy in the primary grades. Educational Leadership, 53(2), 14-17.

Hammond, K. R. (1971). Computer graphics as an aid to learning. Science, 172, 903-908.

Hanna L., Risden K., Czerwinski, M. & Alexander, K. (1999). The role of Usability Research in designing Children's Computer Products. In A. Druin (Ed.), The Design of Children's Technology, pp. 3-26. San Francisco, CA: Morgan Kaufman. Retrieved from http://research.microsoft.com/users/marycz/ druin98.htm

Haugland, S., W. (No Date.). Selecting Developmentally Appropriate Software. Retrieved on October, 12, 2003 from http://www.childrenandcomputers.com/ Articles/selecting_developmentally approp.htm.

Haugland, S. (1992). The effect of computer software on preschool children's developmental gains. Journal of Computing in Childhood Education, 3(1), 15-30.

Haugland, S. (1997). Computers and young children: Children's home computer use: an opportunity for parent/teacher collaboration. Early Childhood Education Journal, 25(2), p.133-135.

Haugland, S. (2000). Computers and young children: Outstanding developmental software for 2000. Early Childhood Education Journal, 28(2), 117-124.

Haugland, S., Bailey, M.D., & Ruiz, E.A. (2002). The outstanding developmental software and web sites for 2001. Early Childhood Education Journal, 29(3), 191-200.

Haugland, S. & Ruiz, E.A. (2002) Empowering children with technology: outstanding developmental software for 2002. Early Childhood Education Journal, 30(2), 125-132.

Haugland, S. W. & Shade, D. D. (1990). Developmental evaluations of software for young children. New York: Delmar Publications.

Haugland, S. W. & Shade, D. D. (1994). Software evaluating for young children. In. J. L. Wright & D. D. Shade (Ed.s), Young children: Active learners in a technological age, pp. 63-76. Washington, DC: NAEYC.

Haugland, S. W. & Wright, J. L. (1997). Young Children and Technology: A World of Discovery. New York: Allyn & Bacon.

Healy, J.M. (1998).Failure to connect: How computers affect our children's minds-and what we can do about it. New York: Touchstone.

Healy, J.M. (2004). Young children don't need computers. The Education Digest, 69(5), 57-58.

Heath, L., Bresolin, L.B., & Rinaldi, R.C. (1989) Effects of media violence on children: A review of the literature. Archives of General Psychiatry, 46(4), 376-379.

Houser, W.R. (1996). To know is to understand, and many developers don't. Government Computer News, 15(8), p 25(1).

Irwin, A. R. & Gross, A. M. (1995). Cognitive tempo, violent video games, and aggressive behavior in young boys. Journal of Family Violence, 10(3), 337-350.

ISTE (2000). National Educational Technology Standards and Performance Indicators for Teachers. Retrieved on June, 15, 2004 from www.iste.org.

ISTE (2002). Educational Technology Standards and Performance Indicators for All Teachers. Retrieved from http://cnets.iste.org/teachers/t_stands.html.
Johanson, J. (1997). Technology in education: A case for change. University Park: The Pennsylvania State University. (ERIC Document reproduction Service No: ED 410740)
Khalifa, S., Bloor, C., Middelton, W., & Jones, C. (2000).Educational computer software, technical, criteria, and quality. In The Proceedings of ISECON 2000, 17 (Philadelphia), 402.
Kincaid, C. (1999) Alternative Keyboards. The Exceptional Parent, 29(2), 34-37.
Kinzie, M., Sullivan, H.J., & Burdel, R.L. (1992). Motivational and achievement effects of learner control over content review within CAI. Journal of Educational Computing Research, 8(1), 101-114.
Large, A. (1996). Hypertext instructional programs and learner control: a research review. Education for Information, 14, 95-106.
Large, A., Beheshti, J., & Rahman, T. (2002). Designing criteria for children's web portals: The users speak out. Journal of American Society for Information Science and Technology, 53(2), 79-94.
Large, A., Beheshti, J., & Breuleux, A. (1998). Information seeking in a multimedia environment by primary school students. Library and Information Science Research, 20(4), 343-376
Large, A., Beheshti, J., Breuleux, A., & Renaud, (1996). The effect of animation in enhancing descriptive and procedural texts in a multimedia learning environment. Journal of the American Society for Information Science 47(6), pp. 437-448.
Levin, J.R., Anglin, G.J., & Carney, R.N. (1987). On empirically validating functions of pictures in prose. In D.M. Eillowa & H.A. Houghton (Eds.), The Psychology of Illustration, Volume 1: Basic Research, pp. 51-85. New York: Springer.
Liu, M. (1996). An exploratory study of how pre-kindergarten children use the interactive multimedia technology: Implications for multi-media software design. Journal of Computing in Childhood Education, 7(1/2), 71–92.
Lyman, M. & Mather, M.A. (1998). Equal learning opportunity: Assistive technology for students with special needs. Technology and Learning, 19(4), 55-
Mandel, T. (1997). The elements of user interface design. New York: John Wiley and Sons.
McComas, J., Pivik, J., & Laflamme, M. (1998). Current uses of virtual reality for children with disabilities. In G. Riva, B.K. Wiederhold, & E. Molinari (Eds.), Virtual Environments in Clinical Psychology and Neuroscience, (pp. 161-169). Amsterdam: IOS Press.
NAEYC (1994). Media Violence in Children's Lives. Washington DC, NAEYC.
NAEYC (1996). Developmentally Appropriate Practice in Early Childhood Programs Serving Children from Birth through Age 8. Washington DC, NAEYC.
NAEYC (2002) Early Childhood Mathematics: Promoting Good Beginnings. Washington DC, NAEYC.
NCTE (2001) Evaluating Educational Software: A Teacher's Guide. National Centre for Technology in Education, Dublin City University: Dublin 9.
NCTM (1995). Assessment Standards for School Mathematics. Reston, VA: NCTM. Retrieved from www.nctm.org.
Niemiec, R.P., Sikorski, C., & Walberg, H.J. (1996). Learner-control effects: A review of reviews and a meta-analysis. Journal of Educational Computing Research, 15(2), 157-174.
Papert, S. (1980). Mindstorms: Children, computers and powerful ideas. Basic Books, New York.
Papert, S. (1993). The children's machine: Rethinking school in the age of the computer. New York: Basic Books.
Piaget, J. (1962). Play, dreams and imitation in childhood. New York: W.W. Norton
Rieber, L.P. (1990). Using computer animated graphics in science instruction with children. Journal of Educational Psychology, 82(1), 135-140.
Rushton, S. & Larkin, E. (2001). Shaping the Learning Environment: Connecting Developmentally Appropriate Practices to Brain Research. Early Childhood Education Journal, 29(1), 25-33.
Salisbury, D. F. (1990). Cognitive Psychology and Its Implications for Designing Drill and Practice Programs for Computers. Journal of Computer Based Instruction, 17(1), 23-30.
Schery, T.K., & O'Connor, L.C. (1992). The effectiveness of school-based computer language intervention with severely handicapped children. Language, Speech, and Hearing Services in Schools, 23, 43-47.
Scoter, J.V., Ellis, D., & Railsback, J. (2001). Technology in Early Childhood Education: Finding the Balance. Northwest Regional Educational Laboratory. Retrieved on June, 1, 2004 from http://www.nwrel.org/request/june01.

Seymour, S., Sullivan, H.J., Story, N., & Mosley, M. (1987). Microcomputers and continuing motivation. Educational Communication and Technology, 35(1), 18-23.
Shade, D.D. (April 1999). Software Evaluation. Information Technology in Childhood Education Annual, p.276.
Shields, M.K., & Behrman, R.E. (2000). Children and computer technology: Analysis and Recommendations. The Future of Children, 10(2). Retrieved on June, 05, 2004 from http://futureofchildren.org.
Singleton, C. H. (2001). Computer-based assessment in education. Educational and Child Psychology, 18(3), 58-74.
SPA Consumer Market Report. (1996). Washington, DC: Software Publisher Association (SPA).
Spencer, M. (1986). Choosing Software for Children. Retrieved July 5, 2003, from the Eric database web site: http://ericae.net/edo/ED267914.htm
Squires, D. & Preece, J. (1999). Predicting quality in educational software: Evaluating for learning, usability and the synergy between them. Interacting with Computers, 11(5), 467-483.
Steinberg, E.R. (1989). Cognition and learner control: A literature review, 1977-88. Journal of Computer-Based Instruction, 16(4), 117-121.
Subrahmanyam, K., Kraut, R.E., Greenfield, P.M., & Gross, E.F. (2000). The impact of home computer ise on children's activities and development. The Future of Children, 10(2). Retrieved on June, 05, 2004 from http://www.futureofchildren. org.
Swenson, R., & Anderson, C. (1982). The role of motivation in computer-assisted instruction. Creative Computing, 8(10), 134-139.
Turner, J. (1992). Technical Literacy. Montessori Life, 4(4), 32-33.
Wileman, R.E. (1993). Visual communicating. Englewood Cliffs, N.J.: Educational Technology Publications.
Woof, J. (2001). Can software support children's vocabulary development? Language, Learning and Technology, 5(1), 166-201.

# Human Performance Analysis Applied to an Academic Advisement Program

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**Abstract**

*A trend among colleges and universities is to centralize academic advisement programs which provide academic counseling to students at risk and help them be successful in an increasingly competitive environment. A systemic analysis of performance was applied to the program using ADDIE instructional design mode, the Goals Grid Model (Nichols, 2003), and Human Performance Engineering Model(Gilbert, 1996). The performance analysis looked into five aspects of (actuals, optimals, feelings, causes, and solutions) (Rossett, 1987) the performance by individual academic advisers to determine the program performance gaps and to recommend interventions to improve its performance.*

## Introduction

Long held as a valuable part of the educational process in higher education, academic advisement has moved away from college departments into centralized advisement centers. By transferring academic advisement out of the hands of faculty to dedicated staff in academic services divisions, universities have realized benefits such as increased graduation rates.

In a recent news article about the six-year graduation rates among one particular southern state, a sharp discrepancy between universities was revealed. Many variables affect the six-year graduation rate, but academic advisement is considered by many to be a dependant variable for which universities have considerable influence. The assumption has been that if appropriate academic advisement programs were catered to the needs of students then more students would graduate.

A systemic analysis of performance was applied to the program using ADDIE instructional design mode, the Goals Grid Model (Nichols, 2004), and Human Performance Engineering Model (Gilbert, 1996). The performance analysis looked into five aspects of (actuals, optimals, feelings, causes, and solutions) (Rossett, 1998) the performance by individual academic advisers to determine the program performance gaps and to recommend interventions to improve its performance.

## Human Performance Technology Approach towards Performance Problems

There have been many attempts to define human performance technology (HPT). However, no single definition is likely to obtain consensus from HPT practitioners and researchers worldwide (Stolovitch & Keeps, 1999). For this study HPT was defined as a set of systemic methods and processes for solving problems related to the performance of people in organizations. HPT looks at a specific performer and zooms outward in scope to see how that performer is doing in relation to the values of an organization. In the case study presented here, HPT approach is applied to an academic advisement program and specifically the academic advisers themselves. The intent is to apply systematic analysis techniques to explain to what extent the advisement program is successful in fulfilling its promise to students and how the performance of individual academic advisor can be enhanced.

### Mission of the Organization

What was once the sole responsibility of faculty; academic advising is now the responsibility of centralized academic advisement programs in many colleges and universities. The department in this project, The University Advisement Center (UAC) is a centralized academic advisement center at a large state university. The mission of the UAC is to provide academic advisement and developmental counseling to entering freshmen, students with less than 42 hours of transfer credit, students who are undecided on major and at-risk students.

### Target Performers

The UAC is a department of nine academic advisers. Each adviser is responsible for providing developmental counseling to a portion of approximately 10,000 total students. With backgrounds in a diverse array of academic disciplines, all academic advisers share in common successful completion of a college degree. Many advisers hold graduate degrees and/or have greater than five years of experience providing developmental counseling in higher education. Emphasis on quality student service is a value that permeates the UAC culture. As the pay scale is relatively low compared to other jobs in higher education, advisers gravitate toward their roles and responsibilities for the intrinsic value of providing help to others. Academic advisers must be able to be empathetic, listen attentively, identify student concerns, potential problems, and develop custom strategies that utilize multiple resources.

### Performance Problems

At the institution used in this study, at-risk students have four chances before becoming permanently excluded from the university. The program described here is an intrusive advisement program for students who have fallen from academic standing of good to either supervision or probation. Academic good standing is defined at the university used in this paper by a GPA of a 2.0 on a 4.0-scale. Once a student's GPA drops below a 2.0 their academic standing falls to warning. At this point the student must maintain a term-GPA of a 2.3 while taking no less then 6-credit hours. If they neglect to meet these criteria, then they fall to academic supervision.

Once at supervision, students are required to seek academic advisement before registering for future terms. The same criteria for warning are applied to supervision and if at any time a student's cumulative GPA rises to a 2.0 then they return to good standing. On the other hand, if they neglect to meet the requirements for supervision, students fall to academic probation, which is the final standing before permanent exclusion. Through the process of academic advisement, these at-risk students are promised academic assistance. Assuming that advisement is effective, one might expect that a very low rate of students in this program actually fall to academic exclusion.

### Performance Environment

Academic advisers meet one-on-one with students in a private office setting. Virtually all counseling is conducted in person. A limited amount of information between the adviser and student may be conducted by email or phone. Resources that the adviser may use include student records, academic evaluations that include the degree requirements for a student's major, the undergraduate catalog, other university resources such as the Career Center, or Internet resources.

### Target Performance

Optimal performance for an academic adviser should result in a low rate of students falling to exclusion. Although historical trends for this particular program show a decrease in the number of students who fall to exclusion, many questions remain about its actual effectiveness. Possible reasons for a discrepancy among advisers in numbers of students who fall to exclusion could be due to variance in developmental counseling approaches, time allotted for individual advisement sessions, resources utilized, or a myriad of other issues. An issue this analysis project hoped to shed light upon was defining measurable outcomes for academic advisers in their work with at-risk students.

Many academic advisers feel confident about their ability to help students improve their GPA. However, when period reports are released with numbers of students who fall to exclusion, many advisers feel a sense of loss about the students who have failed to succeed. The significance of improving the performance gap could result in a two-fold effect. First, advisers would feel a sense of accomplishment. Second, the university would benefit by retaining more students.

## Guiding Models Applied in the Project

A number of models were used in this project of performance analysis: ADDIE instructional design model, the Goals Grid Model (Nichols, 2004), the Human Performance Engineering Model (Gilbert, 1996) and Rossett's needs assessment model (of actuals, optimals, feelings, causes, and solutions) (1998).

### ADDIE Instructional Design Model

ADDIE model was used throughout the performance analysis that guided us as a management process. Key questions and tasks in the project were listed in Table 1.

Table1: *ADDIE Process in the Project*

| Project Phases | Key Questions and Tasks |
|---|---|
| Analysis Phase | What does exemplary performance look like?<br>Identifying the exemplar/ Calculating PIP<br>How will we measure the performance? |
| Design Phase | What analysis tools are most appropriate to conduct the assessment?<br>Tool Selection/ Identify Stake Holders & Target Audience |
| Development Phase | How do we adapt our tools to best meet the needs assessment?<br>Develop Tools/ Identify Resources |
| Implementation Phase | What can the performers tell us about the performance?<br>Gather Data |
| Evaluation Phase | Formative Evaluation: Are we asking the right questions?<br>Revise Project Statement<br>What interventions can improve the performance?<br>Recommend Interventions |

**The Goals Grid Model**

The Goals Grid Model (Nichols, 2003) was used to develop the project statement. It helped to establish a clear goals and objectives of our project.

Table 2: *The Goals Grid Model in Establish Project Statement*

| Goals Grid Model Questions | Tasks to Clarify the Project Goals |
|---|---|
| What are you trying to *achieve*? *What you want but don't have*. | Identified by the standards of exemplary performance and repertoire of skills necessary for academic advisers in an intrusive advisement program to assist students in rebuilding their grade point average. |
| What are you trying to *preserve*? *What you have and want to keep*. | Identified by the set of performance standards, methods and repertoire of skills that is currently prevalent among the academic advisors that help students to improve their academic performance. |
| What are you trying to *avoid*? *What you don't have and don't want*. | Identified by the skills sets and methodology used by academic advisers in the academic advisement program that are ineffective in uplifting the academic standards of students. |
| What are you trying to *eliminate*? *What you have but want to get rid of*. | Identified by the procedures, skills sets and methods used by academic advisers in the intrusive academic advisement program that is not beneficial and effective towards uplifting the academic standards of students. |

Nichols' Goals Grid model helped us to develop our project goal which helped guide our decisions throughout the project. Our project statement clearly stated this as "*This performance analysis project aims to identify exemplary skills among academic advisers in an intrusive advisement program for at-risk students and identify the repertoire of skills necessary for advisers to assist students in re-building their grade average.*"

**Human Performance Engineering Model**

Human Performance Engineering Model (Gilbert, 1996) formed the foundation of all of our work in this project. The concepts of leisurely theorems and the Performance Matrix (Gilbert, 1996) were critical in all phases of our performance analysis. We tried to analyze the target performance of advisers during advisement sessions at several levels of vantage in the Performance Matrix. These factors played an equally important role in the actions and decisions of the performer during the advisement sessions. For example, are advisers sensitive to cultural differences among students, are they empathetic towards students, are they being resourceful, etc. Most important to our team, the levels of vantage helped us narrow our scope and allowed us to be more effective with our energy and time as we conducted the performance analysis. (Gilbert, 1996)

Table 3: *Performance Matrix of the Academic Advisors*

| Vantage Level | Accomplishment Variables | Content | Purpose | Accomplishment Examples |
|---|---|---|---|---|
| Philosophical | Academic advisement should improve the way a college student feels about being in college | Students and advisers will feel good about their experience | For the good of the individual | Self efficacy; A sense of well-being |
| Cultural | Academic advisement will improve the quality of a student's experience in college | Students will incorporate the university into their identity | For the good of the university | A sense of belonging |
| Policy | Academic advisement will retain students who were at risk of expulsion | Students will improve their grade point averages | For the good of both the university and the student | A greater percentage of students returning to Good academic standing from the Intrusive Advisement Program |
| Strategic | Academic advisement will assist students with improving their grade point averages | Students will develop strategies for success; Advisers will assist students | For the good of both the university and the student | Students will demonstrate successful completion of their course load at the end of each semester |
| Tactical | Academic advisement will assess students individually and develop custom interventions to help students with improving their grade point averages | Students will develop their personal strategies for success; Advisers will assist students individually | For the good of both the university and the student | Students will demonstrate successful completion of their course load at the end of each semester |
| Logistic | Academic advisement will take place in a university designed center under the guidelines set by the university using university resources | Advisers will perform consistently and use the same tools and resources | For the good of both the advisers and the students | Advisers will complete their responsibilities using university resources |

**Needs Assessment Model**

We concentrated upon the selection, design and development of tools and methods in order to determine the performance gap based upon what we had learned from Allison Rossett (1998). The analysis tools used were interviews (stakeholders and subject matter experts), surveys, document reviews and observations of performers. This was performed in order to determine the optimals, actuals, feelings, causes and solutions (Rossett, 1998) as revealed in Table 4.

Table 4: *Needs Assessment in the Project*

| Aspects to Consider | Questions to Answer |
|---|---|
| Optimal performance | Optimal performance among advisers (who/what/how characterizes the exemplary performance?) |
| Actual performance | What's going on among the academic advisers? What are the actual performance levels? |
| Feelings | How do performers (advisers) and stakeholders (department, students and university) feel about the academic advisement program? |
| Causes | What is causing the performance problems among academic advisers? |
| Solutions | Upon performance analysis, what suitable solutions should be suggested that can solve the performance discrepancies among academic advisers? |

**Critical Factors Affecting the Performance of Academic Advisors**

We focused on three main factors that influence the performance of the adviser: tools, performance environment, and motivation and skills. What were the tools available to the academic advisor? Were the tools available to the academic advisor relevant to his performance? Were the tools helping the advisers to gain sufficient feedback from the stakeholders? We also examined the supervision and guidance from the superiors of the academic advisor in some critical advisement issues. How did the factors within the performance environment affect the performance level of advisers? Additionally, we examined the motivation level, communication skills, empathetic skills, listening skills, resourcefulness (Gilbert, 1996) of the academic advisor. Did the academic advisor possess the required knowledge, skills and motivation levels required to perform the job?

Based on a series of interviews with the subject matter experts, descriptive surveys, and stakeholders and on-site observations of the academic advisor advising students, a survey using 1- 5 scale (1, the least important to academic advisement and 5, the most important to academic advisement) was developed and conducted among all the academic advisors identified a list of knowledge and skills essential to perform academic advising to help student improve their GPA.

Table 5: *Essential Knowledge and Skills of the Academic Advisor*

| Knowledge | Score | Skills | Score |
|---|---|---|---|
| Understanding the responsibilities of academic advisor | 4.5 | Listening | 4.83 |
| Strategies that can help a student improve their GPA | 4.5 | Being articulate in your manner of speaking | 4.5 |
| Time Management | 4.33 | Paying attention to details | 4.5 |
| University rules, regulations, and policies | 4.33 | Disseminating information accurately | 4.5 |
| Study Skills | 4.17 | Performing assessment | 4.5 |
| Degree requirements, options with majors, and departmental requirements | 4.17 | Relating complex concepts in a concise manner | 4.33 |
| How to customize strategies to meet the needs of a particular student | 4.17 | Having patience | 4.33 |
| Techniques for balancing work and school responsibilities | 4.5 | Identifying circumstances | 4.17 |
| Strategies that can help a student | 4.5 | Identifying patterns | 4.17 |

| | | | |
|---|---|---|---|
| improve their GPA | | | |
| University Resources | 3.5 | Matching appropriate interventions | 3.83 |
| | | Developing custom interventions | **3.83** |
| | | Taking initiative | **3.67** |
| | | Being persuasive | **3.33** |

Listening skills, knowledge about how to balance work and school responsibilities, and a caring attitude towards the student are the critical components for the performer to perform his/her task. As evidenced by their stories, each adviser takes a similar approach to assist students with improving their GPAs.

