Issues in Accounting Education
Vol. 15, No. 2
May 2000

The Motivation for Collaborative Discovery Learning Online and Its Application in an Information Systems Assurance Course

A. Faye Borthick and Donald R. Jones

ABSTRACT: This paper develops the motivation for collaborative discovery learning online and explains its application in a master's course in information systems assurance. In discovery learning, participants learn to recognize a problem, characterize what a solution would look like, search for relevant information, develop a solution strategy, and execute the chosen strategy. In collaborative discovery learning, participants, immersed in a community of practice, solve problems together. In collaborative discovery learning online, participants seek the knowledge they need and solve problems together in a virtual environment. For this purpose, virtual environments are characterized by web-based access to resource materials and participants' work and web-based discussions occurring in real time (synchronously). This approach to learning prepares students for work environments in which new problems are the norm and professionals work collaboratively to solve them in virtual spaces. The paper makes a case for the course being more effective than lecture-based instruction because of its use of collaborative discovery learning online, more accessible because participants may be anywhere they have Internet access, and more affordable if the development and delivery efforts could be leveraged across multiple universities.

INTRODUCTION

This paper develops the motivation for collaborative discovery learning online and explains its application in a master's course in information systems assurance.[1] In discovery learning, participants learn to recognize a problem, characterize what a solution would look like, search for relevant information, develop a solution strategy, and execute the chosen strategy. In collaborative discovery learning, participants, immersed in a community of practice, solve problems together. In collaborative discovery learning online, participants seek the knowledge they need and solve problems together in a virtual environment

[1] In the course, information systems assurance means providing assurance services for highly computerized information systems, where assurance services are "[I]ndependent professional services that improve the quality of information, or its context, for decision makers" (AICPA 1997).

A. Faye Borthick is a Professor and Donald R. Jones is an Assistant Professor, both at Georgia State University.

The authors are indebted to Harry Dangel, Walter Herndon, anonymous reviewers, Editor David E. Stout, and Associate Editor Jeffrey Cohen for helpful comments.

that enables web-based access to resource materials and participants' work and web-based discussions occurring in real time (synchronously) and sequentially (asynchronously) over the Internet.

Collaborative discovery learning online was applied in a master's course in information systems assurance at Georgia State University. Students solved problems, based on progressively richer contexts, such as preparing lists of risks, evaluating internal control, creating assurance plans, and implementing assurance plans. For each class session, students prepared their solutions to the assigned assurance need, published them where all participants could have web access to them, and developed a group solution during synchronous discussion. When they were available, professional auditors joined the synchronous discussions.

The article argues that the course implemented as collaborative discovery learning online is more effective than lecture-based instruction for developing problem-solving skills, more accessible because participants may be anywhere they have Internet access, and more affordable to universities and students if the development and delivery efforts could be leveraged across multiple universities. This approach to learning also prepares students for work environments in which new problems are the norm and professionals work collaboratively to solve them in virtual spaces.

The article is organized into the following sections: a motivation for collaborative discovery learning online, an argument for the course as collaborative discovery learning online being more effective than lecture-based instruction, arguments for collaborative discovery learning online making education more accessible and affordable, and approaches for assessing collaborative discovery learning online.

MOTIVATION FOR COLLABORATIVE DISCOVERY LEARNING ONLINE

This section develops the concept of collaborative discovery learning online by integrating (1) theories in cognitive and social learning and (2) market forces that flourish in networked computing environments. The cognitive learning theory is that effective problem solving entails discovery learning. The social learning theory is that collaboration in a community of practice prompts learners to develop problem-solving skills. With respect to market forces, organizations cannot resist using networked computing, symbolized by the Internet, to achieve the operational flexibility associated with increasing their responsiveness to constituents.