Taking the time to hear the student articulate their problems with their GPAs is an essential part of the task. Raising the student's awareness of issues related to their responsibilities and the consequences of their actions is accomplish through a variety of techniques, but the end result, to be successful, requires that the student buy into the process and make a commitment to improvement. In the words of the performers this is accomplished through analysis, education, reality checks, and personal attention.

## Analysis Results and Recommendations

The results of performance analysis guided by ADDIE instructional design model, the Goals Grid Model (Nichols, 2004), Human Performance Engineering Model (Gilbert, 1996) and Analysis Model of actuals, optimals, feelings, causes, and solutions (Rossett, 1998) identified the essential knowledge and skills required, and standards of exemplary performance in academic advisement. Accordingly, recommendations were made to enhance the performance of the academic advisors. The recommendations fell into two categories instructional and non-instructional.

### Instructional Interventions

Academic Advisers could benefit from the knowledge about how their individual students are progressing on a semester-by-semester basis. Developing a job aid that instructs an adviser on how to find this information in the database of student records is an inexpensive intervention that would enable advisers to monitor their student's progress. To meet this same need a training workshop could be implemented, but a job aid would be a much more simple and effective tool. The rationale for this intervention comes from our discovery during the calculation of the PIP that advisers had no idea how many of their students return to Good standing at the end of each term.

Some advisers may not understand how or why this information could help them so developing a marketing plan for a job aid like this would be essential. If this intervention is selected the project team recommends that key change agents be targeted among the advisement staff as champions on its use. When introducing the tool a well thought out description of how and why it should be used would also aid in its adoption and assimilation.

### Non-Instructional Interventions

After completion of the document review for the project, it was determined that advisers cannot effectively evaluate their job performance. For example, as long as an advisee/student continues at the university in the status of supervision or fails to probation, the adviser may continue to work with that student, but once that student moves to good academic standing or is excluded, the individual student data is not reported to the adviser.

A recommendation for evaluating adviser performance would be to develop and implement an automatic event notification database linked to the student's academic record. Once a student reaches supervision, their adviser would register the student in the notification database and would input their own email as the path for notification. The adviser would be notified through email when either of the following events occurred: the student moved to good academic standing or was excluded. Results of this notification would be 1) Essential feedback for advisers in evaluating their counseling effectiveness with individual students, and 2) Data from the notification database could also report longitudinal results for all advisers in the department, providing and indicating how specific students of each adviser either moved to good standing and exclusion. This information could be used to study the success rate of advisers, identify exemplars, and to make recommendations for instructional strategies for improving adviser effectiveness and performance.

## Conclusion

Investigating a performance in which the performers are delivering an affective service to the target audience presents some unique challenges. Among these challenges include how one measures the performance. Where quantitative measures lack, qualitative measures proved details necessary for a human performance technician to make recommendations.

Despite the project team's best efforts to quantify the performance in this study, in the end the words of the performers themselves provided us with the data that we needed to clearly understand the performance. From another perspective, through our perceived failure to pin down an exemplary performer, we found one of the richest pieces of data during our assessment. In retrospect, had we skipped steps in the ADDIE model that guided our work, we may not have realized the full extent of problem – advisers don't know how many of their students are returning to Good standing as a result of their work.

This presents a significant barrier for advisers because they lack feedback that could add potential value to the way they approach each new at-risk student. Despite this barrier, Academic Advisers in the University Advisement Center appear clear in their understanding of the expectations of their Director and Associate Director as evidenced by their consensus on 100% of the concepts that emerged from the interviews with the stakeholders. The data from the survey both detail the performance, but also is testimony to a mutual understanding between the performers and the stakeholders about the performance.

The recommendations from the project team reflect the data that we discovered using a systematic process to investigate the performance of Academic Advisers helping students to improve their GPAs. Additional value at the policy level to potentially be gained by choosing one of the interventions recommended could be improved retention at the university in which this performance takes place.

## Reference


Gilbert, T. F. (1996). *Human competence: Engineering worthy performance*, International Society for Performance Engineering, Silver Spring, Maryland.

Nichols, F. (1988). The goads grid: A tool for clarifying goals and objectives. Retrieved 10/8/2005 from http://home.att.net/~OPSINC/goals_grid.pdf

Rossett, A. (1987). *Training needs assessment*. Englewood Cliffs, N.J.: Educational Technology Publications.

Stolovitch, H. D., & Keeps, E. J. (1999). Handbook of human performance technology: Improving individual and organizational performance worldwide (2 ed.). San Francisco: Jossey-Bass/Pfeiffer.

# Lived Experience of the TEEMS Students' Collaboration in Electronic Portfolio Construction: A Study Framework

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**Abstract**

*This is an ongoing phenomenological study. The study examines lived experience of students in the Teacher Education Environments in Mathematics and Science (TEEMS) Programs when collaborating with their peers in an electronic portfolio construction in a technology integration course at a southeast state university. This paper shares with the readers a phenomenological study framework used in mining the meaning of the TEEMS student collaboration. It describes the study background, offers research questions and rationale, outlines the study processes and methods and share with the readers its findings.*

## Introduction

The Teacher Education Environments in Mathematics and Science (TEEMS) Programs are alternative paths to initial teacher certification at a southeast state university. With a middle and secondary focus, the TEEMS Programs require 45 credit hour at the graduate level and full time enrollment. Students entering TEEMS Program must have an undergraduate degree in their content field and must pass a rigorous selection and interview process for admission. Admission occurs once a year in each content field to form cohort groups. Students who finish the TEEMS Programs study will obtain a master of education degree and recommendation for initial teacher certification in the state (Shoffner, 2005). Though expanded to include the Certification Program for Reading, Language, and Literacy (RLL) and the Certification Program for Teaching English as a Second Languages (ESOL), these alternative preparation programs are still referred to by their originally acronym name: TEEMS Programs.

No Child Left Behind Act of 2001 presents a great challenge to the whole society to help every child to achieve at a higher level and prepare them for the future (U.S. Department of Education, 2002). It recommends that by the eight grade all students should be technologically literate and it references technology as a very important source of support for teaching and learning across the curriculum. To better prepare teacher force to meet this challenge, many teacher education programs include educational technology courses in their program study. Many of these educational technology courses are designed according to NCATE and ISTE standards and are designed to increase effective use of technology in K-12 schools.

The Middle-Secondary Education and Instructional Technology (MSIT) Department at a southeast state university offers multiple sessions of a technology integration course (IT 7360: Technology for Educators) for its students in the TEEMS Programs every semester. The course was designed to help the TEEMS students to meet the National Educational Technology Standards for Teachers (NETS) by the International Society of Technology in Education (ISTE) (Shoffner, 2005). IT 7360: Technology for Educators is a required three credit hour course that prepares the TEEMS students with essential skills and knowledge to integrate technology in their instructions. The course requires the TEEMS students to complete a series of assignments that involve using technology to solve instructional problems. Also the TEEMS students are required to complete three structured reflection papers at the beginning, mid point and at the end of the semester. In addition to this, the TEEMS students must construct an electronic portfolio to demonstrate their competency in instructional design and technology integration. The electronic portfolio includes student professional development materials, and a technology enhanced learning environment in his/her subject. The learning environment consists of an instructional unit plan, sample lesson plans, student-centered learning activities, and assessment plans (Shoffner, 2005).

## Problem Statement

Three surveys, Technology Proficiency Self Assessment Survey, Teacher's Attitudes toward Computers and Student Information Survey were administered in IT 7360 at the beginning of each semester. Technology Proficiency Self Assessment Survey was created by and used with permission of Dr. Margaret Merlyn Ropp (2005). The Student Information Survey collected information about the TEEMS students' basic professional experiences, computer proficiencies, their knowledge of technology standard, and their stage of adoption of technology in their instructions. The results of these surveys and observations by the course instructors indicated that the technology proficiency of the TEEMS students was low and their knowledge of technology integration was limited at the beginning of the course.

The low technology proficiency and the limited understanding of the theoretical framework behind technology integration presented a daunting challenge to the course instructors of IT 7360. One effective way of overcoming such a challenge was to create an active learning community among the TEEMS students by capitalizing on their shared knowledge and expertise. Over the past three semesters, course instructors encouraged the TEEMS students to collaborate with their peers when constructing their electronic portfolios. The documented observations of instructors as well as the responses of students in their reflection papers suggested that the collaborations among the TEEMS students when constructing their electronic portfolios was an important phenomenon and need a systemic study to reveal its essence. This phenomenological study was to describe collaborative learning experiences when constructing their E-Portfolio using the participants' own words to reveal their true and lived experience.

**Research Questions and Rationale**

Three major questions guided this study. (1)What is lived experience of the TEEMS students when collaborating with their peers in the construction of their electronic in a technology integration course? (2) How might knowledge generated from the answers to the question be used to help the TEEMS students collaborate more effectively in their electronic portfolio construction? (3)How might the answers to the question be used to help IT 7360 instructors facilitate effective collaboration during electronic portfolio construction?

Underneath the first major questions, a set of questions were asked.

- What are criteria the TEEMS students used in selecting their partner to collaborate in the electronic portfolio construction?
- What are attributes and characteristics do the TEEMS student use to describe their partners in collaboration?
- What are things the TEEMS students do that make them feel they are collaborating in electronic portfolio construction?
- What roles do the TEEMS students assume when working collaboratively in electronic portfolio construction?
- What expectations do the TEEMS student have for each other in collaboration (responsibilities, portfolio contents, task deadlines, and the effectiveness of collaboration)?
- What factors do the TEEMS students describe that facilitated their collaboration?
- What factors do the TEEMS students describe that impeded to their collaboration?
- What are the most exciting moments during their collaborations in electronic portfolio construction?
- What are the most frustrated moments during their collaborations in electronic portfolio construction?
- What are the interesting events happened during their collaboration in electronic portfolio construction?
- What factors do the TEEMS students contribute to their sense of satisfaction upon completion of the portfolio?
- What factors do the TEEMS students contribute to dissatisfaction upon completion of the portfolio?

Collaboration refers to the phenomenon, the intuitive experience, shared when the TEEMS students worked together to achieved the pre-determined aim of constructing an electronic portfolio. It is the critical phenomenon under the study and its units of analysis are collaboration experiences of the individual TEEMS students in IT 7360 course. The site of study is at the College of Education in a southeastern state university.

Collaboration as a social phenomenon is complex and frequently misunderstood (Youtz, 1997). As a result of varied and multiple interpretations regarding what defines collaboration, it is little wonder that so many studies on collaborative learning exist. Specifically for this study, the researcher wants to examine his own TEEMS students' collaboration when constructing their electronic portfolios to better understand the essence of this phenomenon as described by their own words. This study by its nature was limited to the TEEMS students who collaborate with their peers in electronic portfolio construction in IT 7360 course.

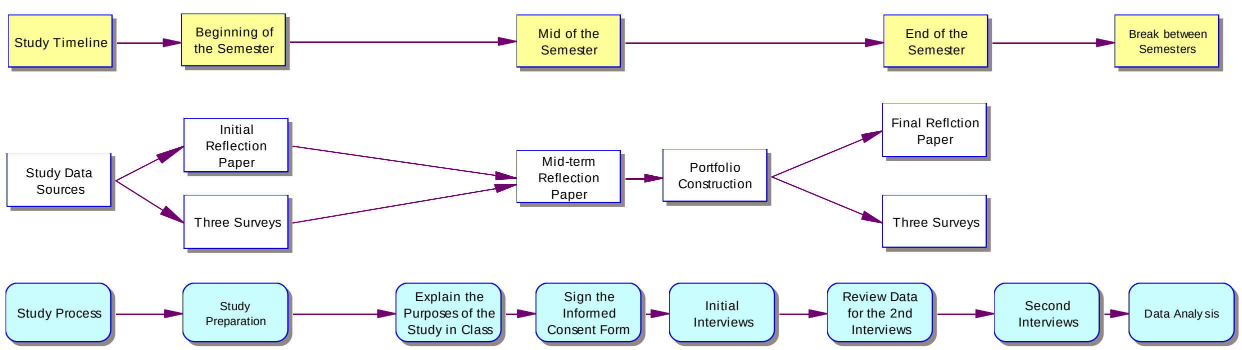
The purpose of this investigation is to determine what constitutes the essential experience of the TEEMS students who collaborate in their electronic portfolio construction. According to Van Manen (1990), phenomenological research is the study of essence of phenomena by mining and describing experiential meaning as people live them. By revealing the essence of collaboration among the TEEMS students, the investigation should provide stronger evidence for the employment of collaborative learning in the IT 7360 course as a means of facilitating learning and the construction of the electronic portfolios.

**The Process and Methods**

The phenomenological approach (Creswell, 1998) was selected for this study because the intent was to better understand the meaning of "lived experiences" of the several individual TEEMS students in IT 7360 course. If phenomenology mines the meaning of lived experience, this phenomenological approach employed here examines the TEEMS students' lived, conscious experiences and uncovers what constitutes the essential features and essence of their lived experiences (Van Manen, 1990).

Figure 1: *The Study Timeline, Data Sources and Study Process* reveals the design of this study. The study was started in fall 2004. The major means used for this study are two interviews in addition to the TEEMS students' reflection papers and two sets of surveys done at the beginning and at the end of the semester. The first interviews were well-structured and the same questions were asked to all the participants. The interviews were conducted two weeks after the TEEMS students started their collaboration in the electronic portfolio construction right after their mid-term reflection paper. The interviews were a little over 20 minutes on average. The purposes of the first interviews were to collect data about the TEEMS student collaboration and their feel about the collaboration partners. The first interviews also provided possible and crucial information to customize interview questions for the second interviews in order to facilitate deeper and richer reflection and description of their collaboration experiences during the interviews in the second stage.

Figure 1: *The Study Timeline, Data Sources and Study Process*




The second interviews were conducted two weeks after they finished their course. The second interviews focused more on describing their experiences of collaboration as a reflective process. "Phenomenological reflection is not *introspective* but *retrospective.*"(Van Manen, 1990, p.10 original emphasis) For this reason semi-structure interviews were used which asked each participants a set of fixed questions as well as some customized and improvised questions during the interview to facilitate reflection and to uncover the essence of their collaboration. The second interviews were about one hour on average.

Four TEEMS students participated in this study in the fall 2004. They all signed the informed consent forms after the researcher carefully explained the nature and the process of this study. The explanations of the study focused on the confidentiality. They were ensured and understood that all interviews were conducted individually and their interview content would remain confidential and would not be revealed to others including their collaboration partners. Each interview was taped, transcribed into text, and then analyzed.

Four TEEMS students participated in this study. They all entered into the same TEEMS program majoring in Math Education in the summer of 2004. Among the four TEEMS students, one was a pre-service teacher and other three were in-service teachers. The pre-service teacher did not have any formal classroom teaching experience while the three in-service teachers had been teaching math on provisional status since 2003. Two in-service teachers, who collaborated on their electronic portfolio construction, worked in the same department of the same school public high school and had known each other since Spring 2003. These two TEEMS students collaborated whenever possible both in their work at school and in the study at the TEEMS programs.

## Preliminary Findings

This study is still on-going. Presented below are the preliminary findings. The themes emerged from data analysis of the second interviews revealed a few interesting insights of the TEEMS students' collaboration with their peers in their electronic portfolio construction.

### Defining Collaboration

Although the study participants had their own definitions about their collaboration in electronic portfolio construction, they all agreed that it was serious undertaking with "a big task" and pressures of "deadlines." The participants did not talk much about responsibilities, roles, and goals as the researcher had expected reflecting upon their collaboration. However, they defined their collaboration in electronic portfolio construction as basically "working together" to get things done, "to solve your problems", "fun" and "part of our life", "things we do often…", "wonderful learning experience". The study participants offered very similar definitions of their collaborations.

> "Well, it's simply working together, you know, to get things done. Creating our portfolio, you know, was a big task and … Working with [name omitted] made things much easier. You don't have to always stand on your own. Just like you have your buddy.... working together, especially the one that you have collaborated before and you know [name omitted] is good on this." (Interviewee A, p. 3)
>
> "Working together to solve your problems… It's fun and it's part of our life, things we do often. We always collaborate in our math courses and it was just another wonderful learning experience with her…" (Interviewee B, p. 4)
>
> "Collaboration is a way to get busy and crazy… As a matter of fact, we accomplished a lot each time we work together…but sometimes, especially when you see the deadline was just around the corner, Oh, man…"(Interviewee D, p.3)

### Collaboration Partner and Positive Pre-Collaboration Experience

All the study participants enjoyed their collaborations and spoke highly of their collaboration partner. The study participants had very positive experiences of collaborating with their partners before their collaboration in their electronic portfolio construction was just "things we do often…" Their positive comments on their collaboration partners revealed that their satisfactions of collaboration and also indicated the importance and impact of the positive pre-collaboration experience with their partners on their collaborations in electronic portfolio construction.

> "We collaborate in our work at school and in our study at Georgia State [University]. She is my buddy and she is so quick on things and always has a lot of wonderful ideas. I knew we would do a great job!, I mean in portfolio" (Interviewee A, p.7)
>
> "He is very professional, always on the tops of things, very detail oriented, trustworthy and easy to work with. We worked together before… we are very different but we like each other. I enjoyed working with him…he's a great guy to work with." (Interviewee C, p.7)
>
> "We did two big course projects last summer and it worked quite well…She always knows what to do and always get things done fast. …In an intensive program like Math TEEMS, you want to work with a colleague like her."(Interviewee D, p.9)

### Unique Ways of Collaboration

Two study participants worked in the same school and lived close to each other but quite a distance from the University. A lot of collaboration work was done on the way to the University and on the way back home. Their descriptions depicted an interesting picture that mirrored off their collaboration experiences

> "We designed our layout that evening at Georgia State [University]. The we revised the layout on the drive home, We rode together to school… Entire drive home, we completed the page layout and divided the [web] pages to work on… the drive was about 40 to 60 minutes, we discussed portfolio all the way home." (Interviewee A, p.15)

> "We also discussed our assignment on the way home, we spoke so loud in the car… We also planned our assignments for the class around the portfolio so that we had a really cool Polynomials theme that we can now use in our classrooms." (Interviewee A, p.16)
> "As much as I hated driving to Atlanta, the drives seemed to allow us to get so much done. Sometimes we would talk about other things, but in the car proved to be the most convenient time for us to think aloud and discussed our ideas. I also enjoyed every minutes of working with [name omitted]. We were able to help each other and improve our teaching abilities and give each other wonderful ideas. It always made the driving home so fast" (Interviewee B, p.15)

**Exciting moments**

We felt the favor of excitement of collaboration in above description. Yet the more obvious exciting moments were those when they were "in the zone," when they saw "the light at the end of the tunnel," and when they saw their great accomplishment.

> "We felt that we were in the zone…Everything just fits in …we knew we would finish it that day and the portfolio was great, all of our documents were in place and links were fine, everything was fine, we were in the zone, in the zone, you know!" (Interviewee D, p. 21)
> "Exciting moments… The day when we finished our portfolio. It was a great day, and I was in the lab first. [Name omitted] came in late and I remember it was Saturday…He asked me 'Are you ready? Let's finish it today.' He sounded so confident and … Almost instantly, um… I saw a light at the end of the tunnel. That moment…was so exciting!! That day was just a great day!" (Interviewee C, p.20)
> "I showed our portfolio to my students, my daughter and husband and I also showed it to my colleagues at school. I got great response like 'Good grief, how much did you guys do this semester.' It was exciting when you heard comments like this and you know that you did a great job. It's a big accomplishment. I was extremely proud…" (Interviewee B, p.22)
> "We checked all the links and images on our portfolio on another computer. At that moment, the portfolio suddenly became mine. We worked on it for weeks and I felt so weird that it suddenly… like your baby was born. It was the most exciting and it was weird too…Anyway, it was exciting. The portfolio site was extremely comprehensive and others could definitely use it." (Interviewee A, p.23)

**Frustrations**

In describe their frustrations experienced during their collaboration revealed the obstacles that impeded their collaboration and should get our attention. These frustration moments indicated that the collaboration format, tools, individual working styles, and even the physical well being were important factors contributed to their frustration.

> "Definitely, I hope to have more visualized collaborations… synchronized but visualized when we were working at home. We talk a lot on our cell phones. But really hope to see …I am a visual learner. I need sometimes to see what was on her screen… If I could do that, some problems we talked for hours could be solved, you know, just one click." (Interviewee D, p.16)
> "The E-Locker (a web format file transferring protocol that university offers to all the students to access their files on university network drive) was not user-friendly, we tried a few times to upload our portfolio files through it. Oh, it was horrible. We ended up with broken links, and missing images, and our pictures were gone… And we decided that we need to work together at the computer lab downstairs." (Interviewee C, p.11)
> "Find a good chuck of time to work together was always a problem. Let's me take that back, it's not really a problem but it's difficult. Difficult, you know what I mean. I need a big chuck of time to work on it. It's just me. I can not work 30 minutes on the portfolio and shift gears to work on something else for another hour and then come back to work on portfolio again. It's just not me." (Interviewee D, p.14)

"Sometimes we were so tired after our evening class when we met in the lab. We sat there doing nothing … I was tired, I wanted to go home, and sleep." (Interviewee C, p.16)

## Conclusion

Though the results presented above are preliminary, it already begins to present us a real picture of the TEEMS students' collaboration when constructing their electronic portfolio in the technology integration course and its collaboration essence. "By essence we do not mean some kind of mysterious entity or discovery, nor some ultimate core or residue of meaning…A good description that constitutes the essence of something is construed so that the structure of a lived experience is revealed to us in such a fashion that we are now able to grasp the nature and significance of this experience in a hitherto unseen way." (Van Manen, 1990, p.39) This study, through the reflection on the positive collaboration experience, also confirms the usefulness of social cognitive learning theory, a theory that advocates learning through collaboration in the real social contexts (Driscoll, 2000). Additionally, it adheres to theories regarding distributed cognition, a premise that suggests "learning is not an individual act, even when it undertaken alone" (Duffy & Cunningham, 1996, p.180) and "knowledge does not reside with an individual learner alone" (Gunawardena & McIsaac, 2004, p.376) but is distributed among members of the community. The new picture painted by the participants' own words the researcher got in this study will shed a light on the efforts to facilitate learning through collaboration as a course technology integration course.

## Reference


Creswell, J.W. (1998). Qualitative inquiry and research design: Choosing among five traditions. Thousand Oaks, CA: SAGE Publications.

Driscoll, M.P. (2000). Psychology of learning for instruction. Boston, MA: Allyn and Bacon.

Duffy, T.M. & Cunningham, D.J. (1996). Constructivism: Implications for the design and delivery of instruction. In D. H. Jonassen (Ed.) Handbook of research for educational communications and technology. 170 - 198. New York: Simon & Schuster Macmillan.

Manen, M. V. (1990). Researching lived experience: Human science for an action sensitive pedagogy. State University of New York Press.

Gunawardena, C.N. & McIsaac, M.S. (2004). Distance education. In D. H. Jonassen (Ed.) Handbook of research for educational communications and technology (2 ed). 403-437. New York: Simon & Schuster Macmillan.

Ropp, M.M. (2005). Technology proficiency self assessment. Retrieved 10/3/2005 from http://www.iittl.unt.edu/surveys/demos/tpsa2.htm

Shoffner, M.B. (2005). Alternative teacher preparation programs: Intersection of content, pedagogy and technology. In R. Ferdig & C. Crawford (eds.), 17th International Conference Proceedings of Society of Information Technology and Teacher Education, (pp. 2813-2817). Norfolk, VA: Association for the Advancement of Computing in Education (AACE).

Shoffner, M.B. (2005). The course syllabus of IT 7360: Technology for educators. Retrieved 9/28/2005 from http://msit.gsu.edu/IT/Teachers/Info7360/syllabus/7360_FA05.htm

U.S. Department of Education, Office of Elementary and Secondary Education. (2002.) No Child Left Behind: A Desktop Reference. Available at www.nochildleftbehind.gov

Youtz, S. C. (1997). Verifying the collaboration experience questionnaire: Analysis of a community-campus partnership. Unpublished dissertation, Pennsylvania State University, University Park

# If you build it, will they come? Designing an instructional computer game for an undergraduate computer course.

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## Introduction

This presentation will detail the process and experience of designing *Lifecycle*, an instructional, web-based computer game for my undergraduate Systems Analysis and Design course. I will briefly present the game, discuss the process of designing the game, present the underlying rules behind the game, present initial feedback from my students, and share lessons learned. This presentation should be of interest to anyone considering the design, development, or application of video or computer games to education.

## Why a computer game?

Video and computer games have rapidly become a leading form of entertainment in America and across the world. Huge video game sporting conventions have sprung up in California and Seoul, among other cities, and players regularly compete with each other in local "LAN parties." The NPD group reported that computer and video game software sales exceeded a record $10.3 billion in the US in 2002, slowing but remaining strong with $10 billion in 2003 (The NPD Group Reports Annual 2003 U.S. Video Game Industry Driven by Console Software Sales, 2004). This compared to $9.5 billion in box office sales for the US movie industry in 2002 (U.S. Entertainment Industry: 2002 MPA Market Statistics).

With the emergence of video and computer games as popular entertainment, it is only natural that educators would turn to this new media to examine its potential for use as instruction. More and more researchers have begun to examine video and computer games and many have found that the media holds great promise for engaging instruction (Reigeluth, 1999a; Prensky, 2001; Molenda, 2002; Gee, 2003; Squire, 2003; Aldrich, 2004). More and more instructors are seeing that their students are demanding more engaging instruction, and video games seem like a strong candidate since the students are clearly playing them. Jenkins reports that while 88 percent of surveyed incoming MIT students had played games before the age of 10, more than 75 percent were still playing games at least once a month.

However, is it truly realistic for an instructor to design an educational computer or video game for his class? I decided to test this for myself and began designing a game with the hopes that it not only would be more engaging for the students but that it might actually improve their understanding of the relationship between SAD tools and concepts that I teach in my class. While I am continuing to refine the game before testing the impact on the students' understanding, I found that it is definitely possible to design an instructional game and have it developed. A senior in computer graphics at my university took on the development of the game as a senior project, and it was entirely designed and completed in under a year.

## The game

Lifecycle is an interactive simulation game which seeks to develop an understanding of Systems Analysis and Design (SAD) concepts using the UML methodology. Players will play the role of a systems analyst in charge of a development team. The development team is seeking to develop a quality product for the Client Corporation using very various UML tools to document the system's requirements and design specifications. Players will be scored based on the quality of the system, time spent developing the product, and user satisfaction. Other variables will be stored which will impact the scoring of these key variables. The goal of the game is to develop the highest quality system, in the least amount of time, with the highest customer satisfaction. The game will produce a log of the player's name, player actions throughout the game, and the player's final score.

I designed the game so that my students would be able to discover underlying UML and SAD concepts as well as the relationship between these concepts and the hands-on tools they use to document system requirements through experimentation, feedback, and yes, "play." The focus of the game is on instruction and simulating the long process of analyzing, designing, and developing a system. I envisioned the game scaffolding knowledge presented previously in class. Therefore, the students would receive instruction through lecture and utilize specific UML diagrams in class projects. Lifecycle is then to be played following this initial introduction to the material so that the students can experiment as analysts and receive instant feedback on their choices. UML focuses on a lifecycle of iterations, meaning diagrams are created and revised multiple times. The overall lifecycle of the class project and indeed most projects is often too long for the students to be able to easily make the conceptual connections that I hope they will make. Lifecyle hypothetically will give them the opportunity to repeatedly go through a complete system development process in a short amount of time and have a unique experience each time, while receiving important feedback that will allow them to make stronger conceptual connections while also having factual knowledge, such as UML and SAD terminology, reinforced. While the game design was a daunting task, I believe that this experience has shown that it is possible for an individual instructor to design and have developed, an instructional game that students will enjoy and find meaningful.

## The design process

I had several goals in mind when approaching the task of designing Lifecycle. I wanted the game to be playable via the Web so that my distance students would also be able to use the game. I also wanted the game design to be playable in paper format so that I could test the underlying structure of the game for accuracy prior to having the game actually built. I wanted the game content to reinforce specific conceptual and factual instructional objectives.

I also had several restrictions that would place limits on the game's design. As I would have to rely on a single student to develop the game, it would need to be simple enough that this was possible. I also would only have the student's help for one semester, so the design's complexity would also need to be simple enough to be completely built in a single semester. Because of this, Lifecycle is primarily a text-based game. However, it does utilize images, and I am currently working with a second student to incorporate more audio and refine the visual design of the game.

After recognizing both my primary objectives and the limitations that I was working under, I set about trying to figure out how I would create an underlying structure of rules that would cause the game to behave as needed and reinforce the instructional objectives that I had decided on. I had never designed a game before, so I began by reading a number of books on game design. By far the most helpful resources I had were Salen and Zimmerman's *Rules of Play* (2003) and an interview with Dr. Michael Molenda of Indiana University (personal communication, February 25, 2005). *Rules of Play* is very helpful to the novice game designer because it breaks down the structural design (rules) of a game (usually a board game) at the end of each chapter. This helps you see how game designers tie contextual and conceptual objectives to game rules that will reflect these objectives. Dr. Molenda had designed an instructional board game several decades ago that tried to simulate the process of managing the introduction of change in a school system. He went over the game and how the dice the players' rolled determined game response based on a chart of percentages which was tied to game feedback and action outcomes. This game has since been translated into a Web-based game by Dr. Ted Frick and a group of his graduate students (2005); although, access is currently limited to those on the IU system.

After reading *Rules of Play*, talking with Dr. Molenda, and playing the Web-based Diffusion game, I had a stronger understanding of how to structure my game so that it could incorporate random occurrences, create variable player experiences, and still promote the learning objectives that I was interested in. I first developed the context of the game, the design situation and the system stakeholders. I then determined how I would score the game and translated this into scoring variables which would track player performance. Next, I created a list of player actions, some immediately available, others only available after certain conditions had been met and decided how these actions would impact the scoring variables as well as reflect the learning objectives I had in mind. Finally, I created a list of random impacts and tied many of these to player actions and learning objectives, so that even though the impacts were random, they reinforced learning objectives and could be somewhat controlled by player action. I detailed feedback for all player actions and random impacts, play-tested the design and wrote up a design document which was given to the student developer. I met each with the developer to review the process of the game and help her to understand the underlying rules that shaped and supported the game and its use as scaffolding for learning.

## The game structure

### Variables

As examining the underlying structure of other games was most helpful to me in designing Lifecycle, I will try to briefly present Lifecycle's structure and how it reflects my instructional goals for the game. I will do this by describing the game's variables, player actions, and variable impacts and how they are related to each other and my instructional objectives.

The scoring and indeed much of the game itself is based on five variables: time, business knowledge, quality, client satisfaction, and project status. The player's final score is determined at the conclusion of the game (when time has run out or the project has been completed) by adding the player's scores from the time, quality, and client satisfaction variables. A player has a maximum of 50 weeks to complete the project (achieve 100% in project status variable). The time variable measures how many weeks (turns) have been used. This variable is impacted by player actions (which use up one or more week, depending on the action), as well as random impacts which can add to or reduce the number of remaining weeks the player has. At any time, the player can look at the screen and see how many weeks he has left. The pressure of this time limit helps reflect to the students the actual pressures that come on a systems analyst in a real-world project. Furthermore, the pressure is there to try and help demonstrate some of the conceptual issues I cover in class, including how the developer's natural inclination is that taking time up front to document the analysis and design of a system before building it is a waste of time, while, in reality, jumping into building a system without establishing what the system needs to do and how these objectives can be best be met can result in longer development times. Therefore, players are trying to complete the project in the shortest amount of time, but also with the highest quality and client satisfaction.

Business knowledge is a percentage rating that identifies the analyst's understanding of the system and the business problem it is trying to solve. It is heavily influenced by how much the player has involved stakeholders in the development process. This supports the user-centered design process which I teach in class. This score is never revealed to the player, but is used to measure the impact of various activities throughout the process. It has a direct impact on the success or failure of the different activities. The state of the business knowledge is alluded to through conversations with stakeholders but never quantifiably defined to the player.

The quality variable is related to the quality of the system that is being developed by the player-analyst. This variable is impacted by player actions and is also heavily impacted by the business knowledge variable. This reflects the concept that if an analyst does not truly understand the business logic behind the system, then quality will likely suffer. The quality score can only be determined through the user testing action, which will reveal what level of quality the currently developed aspects of the system are showing.

Client satisfaction is a very important variable in terms of player score. This reflects the concept we discuss in class that clients must be involved or they will have no investment in the resulting system, even if it is a good one. Client satisfaction is therefore impacted by the level of stakeholder involvement in addition to the quality of the system that is developed. The level of client satisfaction is only revealed to the player by talking with stakeholders or conducting user testing on the system.

The final variable, project status, simply shows what percentage of the project has been completed. This variable is only impacted by the player action implement system. To complete the game, the player must have finished implementing (building) the system (100% score) within the 50 week time limit. The concept that an analyst can build a system more quickly if he has a true understanding of what the system's requirements are is reflected by the variable impact and time taken by the implement system action. The higher the business knowledge score, the higher the gain in project status when implementing the system, and the less amount of time used up by the action. So, if the player tries to implement the system at the very beginning of the game without taking the time to understand what must be built before trying to build it, the action takes a long time in terms of weeks and results in little gain in terms of completing the project. Furthermore, the low business knowledge rating in this instance would also result in poor quality. This reflects how these variables tie together to support the underlying concepts which I want the game to reinforce.

**Player actions**

Player actions are the actions the player can take each turn of the game. Initially, there are certain actions which the player can take and additional actions are revealed to the player when certain conditions are met, such as talking with specific stakeholders or completing other actions. The following outline shows the player actions available in the game and which ones are initially available as opposed to which are "unlocked" by other actions in the game.

A. Initially Available:
    a. Talk to Stakeholders
    b. Generate/Refine Requirements Specification Document

c. Brush up technical skills
d. Take Ms. Manner's Composition and Elocution Course
e. Schedule Team Meeting
f. Implement System

B. Unlocked by Stakeholders:
  a. Develop Change Management Plan

C. Unlocked by Actions
  a. Conduct Feasibility Analysis: Unlocked by Generating Requirements Specification Document.
  b. Develop/Refine Use Cases
  c. Develop/Refine Class Diagrams
  d. Develop/Refine Activity Diagrams
  e. Develop/Refine Sequence or Communication Diagrams
  f. Iterate Documents

D. Unlocked by Actions AND Stakeholders
  a. Conduct User Test

The actions take a different number of weeks to complete, with most taking one week, some more, and one- implement system taking a variable amount of time based on the player's current business knowledge. Each action results in different impacts on the variables discussed above. For example, if a player were to talk to a stakeholder as an action, it would use one of the fifty weeks available to complete the project. Depending on which stakeholder the player tries to talk to, the action could unlock additional actions, unlock additional stakeholders, positively impact business knowledge and client satisfaction, and so forth. If the player tries to talk to certain stakeholders without first talking to the "boss" and getting management support, he might waste a week trying to talk with the stakeholder without getting any response. This is an example of another concept we cover in class, the need for management buy-in. As another example, talking with the secretary could also reveal the general client satisfaction level around the office.

Other actions are specifically tied to diagrams taught and used by the students in class. The use cases, class, activity, sequence and communication diagrams are all diagrams the students complete in class. The students are able to have the sequence of these diagrams, their names, and what they are used for reinforced by playing the game. Each of these actions help to enhance the analyst's business knowledge score, and once all of the documents have been completed once, the player is able to iterate the documents, which allows for them all to be refined at a lower cost in terms of time. This reinforces the concept of an iterative system lifecycle, as taught in class.

Finally, there are some actions tied to additional concepts covered by the random impacts built into the game. I talk with the students in class about what skills are important for a systems analyst to have. These include strong communication, technical, and teamwork skills. These concepts are reflected by negative random impacts that can occur if the player does not have the foresight to strengthen each of these areas by using the appropriate action. This can be further described by looking at the random impacts in the game.

**Random impacts**

Random impacts are used in the game to both add variability and increase the value of replaying the game, as well as to reinforce additional concepts, such as the importance of various skills to a systems analyst. The random impacts in the game are as follows:

1. Technical miscommunication
2. Foot-in-mouth
3. Poorly written communication
4. Super programmer
5. Programming mishap
6. Change request
7. Team argument
8. Stakeholder unavailable
9. Team member sick

Each turn there is a percentage chance that a random impact will occur. Most of the impacts are negative and can cause the player to lose turns, such as if there is an argument on the team. The chance of these impacts can be reduced by certain actions. For example, the more team meetings are scheduled, the smaller the chance that if a random impact occurs, and that impact is a team argument, that the negative impact will actually occur. Instead, the player will be given feedback that identifies how the team was able to handle a potential argument well and kept working seamlessly. This reinforces the importance of teamwork skills. Other impacts are similar, such as the change request. If the player has developed a change management document, then weeks can be lost adding additional functionality requested by the client. The importance of managing change requests is another concept we discuss in class. One of the impacts is positive, the super programmer. If the player is implementing that turn and this random impact occurs, one of the analyst's team members turns in a great programming performance, and completes the implementation in much less time than normal. These impacts are meant to add to the game's fun and unpredictable nature and make each replay different than the previous while also reinforcing additional concepts covered in class.

**Lessons learned**

My goals for this project were to create a fun, instructional game which could be developed by one undergraduate student in one semester. I believe I have succeeded in this and have also learned a number of lessons along the way. While I was able to have the game completed in one semester, the student did not manage to get out all of the bugs, and despite pledging to tighten them up over the summer, promptly disappeared and stopped answering emails, so a large lesson coming out of this was to not turn in that final grade until the game was truly finalized. While I can look back on this with a bit of a chuckle now, I was quite panicked at the time because it was very important that the game accurately followed the underlying rules which I had defined and the student's final version did not. I have been able to locate a second student now who is removing these bugs and adding additional multimedia elements, such as sound, to the game, so I believe my delay in introducing the game to my class will be worth the wait, as the new version should be more entertaining and require less reading on the player's part.

Another important lesson which I learned in this process is how important it is to come to an understanding of what the underlying rule structure of your game will be and how this reflects your instructional goals. It was very important for me to design the game and be able to test it on paper before turning it over to a developer. This allowed me to test the logic that I had developed and ensure that it was sound.

Ultimately, while the process of developing Lifecycle was very valuable to me, I have not yet determined if the game is a true success because I have not yet turned it over to my students. Once the game has been revised, and I reach the point in the semester where my students have been introduced to all of the UML documents covered in the game, I hope to be able to test its impact on students who play it. I envision this game being incorporated into the class as a form of scaffolding. I believe it will be very important to debrief the students and talk about lessons learned from their experience. Students must be asked to analyze their play and what they learned from the game or it will likely remain nothing more than a game to them. I think this analysis both in a group discussion and possibly through a journal assignment, would be very important to successfully using an instructional game like Lifecycle. In conclusion, this was a challenging but valuable experience which I hope will prove valuable to others. Much research remains before I can call Lifecycle a success, but the first steps have been taken, and it is my hope that this will help others to begin their own journey into designing instructional games.

**References**


Aldrich, C. (2004). Simulations and the future of leaning: an innovative (and perhaps revolutionary) approach to e-learning. San Francisco, CA: Pfeiffer.

Frick, T. (2005). *Diffusion Simulation Game*. Retrieved February 25, 2005, from http://www.indiana.edu/~istdemo/dsg/login.phtml

Gee, J.P. (2003). What games and have to teach us about learning and literacy. New York, NY: Palgrave Macmillan.

Jenkins, H. (2002, March 29, 2002). Game Theory: How should we teach kids Newtonian physics? Simple. Play computer games. Technology Review.

Molenda, M. (2002). A New Typology of Instructional Methods (updated February, 2005). Paper presented at the Annual Conference on Distance Teaching and Learning, Madison, WI.

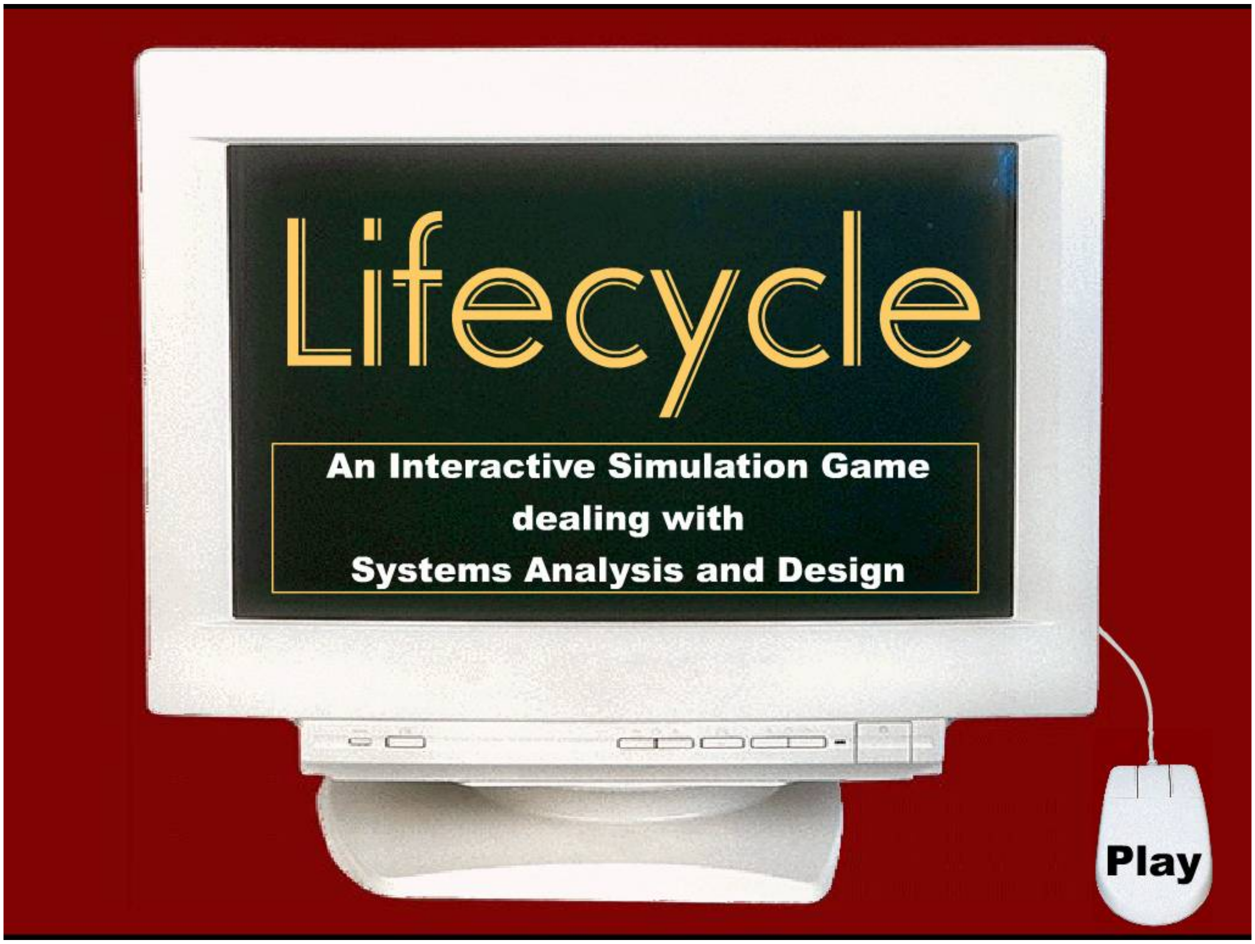
The NPD Group Reports Annual 2003 U.S. Video Game Industry Driven by Console Software Sales. (2004). Retrieved February 21, 2004, from http://home.businesswire.com/portal/site/google/index.jsp?ndmViewId=news_view&newsId=20040126005198&newsLang=en

Prensky, M. (2001). Digital game-based learning. New York, NY: Mcgraw-Hill

Reigeluth, C. M. (1999a). What is Instructional-design Theory? In C. M. Reigeluth (Ed.), Instructional-design theories and models: A new paradigm of instructional theory. Mahwah, NJ: Lawrence Erlbaum Associates.

Salen, K., & Zimmerman, E. (2003). *Rules of play: game design fundamentals*. Cambridge, MA. The MIT Press.

Squire, K. (2003). Video games in education. International Journal of Intelligent Simulations and Gaming (2) 1.