Cognitive Aspects of Learning

Learning theorists characterize learning to solve problems as "discovery" learning, in which participants learn to recognize a problem, characterize what a solution would look like, search for relevant information, develop a solution strategy, and execute the chosen strategy.[2] In this characterization of learning as problem solving, specific facts are irrelevant until they need to be brought to bear on a particular problem. In problem solving, the acquisition of facts ceases to be the principal learning activity. Instead, the focus is on how well one can formulate and evaluate problem representations and match information to aspects of the

[2] Different aspects of this process appear in Anzai and Simon (1979); Kulkarni and Simon (1988); Dunbar (1993); Norman and Spohrer (1996); Brandt (1997); Okada and Simon (1997); Sabelli (1998); Schank (1998).

problem during the search for a solution. This puts the premium not on what one remembers but on how well one can characterize relevant information, find required information, manipulate relationships, shift between problem representations, and make inferences. According to this theory, developing one's ability to solve problems in a given domain should prepare one for approaching *any* problem in the domain, not just those currently being solved in the classroom (Mallach 1996).

Social Aspects of Learning

Learning, however, is as much a social as an individual cognitive phenomenon (Vygotsky 1978, 1986; Roschelle 1992; Scardamalia and Bereiter 1994; Harasim et al. 1995; Wenger 1998). An implication of learning as a social phenomenon is that educational courses designed to transfer knowledge in discrete, tidy units in a classroom are not good preparation for enabling participants to contribute to organizational goals that cannot be well specified in advance, e.g., providing assurance for systems that deploy advances in information technology in unanticipated ways. Instead, learning events ought to prompt participation in the communities of practice[3] the learners are entering. In a community of practice, members of a group learn from each other by working together as they develop a common sense of purpose, including a common way of thinking about how work gets done and what is necessary to accomplish a task. In this mode, learners "situate the decomposed task in the context of the overall social practice" (Brown and Duguid 1993, 12). This means that instead of being simply lectures, learning events would be designed "so that newcomers can legitimately and peripherally participate in authentic social practice in rich and productive ways—to, in short, make it possible for learners to 'steal' the knowledge they need" (Brown and Duguid 1993, 11). This kind of participation is known as legitimate peripheral participation (Lave 1991; Lave and Wenger 1991).[4] The peripheral aspect of the participation connotes newcomers' mastery of knowledge and skills as they develop into fully participating members of a community.

In many work environments, new problems are the norm and groups of professionals work together to solve them (Schrage 1990; Brown and Duguid 1991, 1993, 1998; Gundry 1992; Nonaka 1994; Macdonald 1995; Vega and Lacey 1996; Leidner and Fuller 1997; Raelin 1997). Combining the cognitive and social aspects of learning leads to the premise that immersing learners in a community of practice in which they solve problems together (collaborative discovery learning) is more likely to be effective in preparing students for the current work environment than learning events characterized by teachers standing in front of classes dispensing knowledge—the "sage on the stage" model. That is, it is more important to help students learn how to find or create knowledge as they need it and to negotiate its meaning within the community of practice rather than

---

[3] *Communities of practice* signifies "a theory of learning that starts with this assumption: engagement in social practice is the fundamental process by which we learn and so become who we are. The primary unit of analysis is...the informal 'communities of practice' that people form as they pursue shared enterprises over time" (Wenger 1998, iii).

[4] Cognitive scientists agree that human cognition has both cognitive and situational aspects, although they do not always reach consensus on how the two aspects should relate to each other, as discussed in a special issue of *Cognitive Science* 17(1) (1993) on situated action.

to teach them only what the teacher believes they need to know now.[5]

Market Forces

As soon as one company creates a competitive advantage for itself through adroit use of information and communications technology, other companies have strong incentives to do likewise. The cascading effect of companies doing likewise then creates competitive pressures for other companies to follow suit lest their customers move to trading partners that they deem to be more responsive to their needs. Because these competitive advantages have not been sustainable over the long run, even first movers are compelled to make even more effective use of information technology (Deibert 1997).

In the current business milieu, the premium is on companies that are able to use information networks to configure production chains to take advantage of opportunities for economies of scale and scope and of the locations of human talent, raw materials, suppliers, and markets (Castells 1996). For example, once Dell Computer Corporation demonstrated how to take orders online and then orchestrate production for each customer, carmakers tried to figure out how to do likewise (McWilliams and White 1999). General Motors Corporation and Ford Motor Corporation are independently creating online supplier networks for all the goods and services they buy (White 1999). In addition to using the networks for their own purchases, the carmakers want their suppliers to use the networks to do business with each other. For example, the carmakers intend to lower their costs by buying steel for resale to their suppliers, thereby forcing steel companies to accept lower prices (Matthews 1999).

The cascading effects of competitive use of information networks begetting even more competition also apply to companies' investments in their intellectual capital. The existence of networks that have become the actual production chains has spawned the growing need for more education for employees and for more continuing education for them. The traditional providers of education have been universities. Evidence is accumulating, however, that universities' quasi monopoly as purveyors of education and educational credentials is eroding (Vedder 1998; Katz and Associates 1999). Signs that universities are not fulfilling all the educational needs of employers are manifest in articles and books chronicling companies' attempts to transform themselves into team-based learning organizations.[6] Another sign of unmet educational needs in companies is the growth of corporate universities (Davis and Botkin 1994; Moore 1997; Meister 1998). Given the growing importance of continuous learning as an organizational strategy (Nonaka 1994; Macdonald 1995), corporate demands for learning are likely to continue.

Companies may have recognized that they had unmet educational needs, but as long as learning experiences required the physical presence of a human instructor, providing them was held to be cost prohibitive. That

---

[5] Similar themes, e.g., that learning is a social activity in which "teaching is enabling, knowledge is understanding, and learning is the active construction of subject matter" (Christensen et al. 1991, xii), have also arisen in the context of discussion teaching (Christensen et al. 1991) and in the education literature (Peters 1966; Garrison and Shale 1990; Jonassen et al. 1995; Bonk and King 1998).

[6] See, for example, Hayes et al. (1988); Schrage (1990); Senge (1990); Womack et al. (1990); Drucker (1992, 1993); Katzenbach and Smith (1993a, 1993b); Davis and Botkin (1994); Laubacher et al. (1997); Downes and Mui (1998); McDermott et al. (1998).

perception is changing, however, as information technology becomes more pervasive and less costly (Sangster and Lymer 1998; Katz and Associates 1999). Now, managers imagine a world in which education/training can be delivered through technology any time and any place a learner needs it. If technical, qualitative, and organizational limitations were overcome so that education became available ubiquitously, the limitation on learning would be learners' attention and their capacity to learn instead of inadequacies of the educational delivery system. In such a world, universities would likely have competitors, striving to make education more effective, accessible, and affordable (Stecklow 1994). Furthermore, some of these competitors, unlike universities, might be able to avoid maintaining extensive physical facilities and coaxing tenured faculty into learning new instructional approaches (Blustain et al. 1999; Farrington 1999). To the extent they could avoid these fixed costs and spread development costs across large numbers of learners, competitors offering media-based models of learning might experience higher profit margins (Davis and Botkin 1994). Thus, competitors could potentially provide more accessible learning experiences at less cost than universities (Vedder 1998). The initiatives of competitors therefore prompt a sense of urgency for universities to make learning experiences more effective, accessible, and affordable.

MAKING EDUCATION MORE EFFECTIVE THROUGH COLLABORATIVE DISCOVERY LEARNING ONLINE

This section explains how collaborative discovery learning online was applied in a master's course in information systems assurance[7] at Georgia State University, an urban research university. The implementation is explained in terms of course learning objectives, the resources available to students, what students do before and during online class sessions, the resources participants develop during the collaborative learning that occurs online, the facilitator's role, the configuration of the computing infrastructure for the course, results for the online course, and limitations of these online classes and of collaborative discovery learning online.

Course Learning Objectives

The learning objectives for the course are for students to learn to identify risks, evaluate internal control, develop assurance plans, and implement assurance plans for highly automated information systems (Vygotsky 1978, 1986).