Lifecycle
An Interactive Simulation Game
dealing with
Systems Analysis and Design
Play


Lifecycle
Choose the Activity you wish to perform
Rules
Game
Your project is 0%
Weeks used: 0
STAKEHOLDERS
Mortimer Bossman
Profile
Sylvia A. Sisstant
Profile
Ed User
Profile
Janet Hardware
Profile
ACTIVITIES
Talk to Shareholders
Generate/Refine Requirements Specification Document
Brush up Technical Skills
Take Ms. Manner's Composition and Ellocution Course
Schedule Team Meeting
Implement System
Develop Change Management Plan
Conduct Feasibility Analysis
Develop/Refine Use Cases
Develop/Refine Class Diagrams
Develop/Refine Activity Diagrams
Develop/Refine Sequence or Communication Diagrams
Conduct User Test
Iterate Documents

# The computer literacy class – back to basics

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**Abstract**

*Computer literacy is a phrase that is often quite elusive. How does it relate to information literacy? Is there a body of information skills that comprise computer literacy for everyone, and if not, can it be called 'literacy'? How is it implemented and assessed? Answers vary according to what program you view and the assumptions behind the programs. This paper surveys assessment and administration of a number of computer literacy programs and literature and extrapolates its findings onto the case of a computer literacy program of an urban east coast college*

## What is computer literacy?

Definitions of computer literacy vary according to the type of academic program in which the learned skills will be used (N.D., 2005; Zestotarski, 2000). In common discussion, computer literacy means little more than the ability to use very specific programs such as Microsoft Word, Internet Explorer and Microsoft Outlook, and to perform well defined tasks by rote. This is fine in theory, but people use computers to solve problems and achieve results. The effect of this rote mode of learning can be like a child who has memorized a children's book and can, on demand, recite it back, but not know the reason why (N.D., 2005; Patricia Iannuzzi & Donald W. Farmer, 2000; Perkins, 1992).

Information literacy is a term that often gets confused with computer or technological literacy. Information literacy is a superset of computer literacy. A 1999 report from the research Council suggests that the concept of 'fluency' is quite important. Computer Literacy is based in rote learning of hardware and software applications without a particular context. Shulman, (1996) proposes the integration of constructivist techniques with the reasoning that: "In a real life situation, one needs the ability to build and act upon individual realities, while in a situation where the learners are being trained to think and respond in the exact same manner, such as in military training, it is counter-productive to view differing realities. Fluency, with technology, is the understanding of the underlying concepts of technology and as it relates to a K-12 classroom, and are concerned with a 'deep understanding' of technology and the eventually increasing use of it. (Patricia Iannuzzi & Donald W. Farmer, 2000).

The need for authentic instruction is critical if the rote learned skills are to become part of a new computer user's repertoire. Giving our students no more than knowing what button to push is not doing them a service. What is needed is to give students a clear understanding that a computer is a tool and is not a thing onto itself, but merely designed to help solve problems and accomplish work (Vaz, 2004). A basic failing in trying to differentiate computer literacy and information literacy, is that nothing stands still. There is always new information to learn and new concepts to learn how to employ. Just a short number of years ago there were no USB Flash Drives. This is a wonderful device that solves the fragility issue of floppy disks, and sells much cheaper than any other removable media. Everyone storing data should have a flash drive, but not just to own a new toy. The case must be made that it is good workable technology that can solve a salient problem and not be one of the many marketed solutions in search of a problem. Demonstrations should be done on how to use, but more importantly, why to use them. A case must be made to convince students of this, or most any other technologies' merit, since most people have had problems with floppy disks not being able to be read between machines. In class, we take apart a floppy disk and the class sees just how fragile it is. We put a USB Drive in a Mac, run something, put it in a PC, run the same file, toss it up in the air and let it hit the ground. When we are done, it goes back into a computer and it always works. This has proved to be a motivating demonstration, solving a problem and building fluency. It seems that in the strictest of definitions, information literacy is more to be sought than computer literacy. As Computer Literacy gives you a tour of the tools, Information Literacy is concerned with how to make the best use of the tools.

As stated by the American Library Association, four aspects were found to comprise information literacy:

1. The ability to recognize when information is needed;

2. The ability to locate the needed information;
3. The ability to evaluate the suitability of retrieved information, and
4. The ability to use effectively and appropriately the needed information. (American Library Association, 1989)

This is quite general, and doesn't appear to address the how, where, why, and when of the situation. We feel that these are not objectives, but outcomes that can be met any number of ways either with or without technology. More interesting is Vitolo and Coulston's Information Literacy Taxonomy, which states that: "With this approach the disciplines express a degree of fluency appropriate for their field. Once the amount of fluency is specified, then individuals can be trained to meet discipline-specified needs and not simply be trained" (Vitolo & Coulston, 2002). Mere knowledge and demonstrated proficiency in the nuts and bolts of computer literacy may have been enough in the past, but as technology moves on, we feel that information literacy, as it relates to technology, is crucial to the success of the student and that learning rote information without context may be quickly forgotten.

**Administration of Computer Literacy Competencies**

In surveying how various institutions administer tests and courses to measure computer literacy, we found a number of differing procedures and we would like to compare and contrast these procedures with York College, an urban four-year undergraduate university that is part of the City University of New York system.

Some institutions have contracted with third party vendors to provide test-out testing for computer literacy skills. Longwood University in Virginia is one of these. It has contracted with a testing service called Smartforce.com, now called Skillsoft.com, (Skillsoft.com, 2005) to administer online computer literacy testing which can be done from any Internet browser twenty-four hours a day. This can be taken any time before graduation. We were not able to see the test, but did find that a number of online remediation books were available from skillsoft.com. This minimalist orientation to the problem seems to be well outsourced, but regardless of the quality of the testing or remediation, the fact that this must be completed any time before graduation appears to be detrimental. If a purpose behind the attainment of computer literacy was to use the skills in the course of a student's undergraduate tenure, this procedure seems counter-productive at best.

At Cal State San Marcos, the Instructional and Information Technology Services department does the testing of computer literacy in-house. A good deal of online information and structure has been provided on their web site. Online, one can find a sample test to be used for practice, a number of articles and glossaries explaining the basics of computer literacy and a listing of many Colleges and Universities along with the course numbers of computer literacy classes the listed institutions provide that will act as waivers of the computer literacy test for transfer students. According to Cal State, the test, if the requirement is not met otherwise, must be taken during the first or second semester of enrollment, which seems advisable. The sample test however appears subjective and quite hard to assess. The answers to questions like: "What is the Dow Jones Average?" or "What is the temperature in New York City?" change minute to minute, and unless the computer instantly scores itself the same second the answer is given, the answer would vary. The test may be taken as many times as a student needs to attain a passing grade. An exception to most other programs is that no courses are offered to teach computer literacy. Instead students are directed to certain books held in reserve in the library or advised to call for tutoring. This may not be adequate for all students and it seems like a piece of a well-designed puzzle is missing.

During the orientation week for freshman at SUNY Brockport, students are invited to take a computer literacy test that, if passed, will meet all school requirements for technology. A sample test is online and the skills are quite basic. The sample test requires both working on a simulated Microsoft Word document with a button which when pushed, displays the correct answer or form, along with a multiple choice section that scores itself (SUNY Brockport, 2004). We seriously doubt if this amount of information is adequate for many majors and hope that the instruction is furthered within class work.

At St. Edwards University in Texas, there is a six-part test based in Internet communications, library research, word processing, spreadsheets and presentations that must be taken prior to graduation. As previously noted we consider late attainment of skills a problem and this is verified by St. Edwards by posting that although the test is a graduation requirement, it is suggested that the test be completed early in a student's academic career since most of the skills will be used in many classes and that the classes will not teach the skills. A student can elect to take any of the modules together or separately, can take the test as many times as needed for successful completion, or take a six week no credit remedial course that will prepare them for the test. A downside of this and similar programs as we see it, is that concepts are assessed in no apparent context. There are no courses that if taken at other institutions, will allow one to test-out of the St. Edwards proprietary test.

The College of Southern Idaho has a similar approach but the content is slightly different bringing up a question of what a student needs to know. If you attend one school the set of skills is different from the set taught and assessed at another school. In this College, students need to take a four pronged test assessing competency in general technology, Internet, email, word processing and a choice of either spreadsheet or presentation applications. Again this may be taken as many times as needed. If the information is not known, courses and self-study aids are available. Once again, this is a graduation requirement. The base of knowledge used since spring of 2005 has been that of the Internet and Computing Core Certification (IC3) created by Certiport Inc. (Certiport Inc., 2005), although they do not use the Certiport test. This test uses Macromedia Flash simulations and encompasses contextual information as well as basic computer literacy concepts. Along with Certipoint and Skillsoft.com there appears to be a movement toward standardized testing of computer literacy skills and the integration of authentic contextualization of skills into problem solving environments. The Educational Testing Service announced at the end of 2004 that they planned to unveil a test to assess both computer and information literacy skills as they relate to computer based technology (Young, 2004). Based on the advice of representatives of seven Universities, the idea behind the test acknowledges that most students arrive at school with certain computer skills such as downloading music or video files and using chat, but these are not the skills needed to do well at school. Schools prize the ability to research and evaluate information from multiple sources. This new test purportedly brings information and computer literacy together and in announcing the test, the ETS proposed that the test was not just for basic computer literacy, but for problem solving and contextualization of skills as well. Recently the ETS has announced a version of this test for high school students to assist in assessing and meeting computer literacy requirements in higher education (Young, 2005). If this proves successful at a high school level, it may be the creation of a new SAT type test and a sizable revenue stream for ETS. Although still in testing, it does raise the problem of specific contexts of technology usage (Cornish, 2005). Someone majoring in physics would use Microsoft Excel differently than someone majoring in business. Similarly, graphics arts majors will use Adobe Photoshop differently than would someone majoring in secondary education. Both programs have massive feature sets and not many users, if any, use every feature in both programs and certainly not for the same purpose. Therefore the 'one size fits all' operating concept of standardized testing may not align well with computer literacy.

One solution to this potential problem is to follow the direction of schools such as Potsdam College and Western Illinois University. At Potsdam, the basic computer literacy course was phased out and in its place the skills required were determined and subsequently incorporated into coursework in a student's major area of study. At Western Illinois University a committee of the faculty senate determined that an integrated program aimed at developing computer competencies should be a shared responsibility of every department of the university. General education courses along with other lower level courses should incorporate appropriate technology. Two sets of competencies would be necessary for graduation. The standard college-level competency test must be passed before the end of the second year of enrollment and the professional competency test must be passed before graduation. The specifics of the professional competency test are left up to each academic department to deploy as it sees fit (Western Illinois University, 2000).

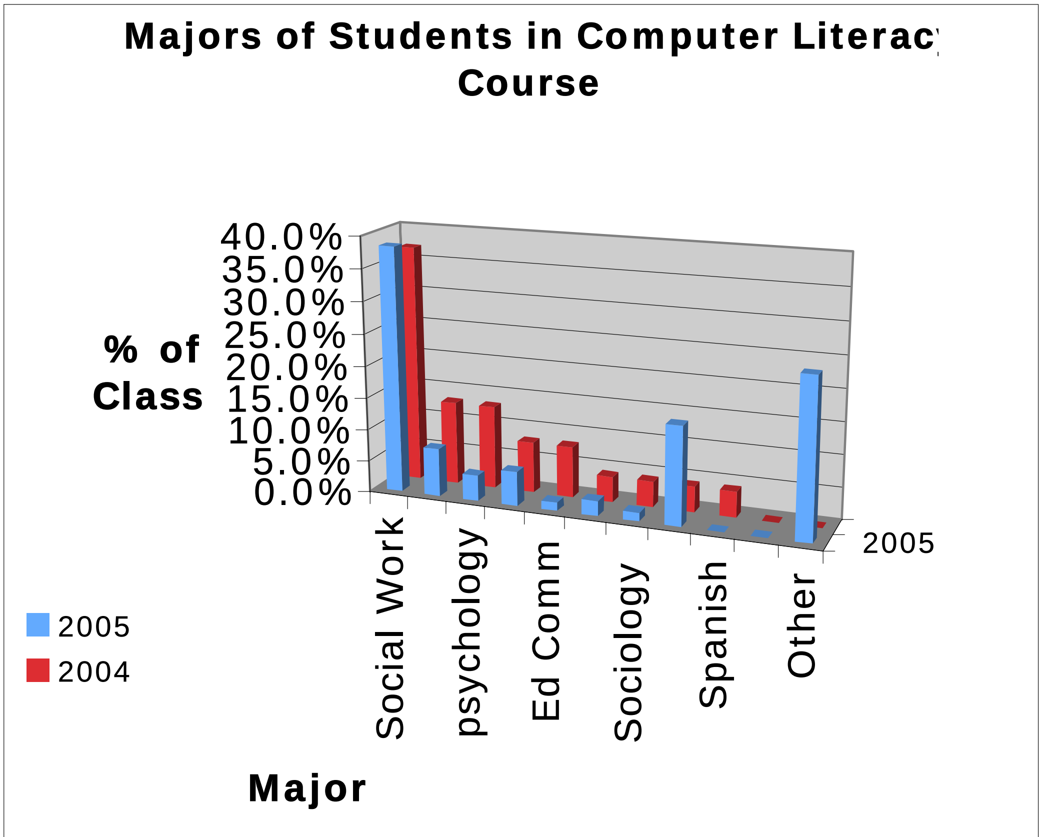
We feel that basic computer literacy should be a responsibility of the entire campus with academics departments working with the IT or computer services department to develop a plan for each academic major concentration. This is probably easier than it sounds since, at least in Potsdam; the teacher education department outsourced the basic computer literacy course to the department of instructional communication and technology for many years. It also becomes a problem when people of various abilities and backgrounds were enrolled. One time when we held such a class, we were asked two questions the first day of class. The first question was asking if we would learn to code JavaScript? The second question asked what was a word processor? As should be apparent, it is not a trivial task to find a level for the class that won't bore the more advanced or lose the beginners.

## The Challenges and Potential Solutions for York College

### Challenges

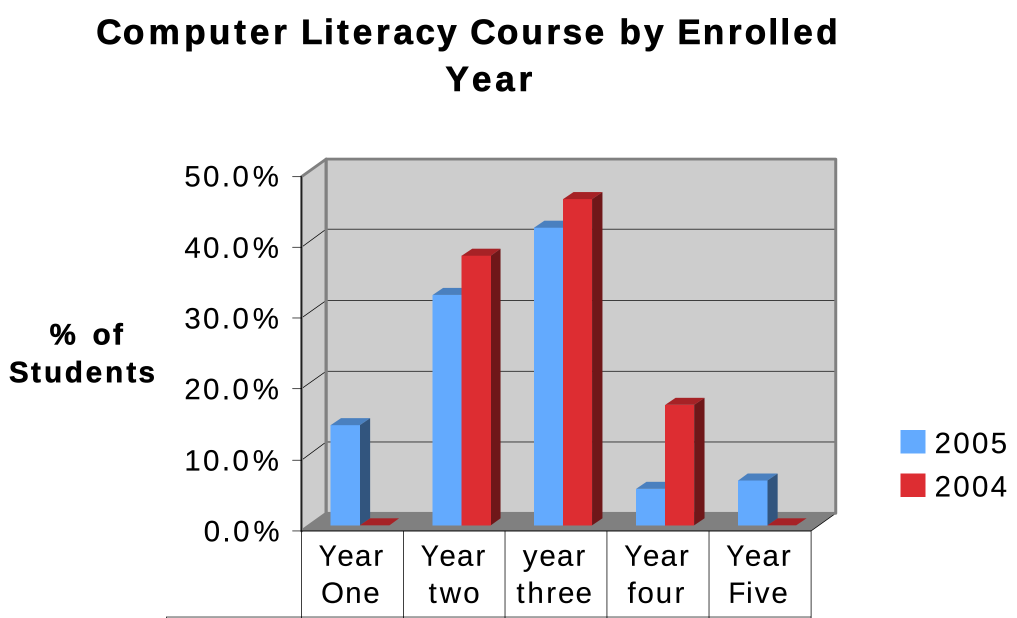
The computer literacy requirement at York is required of every student who enrolls. This is a fourteen-week, one-credit course meeting 1-½ hours a week. Homework must be given the majority of weeks and there are quite a few class projects, causing animosity, since the general feeling of the students is that this is too much work for a one-credit class. Since everyone who does not test out needs to go through the class before graduation, it is quite common for people to pick up the last credit on the way out the door, thereby eliminating any possibility of using the instruction for their work at York.

Table 1.




| | So cial | Ph ys | psy cho | Ear ly | Ed Co | He alt | So ciol | Nu rsi | Sp ani | His tor | Ot her |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2005 | 38. | 7.5 | 4.0 | 5.3 | 1.3 | 2.3 | 1.3 | 15. | 0.0 | 0.0 | 24. |
| 2004 | 37. | 13. | 13. | 8.0 | 8.0 | 4.0 | 4.0 | 4.0 | 4.0 | 0.0 | 0.0 |

Table 2.




| | Year One | Year two | year three | Year four | Year Five |
|---|---|---|---|---|---|
| 2005 | 14.1 | 32.5 | 42.0 | 5.1% | 6.3% |
| 2004 | 0.0% | 38.0 | 46.0 | 17.0 | 0.0% |

Tables 1 and 2 make the point quite well. In 2004 only about 12% took the course during their first year while the majority took it during their third year. This has wasted two; maybe three years where students could be making use of learned skills. In both calendar years the fourth academic year had considerable representation. Since York can be completed in four or five years, the large number of fourth year students taking the course is akin to getting ones last one credit ticket punched before graduation. The general feeling of students taking the course at this late date is that they don't want to be in the class and will do minimum work

Another possible pitfall is teacher expectations of students in areas of the student's majors were not aligned with what was being taught in the computer literacy course. We polled three upper-class sections of a course dealing with multimedia integration into curriculum for teachers. They were asked to answer what technology expectations teachers in their major subjects expected them to enter class possessing. This ranged over a number of majors but all students were in Teacher Education.

Table 3.

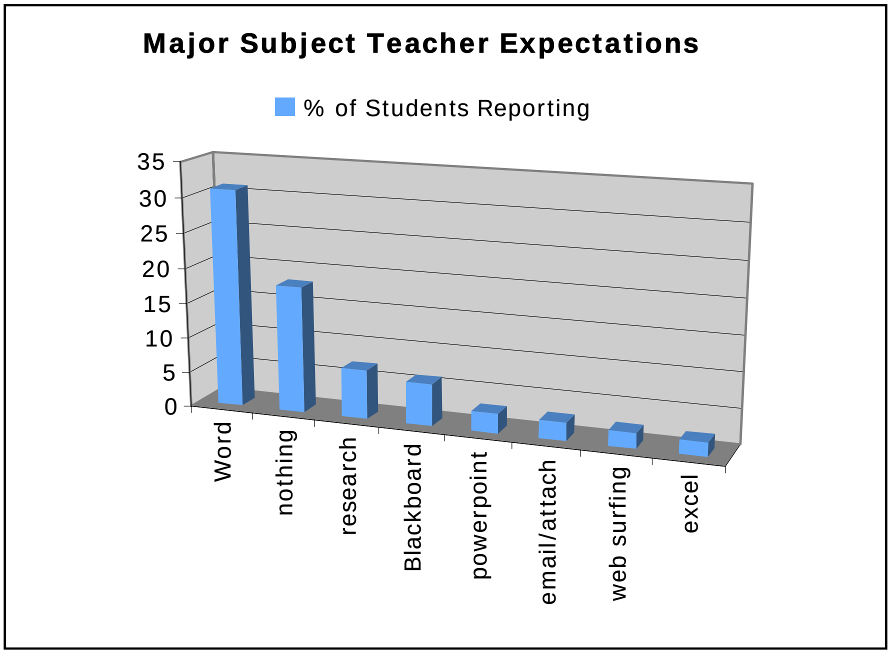



Table 3 shows that after only 30% of teachers expecting knowledge of Microsoft Word, the next largest expectation was that students possess no computer knowledge. We left items off the chart that received one percent or under. These items were: databases, search engines, web site evaluation, computer basics and graphic manipulation. The survey suggests that students are being taught competencies that will be unnecessary. It may also suggest that some instructors are not comfortable enough with technology to integrate its use into their classes. This appears to be a major disconnect.

The basic computer literacy course had a bad reputation according to many students. It was developed in part and administered by an individual with an engineering background and seemed to be too technical and computer science oriented for its student base. According to the homework manual, the subjects seemed to be presented without much discernable context. It was common to hear students complain that they had a harder time understanding the assignment than performing it.

We feel, as recommended by the tenets of Instructional Design, that context is critical and without context there can be no long-term transfer (Dick *et al.*, 2001). The course was later changed, tossing out the old materials and keeping the idea of context in the forefront, creating a curriculum in which, taking a cue from John Keller, (1987) relied heavily on the relevance of the concepts to individual students. Keller stated that to achieve motivation there must be four conditions: attention, relevance, comfort and satisfaction. Unless relevancy is obtained the instruction can be nothing more than disconnected data, easy to forget. The mode most often used in the restructuring of the course was to have the students read about non-contextualized concepts before the class and then provide context and relevancy within classroom discussion. To date these and ongoing changes have improved student perception of the course and resulted in a higher percentage of homework submitted.

**The problem of testing out**

Since the basic computer literacy course is, as stated, quite basic, there are many people who do not need this course but take it regardless since it is a graduation requirement or they need the one credit it provides. A test was developed to allow people to test-out of the course. This competency test went through a number of iterations until we were confident that it provided a realistic assessment of the competencies acquired in the computer literacy course. To our dismay, it was made clear that York was looking for a competency test that would assess not only the skills in the computer literacy course, but also all the skills of a taxonomy of computer competencies that was developed some years back by the Academic Communications and Educational Technology department in conjunction with other disciplines on campus. In general these competencies include the following topics: operating system, word processing, e-mail usage, internet browsing, spreadsheets, graphic usage and presentation tools. To be added were concepts and terminology. Each heading was broken down into 3 to 11 base elements. The computer literacy course according to the taxonomy was meant to meet the operating system, word processing and email usage requirements only. it met more than that, including concepts and terminology, which provide context and graphic manipulation as a function of word processing among others, but it certainly fell short of covering the entire taxonomy. The missing competencies were meant to be addressed by more advanced courses. So, following York's position to test out of a basic computer literacy class, one is required to be competent in double the amount of capabilities taught in the literacy course. The effect of this is to run 6 sections of the computer literacy course each semester when in our opinion it could be well covered by 3 or 4 sections.