From a technique perspective, the course develops students' competence with discrete and continuous application audits and information system development audits. Application audit approaches included computer-assisted audit techniques, digital analysis, analytical review, data querying, and continuous monitoring. The subject matter on system development audits included audit and control of waterfall and sync-and-stabilize approaches to

[7] The syllabus for the course is available at <http://www.gsu.edu/~accafb/ac863.htm>. Graduate students from other universities can enroll in the course (Acct 8630) as "transient students" in order to transfer the credit to their home universities. For the procedure for being admitted as a transient student, see <http://www.cba.gsu.edu/graduate/oaa/bulletin/> (Item 6: Master's Admissions, Transient Students). The course is also available through the Southern Regional Educational Board's electronic campus <http://www.srec.sreb.org/index.asp>.

development[8] and development in object-oriented and enterprise resource-planning (ERP) environments.

The prerequisite for the course is one of the following: (1) an undergraduate course in accounting systems and an undergraduate course in auditing, or (2) a master's course in application prototyping with objects. The co-requisite for the course is a junior-level programming course in C++ or Visual Basic. The two different prerequisite paths, one through accounting and one through information systems, result in the course having a student group with collectively many of the underlying skills required to solve problems in information systems assurance.

Resources Available by Class Session

All the resources for the course, organized by class session, are available from web sites (no textbook is used). These resources include an explanation of the activity (what students are to do) for each class session. Consistent with the learning objectives, the activities are one of the following: preparing a list of risks and control weaknesses for a specific context, preparing an evaluation of internal control; creating an audit plan; developing an implementation of an audit plan; or writing a manuscript on an information systems assurance topic to submit to a practitioner journal.

The directions to students for each day's activity incorporate resource materials with study questions. These materials provide explanations of concepts, techniques, and applications, and include professional guidance pertaining to the assurance service. The initial complexity of the activities was minimized by starting with simpler contexts and including more explicit explanations in the resource materials, an approach known as "scaffolding" (Vygotsky 1978, 1986).

An Example Activity in System Development Auditing

The first activity associated with auditing system development (occurring about midway through the course) illustrates the kinds of resource materials that were provided to students. This activity required students to develop an audit plan for a system development audit. In system development audits, the auditor examines the process of creating the system rather than the system results. The directions to students were for them to:

> Prepare an audit plan that, if executed timely, would have detected the system development and execution flaws soon enough for the publisher to have avoided the dysfunctional behavior of the magazine fulfillment system. To minimize the likelihood that you fail to identify all the unsuccessful system development practices, start by making a list of them. Then develop an audit plan that addresses each one. For the context, see Rorer (1997).

Resource materials and study questions for this assignment appear in Table 1. The resources are either prescriptive in explaining how to audit systems development, descriptive of system development failures (where, in hindsight, remedies become apparent),

---

[8] In the waterfall approach to system development, which was common for large projects in the 1970s and 1980s, frozen product specifications are the basis for design and construction of components, which are merged in one large integration and testing phase at the end of the project. In the sync-and-stabilize approach, development is iterative in that components are synchronized and stabilized incrementally, e.g., daily or weekly.

TABLE 1
Resource Materials for Auditing System Development

Prescriptive in Explaining How to Audit System Development

Doughty, K. 1996. Auditing project management of information systems development. *EDPACS* 23(7), 1–14.

1. What project management practices are associated with failed projects?
2. What should be the objectives for audits of project management?
3. How would an auditor achieve each objective?

Dykes, W. C., Jr. 1995. Use application program change control to reduce your risks. *IS Audit & Control Journal* 6, 9–11.

1. Why is change control so important?
2. What limits the kind of change control that can be implemented?

Stanford, J. 1995. The project from hell. *Computerworld* (9/4), 81–84.

1. Why is it so hard to obtain an honest assessment of a project's status?
2. What is the danger in keeping bad news from customers?
3. What limits the kind of change control that can be implemented?
4. What can be done when developers seem to be too busy to follow their own procedures, e.g., for change control or testing?
5. Why might developers be so proud of circumventing established procedures?
6. How should development schedules be set? What happens when they are unrealistic?
7. What finally focuses attention on projects in which development is not on schedule?
8. How is it that developers can delude themselves into thinking that subverting change control is productive?

Wessel, D. 1995. A man who governs credit is denied a Toys 'R' Us card. *Wall Street Journal* (12/14), B1.