**Potential Solutions**

In viewing various ways that institutions deal with this and other problems of computer literacy, it has become apparent that computer literacy is a term that is ready to be put to rest. Without appropriate context the potential for learning is greatly diminished. Additionally, there is a real question as to exactly what comprises computer literacy. The word 'literacy' according to Brian Harvey, a computer scientist at Berkeley wrote in 1983 that computer…literacy means that everyone must have the experience in order to function at all in our society (Harvey, 1983), and then goes to question what those skills may be and if they are the same for everyone? Given this environment of conflicting ideas over computer literacy as a thing onto itself and how we feel that it should be broadened at all levels to become a supported and well administered part of information literacy, instead of working at cross purposes, we propose the following potential solutions to solve the problems at York College and elsewhere.

1. Integration of specific uses of technology in contextually appropriate subject areas for each major.
2. Hiring teachers within academic departments that are capable of providing such instruction.
3. Development of individual departmental technology requirements appropriate to each field.
4. Developing sessions during freshman orientation week where incoming students will be encouraged to test out on a departmental level. These test-out-tests will be developed in conjunction between the IT department and the academic units.
5. Requiring that basic computer proficiency be attained by no later than the end of the second semester before allowing continuation into sophomore year. This would require a change in the advisement procedure.
6. Developing two part remediation courses where the first part will be general computer basics and the second half will be handled by individual academic departments.
7. The creation of a series of test-out tests instead of one all encompassing test. We suggest that there be one test-out test for the computer literacy course and then a series of departmentally administered tests given as prerequisites for further course work. The content of these tests and required competencies would vary according to the needs of the academic department.
8. Publishing the set of skills that will be tested to allow students to concentrate on the proper information.
9. Raising the number of credits or lowering the student workload for the computer literacy course.
10. Offering ongoing consultation and tutoring to allow students with absolutely no computer or typing experience to be on a level playing field with the average student.

The idea of one department deciding what knowledge will be privileged for all departments may do disservice if the students do not learn what their major academic department thinks they should know, or if they are taught information one way and according to the pedagogy of their major, need to unlearn skills and learn it again in differing contexts. A partnership must be developed between IT and the academic departments who are served by them for the betterment of the students. When it comes to computer literacy, one size does not fit all.

## References


American Library Association. (1989). *Presidential committee on information literacy competency: Final report.* Chicago.

Certiport Inc. (2005). Certiport IC3 certification. Retrieved May 1, 2005, from http://www.certiport.com/Portal/desktopdefault.aspx?tabid=229&roleid=102

Cornish, A. (2005). Testing computer literacy. On *Morning Edition*: National Public Radio.

Dick, W., Carey, L., & Carey, J. O. (2001). *The systematic design of instruction* (5th ed.). New York: Longman.

Harvey, B. (1983). Stop saying "computer literacy". Retrieved 11/08, 2004, from http://www.cs.berkeley.edu/~bh/stop.html
Keller, J. M. (1987). Strategies for stimulating the motivation to learn. *Performance and Instruction, 26*(8), 1-7.*)*
N.D. (2005). Computer literacy. *Wikipedia* Retrieved May 1, 2005, from http://en.wikipedia.org/wiki/Computer_literacy
Patricia Iannuzzi, B. L., Mike Eisenberg, Bonnie Gratch Lindauer, & Donald W. Farmer, H. B. R., Craig Gibson, Oswald Ratteray, Lori A. Goetsch, Althea H. Jenkins, Mike Eisenberg, Barton Lessin, Patricia Iannuzzi, Bonnie Gatch Lindauer. (2000). Information literacy competency standards for higher education. *The association of college and research libraries*, from www.ala.org/acrl/ilcomstan
Perkins, D. N. (1992). Technology meets constructivism: Do they make a marriage? In T. M. Duffy & D. H. Jonassen (Eds.), *Constructivism and the technology of instruction: A conversation* (pp. 45-55). Hillsdale, NJ: Lawrence Erlbaum Associates.
Skillsoft.com. (2005). Skillsoft information center. Retrieved April 28, 2005, from http://www.skillsoft.com/infocenter/default.asp
SUNY Brockport. (2004). Quiz results: Practice exam. Retrieved March 2, 2005, from http://computerskills.brockport.edu/Angel/PracticeExam.asp?WCI=pgDisplay%5FQuiz&WCE=take&WCU=PRACTICE&ENTRY_ID=20010522144863496
Vitolo, T. M., & Coulston, C. (2002). Taxonomy of information literacy competencies. *Journal of Information Technology Education*(1).
Vaz, R. (2004). The promise of computer literacy. *Liberal Education*, 90(4), p.2.
Western Illinois University. (2000, October 31). Report of the computer competency committee. Retrieved March, 18, 2005, from http://www.wiu.edu/users/mfbhl/report.htm
Young, J. R. (2004, Nov. 12). Testing service to unveil an assessment of computer and information literacy. *The Chronicle of Higher Education*, p. A33.
Young, J. R. (2005, Sept 20). Educational testing service expands efforts to measure computer and information literacy. *The Chronicle of Higher Education*.
Zestotarski, P. (2000). Computer literacy for community college students. *(ED 438 010)*

# Towards the Design and Development of Individualized Online Instruction in Higher Education

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**Abstract**

*The development of computer technologies promised highly for realizing individualized instruction online. This paper reviews and reflects on research efforts and practices that have been made toward the design and development of individualized online instructions in higher education. Based on the comparative analyses of those studies with two traditional distance education design theories, key principles are recommended. Such review and reflection are of primary importance for researchers and practitioners in furthering their explorations and practices.*

## Introduction

The advent and development of computer and telecommunication technologies awakened many researchers and educators with the dream of realizing individualized instruction. However, while a decade went by since the wide spread use of computer and computer-associated technologies, little was achieved toward practical and successful design and development of individualized instruction.

"Individualized instruction" and "personalized learning" were used interchangeably in the literature. In fact, what instruction is to learning is what a means to an end. That is, learning is a possible end to instruction. What an instructor and instructional designer can do is to carefully design and implement the instruction so that learning may be maximized. It is generally believed that when instructions are customized to a specific individual's needs, maximum learning can occur. This paper aims to present a review of recent literature that addressed the issue of how such instruction should be or were designed and developed.

## Recent Research On Learner Differences

There has be an identifiable and continuing effort in the literature that focused on finding the relationship between students' learning styles and their success in and satisfaction with distance learning (Dillon & Greene, 2004; Moore, 2002). Bollet & Fallon (2002) defined learner as "our own individual internal way of processing information via our brain's preferred learning style". It was supported by many authors and researchers that learning styles decided how students learn (for example, Carnwell, 2000; Thompson, 1998). They believed that students' achievement and satisfaction must be a function of and could be predicted by their learning styles. Therefore, in order to enrich students' learning experiences and to personalize their own e-learning processes, "the diversity of learning styles must be in the conscious awareness of the instructor/trainer at all times" (Bollet & Fallon, 2002. p43). As Dillon & Greene (2004) mentioned, "the recognition that learners have different needs is indeed a revolutionary theory, one that promised to move us from mass education to individualized learning" (p9). A number of studies were conducted along this line of inquiry with the hope that suggestions could be made for adjusting instructions based on the findings of significant effect of learner differences on their academic achievement.

Dillon & Greene (2004) performed a pretty exhaustive review on the studies about learning differences and online learning environment. The studies they reviewed were most done in the 90's. This paper summarizes the studies conducted onwards in the same manner.

## Learning Styles And Achievement

Neuhauser (2002) found no effect of learning modality preferences (visual, auditory, and kinesthetic/tactile) and temperament preferences (introversion/extraversion, sensation/perceiving, sensation/judging, intuition/thinking, and intuition/feeling) on students' achievement in an online course.

In another study (DeTure, 2004), the hypothesis that cognitive style scores could predict student success (in terms of GPA) in an online education course was rejected. The cognitive styles in this study included field dependence/independence. In addition, the second hypothesis in the same study was also rejected which stated self-efficacy could predict student success.

**Learning Styles And Satisfaction**

Kanuka & Nocente (2003) found in their study that students demonstrated different personality types as measured by the Millon Index of Personality Styles (MIPS). This instrument measured three aspects of personality types including learners' motivating aims, cognitive modes, and interpersonal behavior. However, these differences in their personality characteristics failed to influence their satisfaction on the web-based instruction. The majority of the participants were satisfied with the course regardless of their personality differences.

**Conclusion**

Not surprisingly, the findings in the reviewed research studies were consistent with one another in that leaner differences were found no or little effect on academic success, satisfaction, persistence, completion of course (Dillon & Greene, 2004). In response to those insignificant results, Dillon & Greene eventually abandoned the fundamental idea of realizing individualized instruction by catering to different learner needs. Both authors continued to propose that, "rather than focusing upon how to modify the instruction to accommodate the needs of the learner, we should instead focus upon modifying the learning to accommodate the demands of the instruction." (p9). The "learning" in their statement meant learning styles and strategies on learner's end. They reinforced their assertion by quoting the goal of all education as "to help learners learn how to learn" (p5). In place of individualized instruction, they suggested, "a more powerful and expedient method of address individual learner needs may be to identify effective approaches to learning and then help students acquire the metacognitive skills needed to adopt those approaches in setting where they have been found to lead to success". (p9)

If a closer look is taken at the studies, it is not hard to find that participants of these studies were either college students or adult learners. If learners chose to study from a web-based instruction that was generally regarded as rather isolated independent study, it is reasonable to assume that the majority of such learners were motivated to begin with. Even if learning styles could have an effect on their learning achievement, the "noise" of high motivation might have diluted the effect. If this is the case, to sustain and even better enhance students' motivation in an online learning environment is crucial to make possible a high degree of academic achievement and satisfaction. In the other words, to individualize online instructions, we must find effective and adaptive strategies to motivate individual learners.

**Implementation Examples**

Is individualized instruction just a dream that is never attainable? Even though the findings regarding to the effects of learner differences on online learning were discouraging, several instructional designs toward personalized instructions were proven successful and received positive feedback from students. One of the designed applied learner-centered method and another employed multi-model, metadata drive approach to create adaptive personalized e-learning. These methods will be depicted in detail as follows.

**Learner-centered Instructional Design And Development (LCD)**

Parchoma (2003) summarized and compared two examples of successful instructional designs that used learner-centered approach as opposed by domain-centered design (Sims, 2001). Domain-centered design, by definition, tends to ignore the needs and characteristics of the learners, instead focuses on "design and development activities that lead to well-organized and well-presented knowledge objects" (Parchoma, 2003. p38). In contrast, learner-centered design focuses on "demographic and cognitive profiles of learners, prior knowledge, perceptions, preferences, needs, goals, characteristics, and experiences of learners"... and on "ensuring that essential content is contextualized in learner experiences and/or goals so that learners will be motivated to value it" (Parchoma, 2003. p38).

In practice, learner-centered design was realized by involving learners in all phases of analysis, design, development, implementation, and evaluation (ADDIE). Rich information was collected about target learners in the analysis phase and learner profiles were set up to blueprint the course plan. Such information included, "demographic information, comfort with and access to technology, learning styles and preferences, comfort with language of instruction, competing responsibilities and learning goals, academic self-concept, achievement experiences, perceptions of authority, and idiosyncrasies" (Parchoma, 2003. p40). Such learner profiles were used to select "course features and delivery modes" (Parchoma, 2003. p43). Target learners participated in the task analysis so that "the inclusion of options may allow learners to choose personalized learning activities and pathways" (Parchoma, 2003. p41). Besides task analysis, students also actively provided feedback on the effectiveness of scaffolding and self-monitoring strategies when the course was being designed and developed.

At the implementation phase, instructors interacted with each individual student and efforts were made to establish instructor-learner rapport. To foster "trust and caring" in the learning environment, not only the instructors offered "timely support and encouragement" to each individual, but also "opportunities for off-task student-to-student communication" were provided so that sense of isolation in learners could be overcome (Parchoma, 2003. p41). Finally, deliberation was exercised in the evaluation phase, "LCD emphasized formative rather than summative, iterative rather than periodical, and lateral rather than hierarchical evaluation strategies" (Parchoma, 2003. p41).

Two courses were designed, developed and piloted in two different institutions by utilizing the LCD design principles. These courses turned out to be a huge success on account of the unprecedented completion rate and positive remarks given by the students.

In conclusion, as the author termed it, "LCD is itself a work-in-progress" (Parchoma, 2003. p52). Five phases of ADDIE was not a once-and-for-all, but always ongoing, cyclic process: including leaner profile analysis, alignment of course structure, content, features, and delivery modes with learner's needs and desires, task analysis, constant user evaluation, continued revision based on evaluation and feedback…

**Analysis Of This Approach.**

It seems that individualized instruction means a lot of efforts for the instructor and instructional designers. Perhaps, it is not practical and economical to achieve at all. Yes, it is true that a lot of deliberations and considerations should be taken, but it might be the only strategy to win an edge over other designs in the online learning market.

This decision-upon-input mechanism doesn't mean everything is fluid. As Parchoma (2003) concluded at the end of the article, "many appropriate LCD choices are temporal and iterative. The basis for making LCD choices—matching detailed learner profiling and task analyses with effective pedagogical, administrative, and technological choices—remains relatively stable."(p52). The following section will present a successful adaptive "engine" that employs three models and metadata to design and deliver personalized learning.

**Adaptive Personalized E-learning**

Inspired by the Intelligent Tutoring Systems (ITS), Conlan, Wade, Bruen, & Gargan (2002) presented an engine, namely Adaptive Hypermedia Systems (AHS). By merging three models: content, learner, and narrative modeling, this engine is driven by metadata. The definitions of metadata and the three models are described in detail as follows.

The basic idea of the content model is that the engine should have a repository of reusable learning objects (LO). The learning objects must be fine-grained enough to be reusable, "the smaller the granularity of the content the greater potential exists for the LOs reuse" (Conlan et al., 2002. p102). In addition, each unit has to contain enough information so that each of them is meaningful and can be easily sequenced with other units to make a coherent and logical flow. Usually, each LO represents one learning objective. Another important concept in the content model is "candidate content group". "Each candidate content group contains learning objects that fulfill the same content requirement" (Conlan et al., 2002. p103). This way, the repository consists of clusters of LOs of similar content subject while the subject of each cluster is different from that of any other cluster.

Metadata in the content model "describe both technical and pedagogical aspects of the LO. This information is only useful to a course designer in selecting appropriate learning content, but can be used by an adaptive engine to select appropriate content where there may be many candidate LOs available to fulfill a learning or technical requirement" (Conlan et al., 2002. p101).

The learner model stores the predicted learner characteristics and pedagogical strategies. Some mechanism is used to "populate the model" (Conlan et al., 2002. p103), such as a pre-test or questionnaire, inquiring learners' prior knowledge, learning objectives, and learning style preferences. Such information is uploaded and stored in the model so that "the system can consult with the learner model to adapt the performance of the system to each student's characteristics" (Conlan et al., 2002. p103).

The narrative model decides what instructions should be delivered based on the information the system gathered from the learner, "the narrative model for a course describes the rules, developed by domain and pedagogical experts, which govern the range and scope of personalized course that the adaptive engine can produce for learners" (Conlan et al., 2002. p105). Congruency, coherency and contextualization are the three principles that the model follows. The course should be structured in the way that is congruent with expert's knowledge of the domain. The arrangement of learning objects should be coherent and can fulfill the learning goal of the user. Another important consideration of the model is contextualization, "to achieve effective learning this personalization should put the content in a context that the student can understand and to which they can relate" (Conlan et al., 2002. p103).

This adaptive hypermedia services were put into use for the design and delivery of an undergraduate computer course. Upon completion of the course, students were surveyed regarding to their perceptions and satisfaction level with the course. 87% of the students were happy with how the content was structured in the personalized courses, which indicated a huge success for the first trial of this design.

**Analysis of this approach**

One feature the author emphasized again and again in this system is that all decisions about the design and delivery of the course were made at runtime. The adaptive system was designed in the way that personalized instruction is created automatically in real time. This design approach bears a lot of similarity with Merrill's (1999) instructional transaction theory (ITT). The goal of ITT is to realize adaptive automatic instructional design in an interactive learning environment. The theory focuses on the following three aspects:

- ✓ The idea of transaction: transaction is algorithm-controlled interaction, in other words, the sharing of leadership between learner and instructor.
- ✓ Knowledge objects: knowledge objects are interrelated elements of knowledge. There are four kinds of knowledge objects: entity, property, activity and process.
- ✓ Classes of instructional transactions: there are 13 classes of instructional transactions, including: identify, execute, interpret, judge, classify, generalize, decide, transfer, propagate, analogize, substitute, design and discover.

The instructional transaction theory was a breakthrough towards realizing individualized instruction. However, the "expert" system of transactions that makes all the decisions regarding to the design and development of the instruction takes too many considerations into account. Thus, building such a system is too formidable a task for many instructional designers. Nevertheless, the success of this adaptive hypermedia system presented above may herald the real arrival of the era for individualized instructions.

## Several Principles of Individualized Instruction Design and Development

Based on previous literature and success stories, the following principles can be concluded as germane to the design and development of individualized instructions: 1). constant transaction/dialogue between the proctor, instructional designer and the learner (or shared control between learners and instructional designer, proctors); 2). breaking down domain content into meaningful units; structuring the units into a coherent flow and contextualizing the flow according to learner characteristics; 3). mechanisms of motivating learners; 4). metacognitive training to help students to develop self-direction.

**Transaction/dialogue And Shared Control**

Constant transactions between the proctor, instructional designer and the learner will equip the designer and proctor with rich information about a student's characteristics, needs, wants, learning styles, and desires. Dialogues between the two parties can easily form a feedback loop, so that the proctor can monitor the learner's progress and motivation level and therefore quickly adjust the instruction. Built based on Skinner's social constructivist theory, Keller's (1968) personalized system of instruction also involved a "high level of student-student and student-instructor interactions" (Pear & Crone-Todd, 2002). Beyond these pedagogical concerns, frequent dialogues can affect students emotionally and can help students to overcome the sense of isolation. Dialogue was proposed to be a very important variable for the independent learning in Moore's (1993) theory of transactional distance (Garrison, 2000). Learner involvement in distance instructional design conforms to concurrent distance design theories.

Garrison (2000) pointed out that there was an identifiable shift from structural to transactional theoretical framework and models. Among the transactional theories, "shared control was seen to be reflective of the transactional nature of an educational experience"(Garrison, 2000) (p7). Nevertheless, teacher-learner dialogue is not the end of the shared-control story. Control embodies much more meaning than that. "The control model places within the macro structural level of teacher, student and content the micro level transactional elements of proficiency (ability and motivation), support (human and non-human resources), and independence (opportunity to choose)"(Garrison, 2000. p7). Moreover, under such a shared-control circumstances, the learner should not only choose his/her learning objectives, but also can choose the pacing rhyme which is comfortable to him/her. The ability to allow student to self-pace his/her own learning was regarded as one of the defining features of a personalized system of instruction (PSI) (Grant & Spencer, 2003).

**Learning Units And Motivation Concerns**

Besides self-pacing, Grant & Spencer (2003) determined that "unit mastery requirement" to be another defining feature of a personalized system of instruction. "In a PSI course, content is separated into portions called units. To advance from one unit to the next, students must demonstrate that they have learned the unit's material" (Grant & Spencer, 2003. p2). The concept of breaking down learning contents into units coincides with the "knowledge object" idea in Merrill's instructional transaction theory and the idea of learning objects. It's not surprising to find this coincidence because it is much easier to organize small chucks of information than to rearrange a single, bulky piece of non-delineated material.

Different users can come to the instruction with a variety of differences, including prior knowledge and learning goal. One important method of sustaining students' motivation is to present topics they evaluate highly (Rheinberg, Vollmeyer, & Rollett, 2000). Proper structuring and contextualization are very important too because 1). the structuring of content units should reflect the expert's knowledge of the domain, so that no false presentation is offered to the learner; 2). it is possible to buttress students' motivation (one source of positive incentives is "the mental interaction with the learning material makes a coherent structure out of many linked details" (Rheinberg et al., 2000. p518)).

**Metacognitive Instruction**

The ability of self-regulation is seen as the one of "our most important quality as humans" (Zimmerman, 2000) (p13). The ultimate goal of higher education is to develop students into self-regulated learners. Helping students to attain self-regulation should be the goal of online learning as well. The introduction above about Merrill's transaction and shared control may have given readers an impression that the individualized instruction is designed rigorously according to the prescribed rules where instructors have complete control over the structure of the presentation. Based on their research findings, Lee & Gibson (2003) suggested, "it is desirable for students to have an opportunity to assume some direction related to their learning. Instructors should modify traditional authoritative roles and interact with participants in a facilitator role to create such an environment" (p185). As mentioned above, Dillon & Greene (2004) also advocated that we should teach learner how to learn. It is very desirable that a balance should be considered and achieved between structure and allowance for students' self-direction and –regulation in an individualized instructional design.

## Summary

This paper has reviewed efforts that have been made toward the design and development of individualized online instructions in higher education. Individualized instruction design should take into account students' differences, needs, desires and preferences, endorse learner-instructor shared control, promote transactions among different parties of users, instructors, and instructional designers, allow for easy modification of learning content, and warrant quick adjustment upon feedback from the leaner. In addition to these requirements, considerations should be given to motivation and metacognitive concerns.

## References

Bollet, R. M., & Fallon, S. (2002). Personalizing E-Learning. *Educational Media International, 39*(1), 39-45.

Carnwell, R. (2000). Approaches to Study and Their Impact on the Need for Support and Guidance in Distance Learning. *Open Learning, 15*(2), 123-140.

Conlan, O., Wade, V., Bruen, C., & Gargan, M. (2002). *Multi-model, Metadata Driven Approach to Adaptive Hypermedia Services for Personalized eLearning.* Paper presented at the the Second International Conference on Adaptive Hypermedia and Adaptive Web-Based Systems.

DeTure, M. (2004). Cognitive style and self-efficacy: predicting student success in online distance education. *The American Journal of Distance Education, 18*(1), 21-38.

Dillon, C., & Greene, B. (2004). Learner differences in distributed learning: Finding differences that matter. *Class handout*.

Garrison, R. (2000). Theoretical Challenges for Distance Education in the 21st Century: A Shift from Structural to Transactional Issues. *International Review of Research in Open and Distance Learning.*

Grant, L. K., & Spencer, R. E. (2003). The personalized system of instruction: Review and applications to distance education. *International Review of Research in Open and Distance Learning, 4*(2).

Kanuka, H., & Nocente, N. (2003). Exploring the effects of personality type on perceived satisfaction with web-based learning in continuing professional development. *Distance Education, 24*(2), 227-245.

Keller, F. S. (1968). Goodbye, teacher. *Journal of applied behavioral analysis, 1*, 79-89.

Lee, J., & Gibson, C. C. (2003). Developing self-direction in an online course through computer-mediated interaction. *The American Journal of Distance Education, 17*(3), 173-187.

Merrill, M. D. (1999). Instructional Transaction Theory (ITT): Instructional Design Based on Knowledge Objects. In C. M. Reigeluth (Ed.), *Instructional-Design Theories and Models: A New Paradigm of Instructional Design* (Vol. 2, pp. 397-424). Mahwah, NJ: Lawrence Erlbaum Associates.

Moore, M. (2002). Editorial. *The American Journal of Distance Education, 16*(2), 61-64.

Moore, M. G. (1993). Theory of transactional distance. In D. Keegan (Ed.), *Theoretical principles of distance eduation* (pp. 22-38). London: Routledge.

Neuhauser, C. (2002). Learning Style and Effectiveness of Online and Face-to-Face Instruction. *American Journal of Distance Education*, *16*(2), 99-113.

Parchoma, G. (2003). Learner-centered instructional design and development: Two examples of success. *Journal of Distance Education*, *18*(2), 35-60.

Pear, J. J., & Crone-Todd, D. E. (2002). A Social Constructivist Approach to Computer-Mediated Instruction. *Computers & Education, 38*(1-3), 221-231.

Rheinberg, F., Vollmeyer, R., & Rollett, W. (2000). Motivation and action in self-regulated learning. In M. Boekaets, P. R. Pintrich & M. Zeidner (Eds.), *Handbook of self-regulation*. London: Academic Press.

Sims, R. C. (2001). *From art to alchemy: Achieving success with online learning.*, from http://it.coe.uga.edu/itforum/paper55/paper55.htm

Thompson, M. M. (1998). Distance learners in higher education. In C. C. Gibson (Ed.), *Distance learners in higher education: Institutional responses for quality outcomes* (pp. 9-21). Madison, Wisconsin: Atwood Publishing.

Zimmerman, B. J. (2000). Attaining self-regulation. In M. Boekaets, P. R. Pintrich & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 13-37). London: Academic Press.

# Scaffolding Intercultural Collaboration through Constraint-based Discussion Forums

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**Abstract**

*This purpose of this study was to understand the impact of scaffolding through constraint-based discussion forum on high school student's intercultural collaboration and learning. A total of 35 intercultural collaboration dyads participated in this study. They engaged in a series of knowledge co-constructing discussions about understanding different classroom cultures, which was mediated by a constraint-based discussion forum. Findings reveal that there was a mismatch between the student's intention and their discussion message type, limited amount of interaction, and existing discrepancy between student's expectation and the goal of the project. Implications and suggestions for implementation of constraint-based discussion boards are discussed.*

## Introduction

The advent of telecommunication technologies has expanded our ability to interact with others from a distance in a more efficient manner. They have also enhanced students' learning experience of engaging in intercultural learning activities by providing the opportunity for direct communication and interaction with peers from other countries or cultures. However, simply pairing students up and assigning them collaborative tasks does not guarantee the yield of high quality conversations and favorable learning outcomes, such as knowledge that is co-constructed from both learners (Lu, W., Diggs, L.L., & Wedman, J., 2004). Moreover, creating shared understanding through consensus building is a complex cognitive task. Effective collaboration in knowledge co-construction occurs in the inquiry process of consensus building, which is manifested by students' elaboration, justification, and explanation of their ideas (Roth and Roychoudhury, 1992). In order to support the social negotiation of meaning making, it is essential to state the reasoning explicitly. Yet, not everyone is use to or is proficient in articulating his or her thinking. Thus, there is a need to scaffold people not only in how to negotiate effectively in co-constructing meaning but to also scaffold the ability to explicitly express one's own cognitive reasoning. Nevertheless, unlike face-to-face conversations where verbal and non-verbal cues are prevalent, such as a quizzical expression indicating the need for more elaborative description, in a computer-supported learning environment almost all communication is text-based. For this reason, scaffolding plays an even more crucial role in knowledge co-construction in online learning environments.

## Scaffolding in Online Discussions

In this study, two types of scaffolding were employed to promote shared meaning making and knowledge co-construction among learners in a web-based asynchronous conferencing environment. The first type of scaffolding is argumentation scaffolding. According to Jonassen and Remidez (2002) "argumentation is a fundamental process of social negotiation through informal reasoning (p. 237)." However, they further explained, that for collaborative groups to reason collectively, explicating informal reasoning is especially necessary in the process of the argumentation. In addition, they asserted that technology has the capability to facilitate such social negotiation by means of computer-supported collaborative argumentation (CSCA). Hence, Jonassen and Remidez identified constraint-based discussion forums as a type of CSCA scaffold in which they described as pre-structured forms of conversation that are imposed onto the discussion with pre-classified conversational attributes to fit the structure constraining the nature of verbal interactions among participants. Furthermore, unlike threaded discussion forums, constraint-based CSCA has the capability of embedding multiple prompting questions into a conversation through which learners are guided in externalizing their reasoning. Thus, constraint-based CSCA can be considered a method of operationalizing conceptual and strategic scaffoldings of informal reasoning.

The second type of scaffolding is collaborative knowledge-building. A model developed by Stahl (2000) that represented the cycle of personal and social knowledge building was adapted. However, in this study we only focused on the social knowledge building process. Basically, Stahl introduced a number of important phases in the process of collaborative knowledge-building in which it initially begins with learners' personal beliefs. Figure 1 is a diagram that shows the adapted Stahl model in addition with examples of argumentation scaffolding that can be implemented in a constraint-based discussion forum used in an intercultural learning activity. Hence, this study aimed to understand the impact of scaffolding through constrain-based discussion forum on high school student's intercultural collaboration and learning.

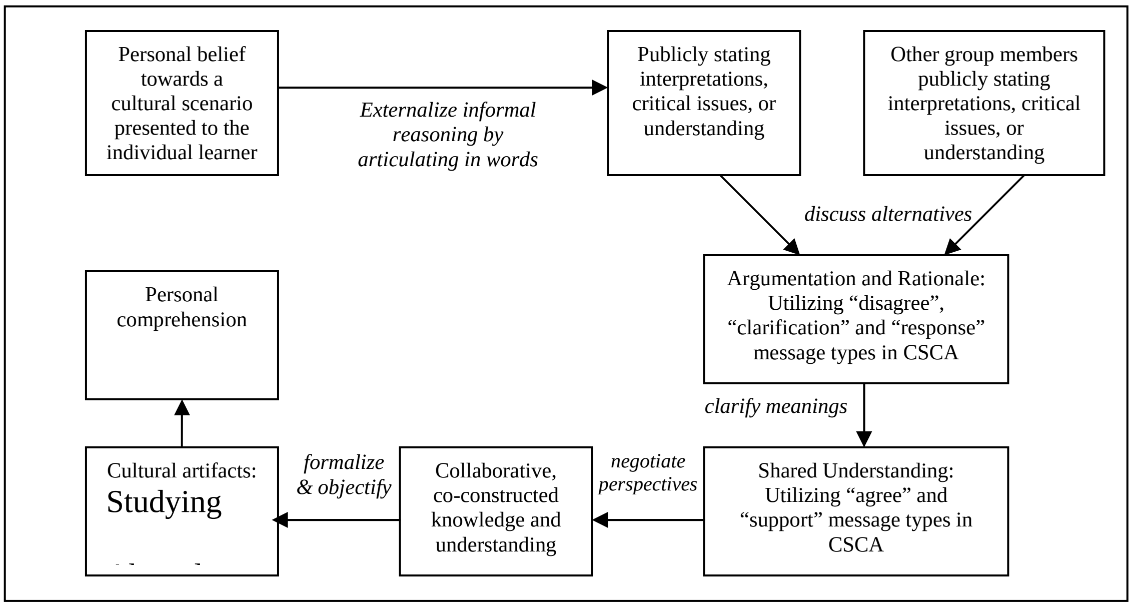


Figure 1. Adaptation of Stahl's model of the social knowledge-building process in CSCA

## Method

This study was part of a larger project, the Intercultural Communication Over the Net (ICON) project, which was a transnational collaborative project between one high school in the U.S. and two high schools in Taiwan that was facilitated in the beginning of the year 2004 by the College of Education at the University of Missouri - Columbia, USA and the Graduate Institute of Education in National Chiao Tung University, Taiwan. Similar to other transnational or international network projects via technology, such as emailing or video conferencing, the ICON project provided the opportunity for participating teachers and students to build local-to-global, cross-cultural understandings through the interaction and collaboration with people from another country or culture.

However, the ICON project was unique in the sense that constraint-based discussion boards were used as the primary tool for communication between the students. Moreover, the project researchers were not only responsible for creating the constraint-based discussion board topics and questions but they also designed and developed the interdisciplinary instructional materials that were used in the project.

### Participants

The participants consisted of 162 students (64 American and 98 Taiwanese) from three different high schools in the US and Taiwan. They were randomly assigned to one of the two conditions; either collaborating with a learning partner from the same culture or collaborating with a learning partner from a different culture. In this study, we only focused on the interaction between the students that were assigned to the intercultural collaboration dyads, which were 35 dyads in total. The participants from Taiwan were students enrolled in an English class and the participants from Missouri were students enrolled in a Theology and Social Justice course. Also, both the Taiwan and American participants were provided with Tablet PCs that had wireless Internet access and they all possessed sufficient computer skills.

**Materials: Collaboration Task**

The main objective of the project was to introduce the students in a systematic way to different cultural traditions and norms as compared to their own so to foster intercultural insight, understanding, and sensitivity. Moreover, it was also decided that the context would easily relate to real life experiences so that the students were encouraged to examine and reflect on their own perspectives, attitudes and cultural background. Therefore, the overall theme for the instructional activities was “Going abroad to study” and the sub-topic was “Classroom Manners”.

At first, the students were shown a video clip presenting a scenario of a prospective exchange student preparing to study abroad (i.e., either Taiwan or America). In the scenario, the prospective exchange student had asked advice from a classmate that was a former exchange student. The conversation between the two students ended with a statement made by the former exchange student in regards to cultural differences in classroom settings. After watching the video clip, the students were then asked to; 1). interpret the meaning of the statement made by the former exchange student, 2). suggest what questions should the prospective exchange student ask, and 3). seek answers to the three most important questions. At the end of this activity, the students were asked to work together to create a web page displaying the outcome of their collaborative discussions.

**Procedure**

Prior to working on the instructional unit, the participants were instructed on the use of the constraint-based discussion board. They also spent a few weeks practicing with a warm up discussion board activity (i.e., What’s in a name?) in order to not only get themselves familiarized with the networked learning system but to also acquaint themselves with their learning partners from the other culture. Three constraint-based discussion boards regarding the main topic “Classroom Manners” (i.e., Understanding why, Asking questions, and Answers for the questions) were then set up with minor differences in terms of message types and structures.

The instructional module was carried out for three weeks. Every student was required to login to the system to check the discussion boards every other day. At the end of the first two weeks, each dyad had to reach a consensus regarding the content of their collaborative discussions. In the third and last week, each dyad had to then collaboratively create their final product, which was a “Going abroad to study Q&A” web page, based on their co-constructed knowledge and understanding.

**Context: CSCA Environment**

The scaffolded discourse environment used in the study was modified from a threaded asynchronous conferencing forum. When creating a new discussion forum in this environment, the instructors were able to define the message types, create the input format, establish prompting questions for each message type, and specify the relationship between the message types. Instructors had the flexibility of creating the structure based on the objectives of the instructional units. Figure 2 shows one of the structures that were implemented in the study. In this example, 7 types of message were created.

When posting messages to the constraint-based discussion board, students first need to choose a message type in order to initiate the discussion; then they are required to type in their message content according to the prompting questions. The available message types depended on the type of the message that they were replying to. For instance, figure 3 shows an example of the pre-structured conversation form. The constraint of replying message types and the guidance of message content enforced students to carry out informal reasoning and explicitly express their thinking.

**Data Collection and Analysis**

Data was collected through three main sources, which were observation from the constraint-based discussion boards, students’ final web pages as artifacts, and the focus group that was conducted after the instructional module was completed. The data analysis strategies used in this study included content analysis, artifact assessment, and inductive analysis. The body of discussion threads were collected and analyzed by a framework adapted from van Boxtel (2001/2002) including the amount and type of student discourse about the problems that has to be solved, individual statements, positions related to the individual statements, elaboration, clarification request, and explanation. The students’ web pages were graded using a rubric generated by the researchers. The focus group transcription was aggregated, open coded, and consequently themes had emerged.

| Message Type | Description | Prompt Questions |
|---|---|---|
| Interpretation | Please use this message type to post your | In your own words, please write |

| | | |
|---|---|---|
| | interpretation regarding what Jenny (character in the scenario) said. | down one of your interpretations. |
| Disagree | Please use this message type if you disagree with the posting. | What do you disagree with?<br>Why do you disagree with it?<br>How would you revise the interpretation? |
| Agree | Please use this message type if you agree with the posting. | What do you agree with?<br>Why do you agree with it? |
| Clarification Request | Please use this message type if you do not understand the posting and need more information about it. | What part did you not understand? |
| Others | Please use this message type if you have something to say but does not fall into the other types. | What other things did you think of? |
| Response | Please use this message type if you want to reply to a clarification request. | Please answer the questions that have been addressed by your learning partner. |
| Support | Please use this message type if you want to add an idea or comment to a posting that you agree with. | Please give an example or comment that support what has been written. |

Figure 2. An example of message types, description of the types, and associating prompt questions

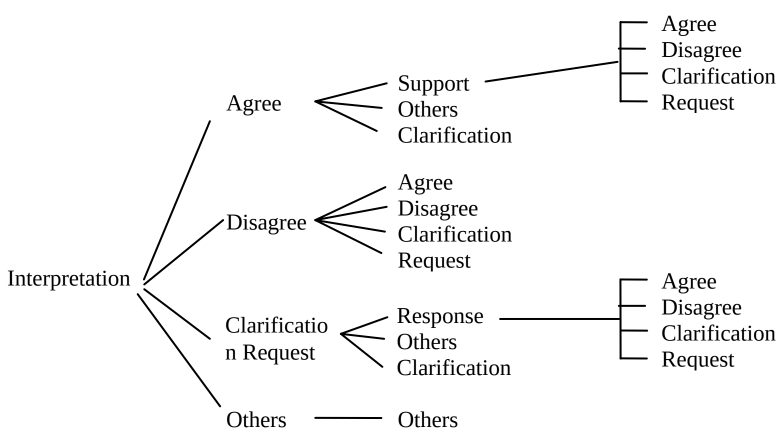


Figure 3. Structure of the relationship among message types

**Results and Discussion**

Mismatching of student intension and message type. From the observation of the discussion threads, we found that the students did not select the appropriate message type that correctly reflected their intention statements. Figure 4 is an excerpt from the discussion board where students were asked to interpret what they thought was the meaning behind the statement made by the former exchange student in the video clip. Student A provided his own interpretation of the following statement "American students talk more than teachers in class", and student B replied to student A's interpretation based on her own learning experience in American classrooms. However, it seems that the second message made by student B, in which she selected 'others' as the message type, could be classified as a 'disagree' message posting instead. Another phenomenon we found was that in some messages, the students did not provide statements in answer to each prompting question. Therefore, the embedded prompting questions did not seem to enforce the students to externalize their thinking.

In the second discussion board (Classroom Manners: Asking Questions), we found that the students did not follow the task instructions accordingly. The main task for this discussion activity was that students had to think of three questions that would be most helpful for an exchange student to ask prior to going abroad to study. Afterwards, they must then come to a conclusion of the three most appropriate questions. However, the statements in the discussion threads did not match the message type. In addition, students tended to answer their own questions instead of negotiating with their learning partner on which questions were the most important. One possible explanation was that students were not utilizing the tools proficiently. It seems that students had no mental model of the discussion board structure. We suggest that future research on constraint-based discussion boards should provide the big picture of the structure so that students will be able to know in advance what message and responding types are available. This idea is similar to procedural scaffolding, a form of scaffolding identified by Hannafin, Land, and Oliver (1999) for learning in an open-ended learning environment. Based on their classification of scaffolding, implementation of constraint-based discussion boards need not only the conceptual and strategic scaffoldings, but also the procedural scaffolding as well.

| | | |
|---|---|---|
| Student A (Taiwan) | Tue, Apr 20, 2004 11:27:21 AM | Message type: Interpretation |
| Prompt: In your own words, please write down one of your interpretations.<br>Because it’s different leading business in class. In America students are the most important roles in class. But In Taiwan is contrary. So they talk more than teacher. | | |
| Student B (American) | Mon, Apr 26, 2004 8:01:35 PM | Message type: Others |
| Prompt: What other things did you think of?<br>Although it is true that students in America may speak more in class than students in other countries, it is not a matter of disrespect. In America, we learn better when we participate and take part in class discussion. | | |

Figure 4. An example of discussion threads

Limited amount of co-constructed knowledge. From the analysis of the final “Going aboard Q&A” web pages, we found that the student pairs separately listed two sets of questions and answers. It was discovered that the students answered their own questions without any negotiation with their learning partner. Therefore, there was limited evidence of knowledge co-construction between the students. This was supported by the observed low interaction in the discussion boards.

According to net etiquette, it is necessary to show courtesy by checking the discussion board regularly and providing timely responses, especially when students are involved in knowledge co-construction activities that require interaction. In figure 4, the original message and the reply message had a six-day time lapse. This did not occur just in this example. Unfortunately, the lack of timely response was commonly observed across all the boards. From the focus group interview, some students expressed that at the beginning they were very excited to participate in the warm up activities, but late or lack of timely response had then discouraged them. Besides, the experimental learning module was carried out during the regular semester. Although we had tried to integrate the learning module into their course curriculum, participants from the schools still had a limited amount of time that could be devoted to this learning experience.

In addition, the teachers had emphasized too much on completing the final product rather than focusing on the importance of the learning process. Originally, the objective of the activity was for the students to bring up and share their own three questions (totaling six questions for each dyad) and then decide together on which three of the six were the most important questions to address. The value of the task was the process of negotiation between the students in trying to come to a consensus on what was important to know. However, due to the lack of time and teachers’ misguidance in pushing students to quickly complete the task, the students did not co-construct their knowledge but just combined what they each knew into one artifact.

Discrepancy between students’ expectation and the goal of the project. In the focus group, some students expressed that their expectation of this project was not fulfilled. They felt that the constraint imposed on the discussion board had actually inhibited their learning. Their first impression and expectations of this project was to make friends from other cultures and to satisfy their curiosity about the current life style in Taiwan/America. Once students found out that there was a specific task that required them to work on more than simply sharing ideas, some of them did not seem to be truly engaged in the learning activity. It is suggested that empowering and encouraging students to have some chitchats might stimulate them to develop intimacy with their learning partner, which might promote more interaction and negotiation on a given task.

## Conclusion

This study examined the impact of scaffolding through constraint-based discussion forum on high school student’s intercultural collaboration and learning. The findings suggest that other than conceptual and strategic scaffoldings, students also need procedural scaffolding (Hannafin, Land, and Oliver, 1999), which can help them utilize a constraint-based discussion forum more adequately. Besides taking the nature of the task into account, offering pre-experiment training, providing sufficient amount of time, and emphasizing net etiquette, should lead to increased amount of discussion board interaction. Moreover, in order to highly engage students in performing a task, understanding the students' needs and expectations are also important issues to consider.

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**References**

Hannafin, M., Land, S., & Oliver, C. (1999). Open learning environment: Foundations, methods, and models. In C. M. Reigeluth (Ed.), Instructional-design theories and models: A new paradigm of instructional theory, Vol. II, (pp. 115-140). Mahwah, NJ: Lawrence Erlbaum Associates.

Jonassen, D., & Remidez, H. (2002). Mapping alternative discourse structures onto computer conferences. In: Proceedings of Computer-Supported-Collaborative Learning (CSCL) Conference, Denver, CO, USA, 237-244.

Lu, W., Diggs, L.L., & Wedman, J. (2004). Building cross cultural partnerships through the Internet: What works and what doesn't. In: Proceedings of the World conference on Educational Multimedia, Hypermedia & Telecommunications (Ed-Media 2004), Lugano, Switzerland, 4782-4786.

Roth, W.M., & Roychoudhury, A. (1992). The social construction of scientific concepts or the concept map as conscription device and tool for social thinking in high school science. Science Education, 76(5), 531-57.

Stahl, G. (2000). A model of collaborative knowledge-building. In B Fishman & S. O-Connor-Divelbiss (Eds.), Fourth International Conference of the Learning Sciences (pp. 70-77). Mahwah, NJ: Lawrence Erlbaum.

van Boxtel, C., & Roelofs, E. (2001/2002). Investigating the quality of student discourse: what constitutes a productive student discourse? Journal of classroom interaction, 36(2)/37(1), 55-62.

# Instructional Design Model for Online Certificate Programs (OCEP-ID)

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**Abstract**

*The use of the internet to deliver education has increased dramatically over the last decade. There are many statistical results that prove this information. Educational institutions offered distance education courses additional for each year. In addition, institutions offered degree and certificate programs over the Internet. Therefore, two online certificate programs will be analyzed and then instructional design model for online certificate programs will be proposed in this study.*

## Introduction

There has been a tremendous problem around the world in recent years. This problem is related to rapidly changing profile of human resource in many fields. For example, a half life of an engineer's technical skills was reported in Smerdon's article (1996). Half life refers to the length of time it would take for half of everything an engineer knew about his/her field to become obsolete. It takes 7.5 years for mechanical engineers, 5 year for electrical engineers, and 2.5 years for software engineers. It is clear that job and carrier changes come more frequently for today's adults than ever before.

Human capital needs include requirements for employees to develop their skills, to adapt rapid change in the work place, and to bring innovation into solving problem. Organizations, private sectors, and universities are trying to supply the demand for qualified employees in many countries. Thus technical training, graduate programs, and certificate programs are provided in many ways for students and employees.

One of the effective ways to educate people especially adult is through online learning. Because, it is suitable for especially working adults who work fulltime and seek for continuous education as a part-time student and allow them to achieve their goals.

It can be concluded that offering online certificate programs is one of the reasonable way of updating employees' knowledge and skills, and providing improvement opportunity for life-long learners.

## Purpose and Intend

Two online certificate programs (Online Information Technologies Certificate Program, E-Course Certificate Program) are investigated in this study. Both have similar design properties but we are not sure that there is an exact model that is followed while they were developed. Although there are some models used for online learning, we could not find any specific model devoted to developing online certificate programs. In addition, Gustafson and Branch (1997, p. 78) states that "most authors completely ignore mentioning the conditions under which their models should be used". Therefore, we have tried to develop a new ISD model for online certificate programs based on ADDIE (Beckschi & Doty, 2000) and Rapid Prototyping model (Tripp & Bichelmeyer, 1990).

## OCEP-ID Model

OCEP-ID Model explains process that provides a means for decision making to determine who, what, when, where, why, and how questions of online certificate programs. The followings are the steps of our model (Figure 1);

- General Analysis (problem, need, audience, task, job, content)
- General Design (objectives, instructional analysis and strategies, evaluation)
- Prototype Loop
  - Design
  - Development
  - Implementation
  - Evaluation
- General Evaluation (Summative)

As mentioned earlier, this model was created with help of ADDIE and rapid prototyping of Instructional Design Models. ADDIE is broader model and it is not developed for online learning. However, we thought that it defines the necessary steps to develop an ISD model as it is systematic and well-defined. We have changed development and implementation phases of ADDIE model with “Prototype Loop”, which was designed by using of Rapid Prototyping model.

Before offering a certificate program for a certain profession, you should ensure that there is a real problem due to the lack of certain qualified staff in that specific profession. The existence of such a problem should be extracted from society through several methods, such as communicational channel, field trips, research outputs, trends, reports, etc. The exact problem should be stated explicitly based on interpretation of data indicating a real problem in local or global area. After stating the problem explicitly, next issue is whether we can solve the problem by means of the certificate program.

Once you determine to offer the certificate program, potential participants of that program should be decided. Their existing skills, demographic data, knowledge and attitude in cognitive, affective, and psychomotor domain should be analyzed. Therefore, you can specify the profile of potential participants (e.g. education level, language, etc.). It is crucial to find the ways for accessing them to introduce the certificate program.

In a certificate program, you know that the participants gain specific knowledge and/or skills about a profession. In this part, what will be included in the program in terms of content (what kind of knowledge and skill) should be clarified. Clarifying the content involves in conducting job and task analysis. The job analysis refers to observe the expert to break down job into tasks and prioritize tasks. Each task should be broke down into steps by prioritizing them through task analyses. With the reference of job and task analyses, content is derived, prioritized and sequenced.

With regard to preliminary analysis the main purpose of the certificate program should be clearly stated. The following phases of the design will be based on this purpose.

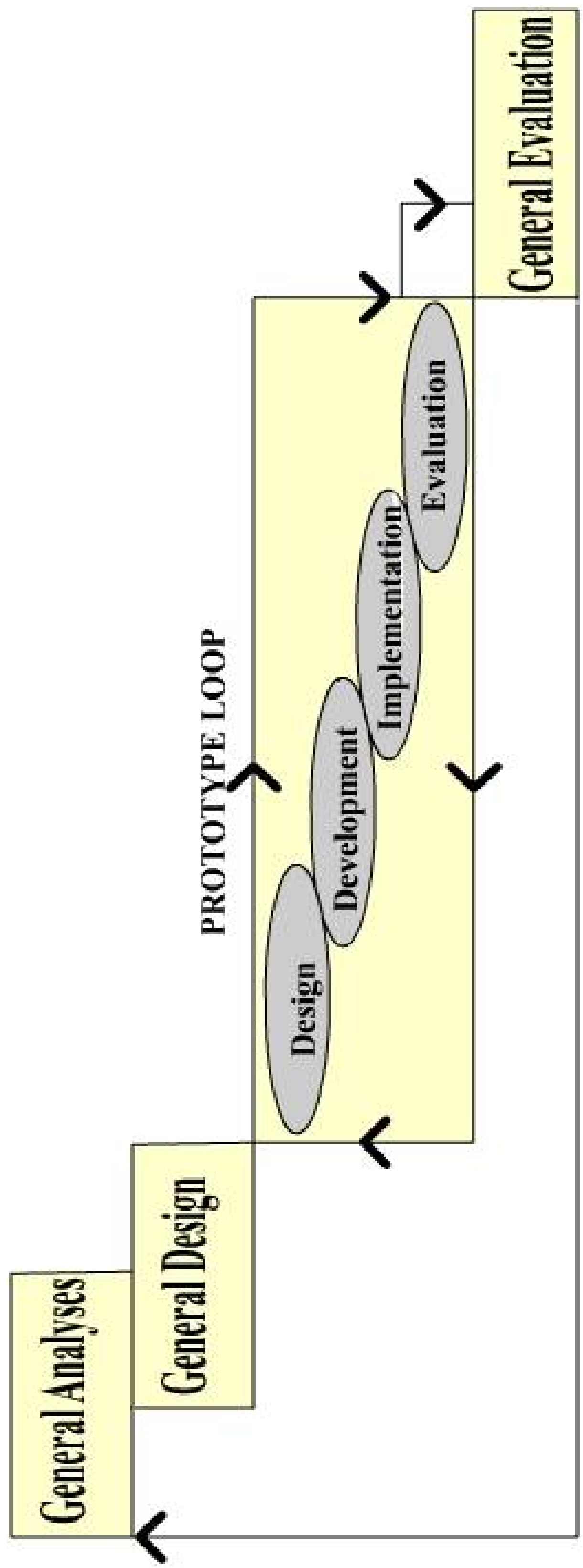


**Figure 1**: OCEP - ID

## General Design

Analysis and design phases overlap at some points. After defining problem, conducting need and audience analysis, you should start the design process as well. That is, they are parallel processes. Overall knowledge and skills to be covered in the program should be defined and be arranged in a proper sequence. The specified content should be divided into a number of courses according to the nature of the content and the target audience. The content load of the courses should be fairly distributed. General goals of each course are written explicitly, that is, what learners should be able to do when they finish each course. At this point the issues related to the program such as the length of the courses, the number of courses in each semester, the length of the semesters, the number of the semesters, and the length of the program should be decided.

General instructional strategy to be adopted and major evaluation strategies should be clarified. Instructional strategies should be developed based on course content and objectives as well as learner characteristics.

## Prototype Loop

Prototype Loop covers design, development, implementation and evaluation of each semester. It means that the content of the semesters are developed successively in this phase. To state more clearly, the courses in each semester are designed through one cycle of the Prototype Loop. Each of these steps goes on partially parallel with the prior and following step. Since each semester may consist of more than one course, the courses are designed in parallel in the prototype loop. In other words, going through the Prototype Loop once means that you design, develop, implement, and evaluate a semester.

### The components of Prototype Loop:

*Design:* In this step the following tasks should be done for each course for preparing a semester in the program;

- Content outline
- Specific objectives (what specific outcomes should be reached)
- Describe the set of materials you'll use
- Determine instructional strategies
- Decide evaluation strategies based on objectives, course content and instructional strategy.

*Development:* After describing objectives, materials, instructional strategies, and evaluation strategies for a semester, it is now time to develop/select them. There are advantages and limitations of using online learning environment. Therefore the materials should be selected from the market or developed based on these considerations. Some of examples are listed below:

- For presenting content; examples, simulations, animations, video, tutorial, interactive examples, summary, games, demonstrations,
- For supplying supported material; links, references, textbooks, handout,
- For preparing interface; images, site-map, help,
- For feedback; quizzes, homework, study guide
- For learner and program evaluation; tests, survey items, projects.

Using an infrastructure such as Learning Management System could be helpful in hosting all the components of the program.

*Implementation:* which techniques of instruction, what modes of instruction, which media, and which follow-up strategies will you employ to deliver instruction are the main questions in this step. No matter how well you develop instructional materials, the way you use them in instructional process determines the effectiveness of the instruction. In other words, unless you apply appropriate instructional strategies for your audience, you will most probably fail in achieving overall program goal. The audience may be heterogeneous in terms of their characteristics and almost all of them are adult learners. Therefore, andragogy is a major theory that helps us to construct all implementation steps including instructional strategy. Andragogy states that "adult learners take control of their education and want to opportunity to learn at their own page, at times and places compatible with the commitments of family, work, and leisure. Also, they demand relevant and applicable coursework and a learning environment that is supportive and collaborative." (Knowles, 1984, p.125)

So, the instructional strategies are selected among a variety of techniques and modes including problem based learning, collaborative learning, authentic learning, role playing, group activities, individualized instruction, discussion, etc. Note that most of the mentioned methods are mainly constructivist approach that is favorable for adult learning.

The customization is an important necessity for online learners. The industry requires huge number of employees who can take initiative, think critically, cope with teamwork, and solve problems. To meet this need of industry and life-long learners, educational programs have to focus on learning rather than standardization or sorting people. In other words the instructional design model should focus on helping all learners reach their potential through customization (Reigeluth, 1999).

The learner support and feedback system should be handled carefully to overcome the disadvantages of online learning environment such as lack of face to face communication. On time, correct, suitable feedback has great importance in order not to de-motivate learners. The learners should not be allowed to alienate. Additional full/part-time staff could be hired for this purpose as instructors may not deal with all the feedback requests.

The media selection is another important issue in implementation step. As the technology has advanced, the text based materials on the web are abandoned rather multimedia components such as, audio, video, simulation, etc. and the collaborative tools such as chat, discussion group, e-mail, audio/video conferencing are embedded into the instructional materials delivered online. Do not compel you to use all media where you need face to face communication. You may also arrange face to face sessions at the beginning and at the end of semesters. In fact, "the trend in technology application is toward hybrid courses, courses that combine some face-to-face time with online experiences; this is much the same as the trend in corporate training toward "blended learning." (Molenda & Sullivan, 2003, p.6).

*Evaluation:* this step is the last one in the Prototype Loop. This evaluation has two functions. First, it has summative evaluation function for the semester which the loop is used for developing. You decide the working or not working aspects of the term. This will affect the same semester of the following application of the certificate program such as updating content of the same course. Second, it has formative evaluation function which affects the following semester design such as increasing online chat hours in the courses to supply students' demands of more and longer chat sessions.

## General Evaluation

The evaluation is related to the overall system effectiveness. The data mainly come from Prototype Loop components, those are design, development, implement, and evaluate. For example, in each semester there might be complaint for page layout of the courses.

There is a need to learn to what extend the learners attain general objectives. Since this is a certificate program a project that covers all the program content could be assigned to assess overall effectiveness of the program.

## Conclusion

This model was prepared based on a real example (Online Information Technologies Certificate Program). The model is developed specifically for online certificate programs. Two paradigms which are objectivism and constructivism were used in this model. Instructional System Development model and Rapid Prototyping model (Tripp & Bichelmeyer, 1990) helped us during proposing this model. We tried to use advantages of these two models. Institutions, collages, universities who want to develop this kind of programs may use this model in their development phases. This model is first draft and can be tested and developed in other cases.

## References

Beckschi, P. & Doty, M. (2000) Instructional Systems Design: A Little Bit of ADDIEtude, Please. In G. M. Piskurich, P. Beckschi, & B. Hall (Eds.) The ASTD Handbook of Training Design and Delivery . New York : McGraw-Hill.

Gustafson, K. L. and Branch, R. M. (1997). Survey of instructional development models, third edition. Syracuse, NY: ERIC Clearinghouse on Information and Technology.

Knowles, M. (1984). The Adult Learner: A Neglected Species (3rd Ed.) Houston, TX: Gulf Publishing

Molenda, M. and Sullivan,M. (2003)."Issues and Trends in Instructional Technology: Treading Water" in Fitzgerald, M.A., Orey, M., and Branch, R.M. (ed's) Educational Media and Technology Yearbook 2003. Englewood, CO: Libraries Unlimited

Reigeluth, C. M. (1999). Instructional Design Theories and Models Volume II. New Jersey: Lawrence Erlbaum Associates.

Smerdon, E. (1996). Lifelong Learning for Engineers: Riding the Whirlwind, National Academy of Enginnering. The Bridge,Volume 26, Numbers 1 & 2 - Spring/Summer 1996. URL: http://www.nae.edu/nae/naehome.nsf/weblinks/NAEW-4NHMJL?opendocument

Tripp, S., & Bichelmeyer, B. (1990). Rapid prototyping: An alternative instructional design strategy. Educational Technology Research & Development, 38(1), 31-44.

# Productivity Differences between Exemplary and Average Performers and Its Implications to Trainers and Instructional Designers

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**Abstract**

*A recent trend in the human competency movement suggests that organizations should use the characteristics of exemplary performers as their standard for hiring and training their employees. The purpose of this research paper is to discuss the previous studies on differences between exemplary and average (fully-successful) performers and novice and expert performers. The findings provide useful implications for trainers and instructional designers in terms of what really distinguishes exemplary from average performers and the need for training people to reach the level of productivity closer to that of the exemplars instead of training people to reach merely minimum performance standards.*

## Introduction

White (1959) first introduced a human trait named competence. Since then, human competence has become an increasingly important topic in training and development. Much research has been conducted with an attempt to conceptualize and measure human competence. Gilbert (1978) suggested that there is a big difference between exemplars and average performers in their performance. He further provided a behavior engineering model that provided an explanation of the reasons for the performance differences. Other research studies provided different perspectives in terms of what really distinguishes exemplary from average performance. A recent trend in the human competency movement suggests that organizations should use the characteristics of exemplars as their standard for hiring and training their employees. Therefore, it is important to find out what makes the exemplars different from average performers. Several research studies on exemplary performers and their productivity differences compared to average performers are discussed below.

## Research Studies on Human Competence

### Gilbert's Human Competence

Gilbert (1978) provided a creative theoretic framework to describe, define and measure human competence. In the first leisurely theorem, he defined human competence as "a function of worthy performance (W), which is a function of the ratio of valuable accomplishments (A) to costly behavior (B)" (p. 18). He further explained that competence is a "social concept" since it is a judgment about the worthy performance (p. 29).

In the second theorem, Gilbert (1978) suggested that there is a big difference between individual performers in their performance. He distinguished people as exemplars versus typical performers and their performance as exemplary performance versus typical performance. He further discussed the notion of potential for improving performance (PIP) as the measure of competence, which is the ratio of exemplary performance to typical performance. PIP serves two functions: it shows how much competence we already have and how much can be improved. PIP and competitiveness are inversely related: the higher the PIP, the less competitive that person or group is; the lower the PIP, the more competitive that person or group is. Because there will always be new exemplary standards, PIP is a "dynamic" measure.

Gilbert (1978) defined exemplary performance as "the worth of the historically best instance of the performance" (p. 30). He later clarified this definition by defining exemplary performance as "the most sustained worthy performance that we can reasonably expect to attain" (p. 40). He explained that it need not be the performance of historically best performer because the exemplar's performance may be improved. He also clarified that the exemplar must be defined relative to a particular accomplishment because the exemplar for one accomplishment may not be the exemplar for another. Performance can be measures by three major requirements which are quality, quantity and cost (Gilbert, 1978).

In the third theorem, Gilbert (1978) examined the behavior cause of the differences in worthy performance between exemplars and typical performers. The behavior here refers to the instrumental human behavior that includes two aspects: repertory of behavior (P) and a supporting environment (E). He maintained that "for any given accomplishment, a deficiency in performance always has as its immediate cause a deficiency in a behavior repertory (P), or in the environment that supports the repertory (E), or in both. But its ultimate cause will be found in a deficiency of the management system (M)" (p. 76). Therefore, in order to improve a performer's competence, we need to decide if we should modify the person's repertory of behavior, or change the supporting environment, or do both. Gilbert further identified the components of the behavior repertory and the environment. The three aspects of behavior repertory include knowledge, capacity and motives, and the three aspects of environment include data, instruments and incentives. "There are great differences in what people accomplish, but small differences in their repertories of behavior" (Gilbert, 1978, p. 39). He suggested the analysis of the components of the behavior engineering model can be used to diagnose why exemplary performance is more than typical performance, and which behavioral component in the model causes the PIP. He claimed the deficiency in performance between the exemplars and typical performers either comes from its environmental support, or a person's behavioral repertory, or both.

During the process of diagnosing performance deficiencies, Gilbert (1978) suggested motives and capacity are usually the last two reasons which cause incompetence because they seldom are the major problems. He further explained that the behavior engineering model itself gives an order of the trouble-shooting process. We should first look at the environmental variables beginning with data. We ask the simple question: are there sufficient, informative, and reliable data to provide performers a guide to how they should perform and how well they have performed against a certain criteria? He pointed out improper guidance and feedback are the largest causes of incompetence. When we look at instruments, we ask the question: do the performers have the appropriate tools and materials to work with? Next, we look at incentives and ask the question is: are there incentives contingent upon good performance? Finally, we look at training as a possible solution to solve knowledge problem. He explained that the behavior engineering model provides different ways to look at behavior and to ask obvious questions in order to improve human competence. It helps to answer the question: what might we do to engineer superior performance or exemplary performance.

However, Gilbert (1978) pointed out that even if we have full knowledge of why the exemplars are superior compared with typical performers, and even if we give all performers the information, instruments, incentives, knowledge, and so on, of the exemplars, there will still be some variance in performance. Someone will still be an exemplary performer because of some inherent characteristics such as quickness, strength, intelligence and ambition. Someone will always find a better way of doing it, have some natural superiority, or have an unusual degree of motive to excel. Therefore, it is impossible to reduce PIPs to 1.0. That means, in some situations, you may train typical performers to reach the level of productivity closer to that of exemplary performers, but you may not be able to reach the same level of productivity of the exemplars.

When comparing human competence, Gilbert (1978) maintained that we should use exemplary performance as the standard of comparison. He pointed out that oftentimes, the average performance of a group of people is established as the standard. The result inevitably leads to mediocrity because it reduces the potential for improvement. Using the exemplary performance as a comparison standard suggests that all performers would achieve what the best have achieved without considering the difference of some inherent characteristics.

**McClelland's Job Competence Assessment Method (JCAM)**

McClelland (1973) challenged the value of intelligence testing and suggested that although intelligence is important to performance, it is other personal characteristics, such as motivation, that differentiate successful from unsuccessful performance in a job role. McClelland and his associates used a research process called Job Competence Assessment Method (JCAM) which is a rigorous empirical method for research the job requirements for exemplary performance and the attributes of the exemplary performers. They identified a list of characteristics of exemplary performers and the critical competencies that clearly differentiate the exemplary performers from the average performers. The competencies held only by the exemplary performers are those that distinguish exemplary from average performance (Dubois, 1993).

Klemp (1982) wrote, "Job competence assessment is a powerful new solution to a problem of how to hire and train people for maximum effectiveness … the best way to find out what it takes to do a job is to analyze the job's outstanding performers and then to study what they do that makes them so effectives" (p. 55).

**Spenser and Spenser's Generic Competency Models**

Spenser and Spenser (1993) summarized 20 years of research using the McClelland's Job Competence Assessment Methodology (JCAM) and provided generic competency models for entrepreneurs, technical professionals, salespeople, service workers and corporate managers.

Spenser and Spenser (1993) defined competency as "underlying characteristics of an individual that is causally related to criterion-referenced effective and/or superior performance in a job or situation" (p. 9). The underlying characteristics refer to five types of competency characteristics: motives, traits, self-concept, knowledge, and skill. According to Spenser and Spenser (1993, p.9-11) motives are "the things a person consistently thinks about or wants that cause action"; traits refer to "physical characteristics and consistent responses to situations or information"; self-concept is "a person's attitudes, values, or self-image"; knowledge is "information a person has in specific content areas"; and skill is "the ability to perform a certain physical or mental task." Among them, knowledge and skill are more visible and easier to develop, while motives, self-concept and traits are more hidden and more difficult to develop.

Spenser and Spenser (1993) called exemplars superior performers and defined superior performance as "one standard deviation above average performance, roughly the level achieved by the top 1 person out of 10 in a given working situation" (p. 13). They pointed out that it is differentiating competencies that distinguish superior from average performers.

Spenser and Spenser (1993) provided a generic competency dictionary, which defines the scoring criteria for the 21 competencies found most often, to differentiate superior from average performers in 286 studies of middle- to upper-level jobs. The 21 distinguishing competencies were categorized into six clusters. Achievement and action cluster focuses more on task accomplishment. It includes four competencies: achievement orientation; concern for order, quality and accuracy; initiative; and information seeking. Helping and human service cluster involves attending to other's needs, interest and concerns and working to meet those needs. It includes two competencies: interpersonal understanding and customer service orientation. The impact and influence cluster reflects individuals concern with his or her influence on others. It includes three competencies: impact an influence, organizational awareness and relationship building. Managerial cluster is a specialized subset of the impact and influence competencies, stating the specific intentions which are especially important to managers. It includes four competencies: developing others, assertiveness and use of positional power, teamwork and cooperation and team leadership. Cognitive cluster is related to the individual's effort to understand a situation, task, problem, opportunity, or body of knowledge. It includes three competencies: analytical thinking, conceptual thinking and technical/professional/managerial expertise. Personal effectiveness cluster reflects certain aspects of an individual's maturity compared to others in relation to work. It includes four competencies: self-control, self-confidence, flexibility, organizational commitment, and other personal characteristics and competencies. Each of the 21 competencies includes a narrative description and a list of full-scaled behavioral indicators ranging from average performance to superior performance. The range of competency levels reveals the differences between the average and superior performers.

In addition, Spenser and Spenser (1993) also presented a series of generic competency models which describe the specific competencies of the superior performers in technical/professional, sales, helping and service, managerial, and entrepreneur jobs. The importance of the competencies is different for each job position. For technical/professionals, achievement orientation is the most frequent distinguishing characteristic of superior technical contributors. For sales people and service workers, the most important competency is impact and influence. For managers, the competencies of impact and influence and achievement orientation are of the most importance. For entrepreneurs, the most important competencies include initiative, seeing and acting on opportunities, persistence, concern for high quality of work, self-confidence, monitoring and recognizing the importance of business relationship. Their findings showed that superior performance in different job positions are defined by a specific set of competencies and the importance of each competency is different for different job positions.

**Other Competency Studies for Various Job Positions**

There are several other studies focusing on specific job positions. Smith (1992) presented a research study which created a model to describe the ideal performance of executives in generic terms. The model described four executive competencies which were considered the most critical for exemplary executives. They include broad industry knowledge, self knowledge, "big-picture" thinking skills, and idea-generation skills.

Kangis and Lago (1997) pointed out two basic qualities or competencies for exemplary sales people suggested by Mayer and Greenberg (1964):empathy ("ability to feel") and ego drive ("ability to conquer"). Empathy refers to the individual's ability to think the way others are thinking, feel the way others are feeling, and react accordingly. Ego drive refers to the salesperson's quality that makes him/her want to make the sale for personal satisfaction and gratification. These two basic qualities make a top performer in sales.

Klenke (2002) described the specific competencies possessed by three women leaders: Ruth Simmons, Mary Kay and Oprah Winfrey. These competencies include transforming/transformational leadership, emotional intelligence and the ability to build trust.

Kasch, Greenberg, and Muenzen (2003) reported that six competency areas in hand therapy practice were identified through a survey study: scientific knowledge, clinical judgment/clinical reasoning, technical skills, interpersonal and communication skills, professionalism, and resource management. Among them, clinical judgment/clinical reasoning and scientific knowledge were of the most importance. Professional practice exemplars and continuum of competence from novice to expert were also identified.

**Kelley's Nine Strategies of the Star Performer**

Kelley (1998; 1999a; 1999b) used the term "star performer" to refer to exemplary performers. He claimed that there are no fundamental (appreciable cognitive, personal-psychological, social, or environmental) differences between stars and average performers. What makes the difference is how the stars use what they have in their heads, not what they have. Therefore, star performers are not born, instead, they are made. After 10 years of research and practice, he and his colleague discovered nine work strategies which are common to star performers, and these strategies proved to be effective in improving productivity. These strategies help to answer the question of what it takes to become a star performer. He asserted that star performers work very differently from average performers. Kelley (1999a, p. 31-35) identified nine strategies that star performers commonly use:

*1. "Initiative: Blazing trails in the organization's white spaces."* Star performers usually go above and beyond the accepted job description or everyday work routines to offer new, bold and value-adding ideas, while average performers usually think about ways to do their job better or to get noticed by upper management.

*2. "Networking: Knowing who knows by plugging into the knowledge network."* Star performers usually develop pathway to knowledge experts who can help them complete critical path tasks, and share their knowledge with others who need it. Average performers usually socialize with other people in order to help their career.

*3. "Self-management: Managing your whole life at work."* Star performers usually create opportunities, choose work which contributes to critical path and ensure high job performance. Average performers, however, focus on how to better manage their time and projects.

*4. "Perspective: Getting the big picture."* Star performers see things in a larger context and through the various viewpoints of customers, competitors, colleagues, and bosses. Whereas average performers see things only from their own perspectives and make sure their perspectives are valued.

*5. "Followership: Checking your ego at the door to lead in assists."* Star performers help organizations succeed while exercising independent, critical thinking on goals, tasks, and methods; whereas average performers only follow the guidelines of the job description.

*6. "Teamwork: Getting real about teams."* Star performers share with team members the group goals, commitments, work activities, schedules, and accomplishments and are positive contributors to group dynamics. Average performers, however, just want to be a part of the team and work cooperatively with others.

*7. "Leadership: Doing small "L" leadership in a big "L" world."* Star performers use their expertise and influence to get their colleagues together to accomplish important tasks. They help the group to create a clear vision, find the resources to accomplish the task and lead the project to successful completion. Whereas average performers think it as an inborn trait that allows them to be in charge and have the power to make important decisions.

*8. "Organizational savvy: Using street smarts in the corporate power zone."* Star performers distinguish it as knowing the competing interests in an organization, promoting cooperation, addressing conflicts, and accomplishing tasks. Average performers think it is a talent of getting themselves noticed by the right people and playing office politics.

*9. "Show-and-tell: Persuading your audience with the right message."* Star performers communicate with others in the most effective and user-friendly format in order to reach and persuade their audience. Average performers focus on getting noticed by upper management through their own image and message, instead of focusing on their audience.

Kelley (1998; 1999a; 1999b) suggested that for average performers to become star performers, they have to change the ways in which they do their work and work with others. The implication for trainers/instructional designers is to help people build skills in these nine work strategies common to star performers.

**Other Strategies Used by Star Performers**

Hanson (1993) suggested that star performers are believed to be strong communicators, negotiators and problem solvers. In order to become a star, you must have vision, take risks and have an entrepreneurial spirit. She summarized some strategies used by star performers (Hanson, 1993, p. 9):

*"Know the currency of your environment."* Stars always attend to company values, and follow the styles that management applauds.

*"Remake your image."* What makes the stars different from the average employees is their performance image. Stars are committed to growing instead of being satisfied with their existing status. They often ask for feedback from their superiors.

*"Visibility."* Star performers understand the importance of being seen, but they advertise their accomplishments without bragging.

*"Cultivate allies."* Star performers know how to show their disagreement in a pleasant way and how to convert critics into friends.

*"Continuing education."* Star performers always continue to develop themselves in order to improve their expertise and expand their knowledge.

**Sandberg's Interpretative Approach to Competence**

A different approach to examine and understand human competence at work, called an interpretative approach, was proposed by Sandberg (2000). He discussed three main approaches used to identify competence: worker-oriented approaches, where competence is defined as attributes possessed by workers; work oriented approaches, which emphasizes on worker attributes that are strictly work-related, such as the approach took by Spenser and Spenser (1993); and multi-method-oriented approaches, which suggest competence is composed of a specific set of attributes (Sandberg, 2000). He suggested these three approaches are essentially based on the scientific principles of the rationalistic research tradition. Sandberg (2000) argued that although the rationalistic approaches contribute to our understanding of competence, the view of competence as a set of attributes may confirm a researcher's own model of competence instead of capturing the workers' competence. In addition, the rationalistic approaches describe human competence indirectly and view it as composed of two independent variables: prerequisite worker attributes and work activities.

Sandberg (2000) then proposed interpretative approaches to competence which views competence as "constituted by the meaning the work takes on for the worker in his or her experience of it" (p. 11). Findings of his research suggest that instead of a specific set of attributes, it is the workers' conception of their work that organizes their knowledge and skills into distinctive competence at work. The workers' conception of work not only defines what competence he or she develops and uses, but also determines the hierarchy of competency at work. The findings challenge the traditional view of competence development as a linear progression from novice to expert and suggest that the change in conceptions of work is more fundamental to competence development. Sandberg (2000) suggested, instead of a specific set of attributes possessed by those exemplary performers, it is the variation in workers' perception of their work that explains why some people perform particular work better than others.

Sandberg's (2000) findings suggest a shift of focus for training and development activities from attributes to workers' conception of their work. Instead of transferring important attributes to workers who don't have them, training and development should focus on facilitating the development of competence through changing conceptions of work.

**Cognitive Mechanisms behind Expert Performance**

Hong (1999) suggested that cognitive psychologists have been investigating expert performance for a long time. Previous research includes the studies on chess expertise (e.g., W. G. Chase & Simon, 1973; de Groot, 1965) and novice versus expert performance in problem solving (e.g., Larkin, McDermott, Simon, & Simon, 1980). Recent research includes the studies on the role of deliberate practice in the acquisition of expertise (e.g., Ericsson, 1996; Richman, Gobet, Staszewski, & Simon, 1996). These studies tended to investigate the cognitive mechanisms behind expert performance. The expert here was defined as "someone who exhibits extremely competent performance or falls in the top 5% of performers in a domain; someone who performs at the level of an experienced professional" (Hong, 1999, p.244). Studies conducted by cognitive scientists (e.g., Rabinowitz & Glaser, 1985; Sternberg, 1998) revealed that "individual differences of cognitive capacity can be attributed to the qualitative and quantitative differences in amount, accessibility, and organization of knowledge, mental representations, accuracy and speed of information processing, and efficiency of cognitive strategies and metacognitive skills" (Hong, 1999, p.244).

Hong (1999) summarized the research findings on expert performance, which helped to identify the underlying cognitive mechanisms that distinguish experts and novices. These findings suggested four typical cognitive characteristics that distinguish experts from novices (p. 245-246):

"*Knowledge base and representations*." This refers to an individuals' domain knowledge. Research studies have shown that experts have better-organized, superior domain knowledge. The knowledge base of experts also includes extensive representations that help with problem solving, the solution process and other components (Richman et al., 1996). Chi, Feltovich and Glaser (1981) suggested experts categorize problems based on basic representations and methods relevant to solving them, while novices sort problems based on surface features.

Ericsson (1996) suggested experts can generate a complex representation of the problem and integrate it with their knowledge to select, evaluate, check and reason about alternative actions.

"*Cognitive/perceptual efficiency*." Previous studies have shown experts can solve problems that novices cannot solve or that experts can solve them more rapidly and accurately. Richman et al. (1996) suggested the thinking process has been automated so that they cannot solve problems without conscious attention.

"*Cognitive strategies*." Previous cognitive studies on novice versus expert performance in problem solving have revealed that experts and novices use different rules and strategies. Experts tend to work forward on problems that are easy for them and work backward on more difficult problems, while novices tend to work backward from the problem goal (Audet & Abegg, 1996; Larkin et al., 1980; Priest & Lindsay, 1992; Simon & Simon, 1978).

"*Metacognition/Self-regulated learning.*" Metacognition has been recognized as a key component which distinguishes experts from novices (e.g., Cheng, 1993; Schwanenflugel, Stevens, & Carr, 1997). Experts have better metacognitive skills such as planning, questioning and solution monitoring.

Hong (1999) suggested that the above characteristics may be required to explain the performance differences between experts and novices. However, how these characteristics interact with each other and what are their comparative importance to the performance still remain unanswered.

## Implications for Trainers and Instructional Designers

### Training for Excellence or Training for Mediocrity

The above research studies have very important implications for trainers as well as instructional designers. They help to answer the very key question in today's training and development: do we train people to reach levels of productivity closer to that of the exemplary performers or do we train people to reach merely minimum performance standards?

Zickefoose (1979) declared that we should stop designing training that produces only average performers. In order to stop training toward mediocrity, we should establish curriculum and assessment based on the optimum performance. Gilbert (1978) suggested using average performance as the standard will reduce the performer's potential for improvement, and therefore will inevitably lead to mediocrity. On the other hand, using exemplary performance as the standard suggests all performers would achieve what the best has achieved. Spenser and Spenser (1993) concurred with Gilbert and suggested organizations should use the characteristics of superior performers as their standard for hiring and training their employees. If they just select and train people to reach the current average level of performance it will be essentially mediocre.

Chase (1997) pointed out that most training programs today focus on improving the skills of inexperienced workers to meet the minimum level of job requirements instead of teaching them how to excel. She quoted what Dean Spitzer, the senior performance consultant in IBM Corp., said: "We tend to base our training on average performance, on mediocrity… rather than modeling mediocrity, let's use a model of excellence. As long as we have to do a job, why not do it exceptionally?" (p. 88). In today's increasingly competitive world, training for excellence will help organizations gain competitive advantage. Therefore, the goal of trainers and instructional designers is to train for excellence instead of mediocrity by using exemplary performance as the standard. It has become a recent trend in the human competency movement.

### Who are the Exemplars?

Exemplars are also called exemplary performers, top performers, superior performers, expert performers, outstanding performers, and star performers. They are also called high fliers and are regarded as the key to provide organizations with a competitive edge (Anonymous, 1995). An important task for trainers and instructional designers is to find out who are the exemplars.

Ellsworth (2000) pointed out that exemplars are not necessarily the best performers in a particular job, because they must be examples whose performance that others can emulate. Therefore, exemplars are not genius with inborn abilities that no one else has or workaholics who sacrifice for their jobs more than others. They are normal people who have achieved the best practices that can e duplicated and achieved by others.

Froiland (1993) summarized several methods to identify star performers. One method, suggested by Harless, was to first analyze the company goals and how individual accomplishments contribute to fulfill those goals. He also distinguished performance from knowledge and specified that star performer may not be the person who knows the most. Kelley (1999b) identified star performers as those who have been nominated by both the managers and their peers. Another method was employed at Du Pont. A group of "stellar" employees were selected from three disciplines, the group then identified key competencies possessed by star performers and nominated a group of workers who demonstrated those key competencies as star performers.

**What Makes Them Become Stars?**

Once the star performers are identified, trainers and instructional designers need to find out what makes the star performers different from average performers. It was suggested that star performers have "success systems" which help them perform better than average performers ("How everyone else can learn," 1976). The previous studies (Gilbert, 1978; Hong, 1999; Kelley, 1998, 1999a, 1999b; McClelland, 1973; Sandberg, 2000; Spenser & Spenser, 1993) have examined the "success systems" and provided different valuable insights on the reasons of the differences between exemplary and average performers. Trainers and instructional designers can use the results of these studies as a foundation to train and develop people to reach the level of productivity closer to that of the exemplars.

**Competency-Based Training Versus Traditional Training**

The competency-based training approach has been the current trend in training and development. It focuses attention on training or developing for "best-in-class" performers, trying to build individual competence to reach the level of exemplary performance specified in the competency models. The competency-based training approach requires trainers to focus on the conditions essential for exemplary performance instead of minimum performance requirements (Dubois & Rothwell, 2004).

The traditional training approach typically involves conducting a training needs assessment to identify what workers must know, do or feel to perform their job successfully, and then identify the gap between the performance requirements and what they actually know, do or feel. The purpose of training is to close the gap in order to reach the minimum performance requirements. The competency-based training, however, focused on building competencies beyond knowledge, skills and attitudes to include other personal characteristics, such as motivation, personal traits, that may distinguish exemplary from merely successfully performers. The purpose of training is to train and develop people to reach the level of productivity closer to that of the exemplary performers. The key questions trainers ask are: what are the essential working conditions for exemplars? What competencies must people process in order to rival the accomplishments achieved by the exemplars? Who is the audience of the training, and what reasonable assumptions can be made about how close those individual's characteristics are to that of the exemplars? (Dubois & Rothwell, 2004).

Dubois and Rothwell (2004) suggested that compared to the traditional training approach, the competency-based training approach has the advantages of describing how exemplary performers achieve their success and recognizing that there are dimensions to performance beyond knowledge, skills and attitudes. It is a more holistic approach. They also pointed out it is important to focus attention on training to build individual competence. First of all, it's highly individualized to meet individual learners' needs. Secondly, competencies provided increased focus on learning objectives and performance expectations. Thirdly, it allows learners to build competencies in a meaningful way to themselves. Fourthly, learners can identify many useful learning resources in different settings. Finally, this approach is practical when training is valuable in achieving organizational success.

**Strategic Systems Model (SSM) and Competency Modeling**

The competency-based training approach suggests that trainers and instructional designers should reexamine the traditional Instructional Systems Design (ISD) model to focus on competence-based training and development. The traditional ISD model is a systematic approach to training and instructional design and development. It is also called SAT (System Approach to Training) or ADDIE (Analysis, Design, Development, Implementation, Evaluation) (Clark, 1995). Dubois (1993) provided a Strategic Systems Model (SSM) by reinventing the traditional ISD model. The SSM focuses on creating and evaluating competence-based employee training and other performance improvement experiences.

The SSM adds the development of the competency models to define the worker's competencies. Rothwell (2002) pointed out competency modeling focuses on discovering the differences between the exemplary and average performers in the same job category. By using competency models as a foundation for training and development, trainers and instructional designers can recognize other alternatives for competency building than training alone (Dubois & Rothwell, 2004).

Spenser and Spenser (1993) also suggested organizations should use competency models which specify the competencies of the superior performers in the decision-making process of recruiting, placement, retention and promotion. These decisions are made by matching between the job competency requirements and person competencies. Competence-based selection has several advantages: help organizations gain competitive advantage, decrease turnover rate, identify people who have the potential to be promoted, greatly cut the new hire learning curve periods and help determine training needs at entry. During the recruiting process, organizations should focus on core competencies that are more likely to predict candidates' long term career success and are more difficult to develop through training; those core competencies are more cost-effective to select than to develop.

SSM and competence modeling has been widely accepted by trainers and instructional designers to establish competency-based employee training and other performance improvement requirements in organization settings (Dubois & Rothwell, 2004).

## References


Anonymous. (1995). Get to know high fliers. *Management Development Review, 8*(1), vii-viii.

Audet, R. H., & Abegg, G. L. (1996). Geographic information system: Implications for problem solving. *Journal of Research in Science Teaching, 33*, 21-45.

Chase, N. (1997). Borrow best practices for better training. *Quality, 36*(10), 88.

Chase, W. G., & Simon, H. A. (1973). The mind's eye in chess. In W. G. Chase (Ed.), *Visual information processing* (pp. 215-281). New York: Academic Press.

Cheng, P. (1993). Metacognition and giftedness: The state of the relationship. *Gifted Child Quarterly, 37*, 105-112.

Chi, M. T. H., Feltovich, P. J., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive Science, 5*, 121-125.

Clark, D. (1995). *Introduction to instructional systems design*. Retrieved October 10, 2005, from http://www.nwlink.com/~donclark/hrd/sat1.html#why

de Groot, A. D. (1965). *Thought and choice in chess*. New York: Basic Books.

Dubois, D. D. (1993). *Competency-based performance improvement: A strategy for organizational change*. Amherst, MA: HRD Press, Inc.

Dubois, D. D., & Rothwell, W. J. (2004). Competency-based or a traditional approach to training? *Training & Development, 58*(4), 46-57.

Ellsworth, J. B. (2000). Training or performance improvement? *Military Review, 80*(6), 2-8.

Ericsson, K. A. (1996). The acquisition of expert performance: An introduction to some of the issues. In K. A. Ericsson (Ed.), *The road to excellence: The acquisition of expert performance in the arts, sciences, sports and games* (pp. 1-50). Mahwah, NJ: Lawrence Erlbaum.

Froiland, P. (1993). Reproducing star performers. *Training & Development, 30*(9), 33-37.

Gilbert, T. F. (1978). *Human competence: Engineering worthy performance*. New York: McGraw-Hill.

Hanson, C. (1993, May 30). Want to be a star? Polish your skills and your image. *Chicago Tribune*, p. 9.

Hong, E. (1999). Studying the mind of the gifted. *Roeper Review, 21*(4), 244-252.

How everyone else can learn from the top performers. (1976). *Training, 13*(10), 72-75.

Kangis, P., & Lago, H. (1997). Using caliper to predict performance of salespeople. *International Journal of Manpower, 18*(7), 565.

Kasch, M. C., Greenberg, S., & Muenzen, P. M. (2003). Competencies in hand therapy. *Journal of Hand Therapy, 16*(1), 49-59.

Kelley, R. E. (1998). How to manage your work life (and become a star). *Training & Development, 52*(5), 56-61.

Kelley, R. E. (1999a). *How to be a star at work: Nine breakthrough strategies you need to succeed*. New York: Times Business.

Kelley, R. E. (1999b). How to be a star engineer. *IEEE Spectrum, 36*(10), 51-58.

Klemp, G. O. J. (1982). Job competence assessment: Defining the attributes of the top performer. In *The pig in the python and other tales* (ASTD Research Series, Vol. 8, pp. 55-67). Alexandria, VA: American Society for Training and Development.

Klenke, K. (2002). Cinderella stories of women leaders: Connecting leadership contexts and competencies. *Journal of Leadership & Organizational Studies, 9*(2), 18-28.

Larkin, J. H., McDermott, J., Simon, D. P., & Simon, H. A. (1980). Models of competence in solving physics problems. *Cognitive Science, 4*, 317-345.

Mayer, D., & Greenberg, H. M. (1964). What makes a good salesman? *Harvard Business Review, 4*, 119-125.

McClelland, D. C. (1973). Testing for competence rather than for intelligence. *American Psychologist, 28*, 1-14.

Priest, A. G., & Lindsay, R. O. (1992). New light on novice-expert differences in physics problem solving. *British Journal of Psychology, 8*, 389-405.

Rabinowitz, M., & Glaser, R. (1985). Cognitive structure and process in highly competent performance. In F. D. Horowitz & M. O'Brien (Eds.), *The gifted and talented: Developmental perspectives* (pp. 75-98). Washington, DC: American Psychological Association.

Richman, H. B., Gobet, F., Staszewski, J. J., & Simon, H. A. (1996). Perceptual and memory processes in the acquisition of expert performance: The EPAM model. In K. A. Ericsson (Ed.), *The road to excellence: The*

*acquisition of expert performance in the arts, sciences, sports, and games* (pp. 167-188). Mahwah. NJ: Lawrence Erlbaum.
Rothwell, W. J. (2002). Putting success into your succession planning. *The Journal of Business Strategy, 23*(3), 32-37.
Sandberg, J. (2000). Understanding human competence at work: An interpretative approach. *Academy of Management Journal, 43*(1), 9-25.
Schwanenflugel, P. J., Stevens, T. P., & Carr, M. (1997). Metacognitive knowledge of gifted children and nonidentified children in early elementary school. *Gifted Child Quarterly, 41*, 25-35.
Simon, D. P., & Simon, H. A. (1978). Individual differences in solving physics problems. In R. S. Siegler (Ed.), *Children's thinking: What develops* (pp. 325-348). Hillsdale. NJ: Lawrence Erlbaum.
Smith, M. E. (1992). The search for executive skills. *Training & Development, 46*(9), 88-95.
Spenser, L., & Spenser, S. (1993). *Competence at work: Models for superior performance*. New York: John Wiley & Sons.
Sternberg, R. J. (1998). Abilities are forms of developing expertise. *Educational Researcher, 27*(3), 11-20.
White, R. W. (1959). Motivation reconsidered: The concept of competence. *Psychological Review, 66*(279-333).
Zickefoose, R. D. (1979). Let's stop designing training that produced only average performers! *Training, 16*(5), 74.