1. In spite of the best-intentioned designs, some computer-made decisions are apt to be misguided or just wrong due to inadequate data being considered. When such instances are called to system users' attention, how should system users behave?

Descriptive of System Development Practices

M. A., and Selby, R. W. 1997. How Microsoft builds software. *Communications of the ACM* 40(6): 53–61.

1. How should development audits of applications developed iteratively, e.g., sync-and-stabilize, differ from those developed with sequential (waterfall) methodology?
2. How does the existence of frequent integrations change what an auditor would do in an application-development audit?
3. Which is a riskier approach to systems development—sequential or iterative? Why? Explain the risks that matter.
4. What aspects of parallel development with frequent stabilization reduce the risk of projects falling behind?

(Continued on next page)

TABLE 1 (continued)

5. Compared to a sync-and-stabilize approach, what are the biggest risks of sequential development?
6. Why doesn't following a sync-and-stabilize process guarantee on-time and bug-free products?
7. What aspects of sequential development increase the risk of developer turnover? What aspects of any development project tend to promote developer turnover?

Kit, E. 1995. Configuration management. *Software Testing in the Real World: Improving the Process*. Reading, MA: Addison-Wesley, 42–44; Validation testing, 77–82.

1. What is the likely outcome of ignoring configuration management?
2. Why is testing able to show the presence of errors but not their absence?
3. In a system development audit, what evidence would give an auditor assurance that each of unit, integration, usability, function, system, acceptance, and regression testing were completed adequately?

or descriptive of system development practices. On the premise that practices "can never be fully captured by institutionalized processes," the prescriptive material about how to audit systems development is intentionally minimized to avoid discouraging "the very inventiveness that makes practices effective" (Wenger 1998, 10). Instead, the larger share of the materials creates a diversity of contexts in system development through sagas of failed development projects and illustrations of the range of current development practices. This approach to providing materials is consistent with resource-based learning (Taylor and Laurillard 1995) and scaffolded instruction (Vygotsky 1978, 1986), in which support or assistance provided by a guide enables learners to complete tasks they otherwise would be unable to finish.

Online access to all source and assignment materials permits all information to be more available than it would be on paper, which increases the likelihood that relevant information can be brought to bear on problem solving. With online access, performance is limited not by what one remembers but by how well one can understand the problem representation and match information to aspects of the problem. Having machine-readable (and thus machine-searchable) access to the work of others—students and professionals—facilitates the creation of a collaborative learning environment and a collective intelligence.[9]

What Students Do

Before each class session, students prepare their materials for the class, convert them to HTML files, and load them on a presentation server that all class participants can access.

To join a class session, students start a web browser, enter the URL for the platform software (WebCT), give

[9] Lévy (1997, 9–10) views the computerization and networking of society as having the potential to "promote the construction of intelligent communities in which our social and cognitive potential can be mutually developed and enhanced." He envisions new information technologies that help "us navigate knowledge, and enable us to think collectively rather than simply haul masses of information around with us" (Lévy 1997, 10). His name for the new architecture for thought enabled by computer-based technologies is *collective intelligence*.

their names and passwords, and open a presentation window and a discussion window. The presentation window enables students to view (and copy) the materials that any student, guest, or the facilitator has prepared for that class. The discussion window enables participants to converse through their keyboards and screens. The discussion scrolls continuously as participants enter their comments. The presentation window and the discussion window appear on screen together.

During a class session, students have the opportunity to ask questions about the resource materials. Once such questions have been answered, students present their approaches to the day's assurance need and discuss the relative merits of various aspects of different approaches, coming to an understanding of an effective approach by negotiating among themselves the meanings of concepts, objectives, and approaches to satisfying objectives (Keegan 1993; Wenger 1998).[10]

In synchronous discussion, participants must make comments in order to be perceived as part of the group (Harasim et al. 1995). Even though software for synchronous discussion typically permits participants to view a list of all logged-on participants, comments are required for other participants to have assurance that one is present and participating. To the extent participants want to belong to the group, this setting promotes active rather than passive learning because of the active nature of the act of making comments.

The written focus of synchronous discussion has other advantages for learning. The "exactness of expression possible with written language" (Henri 1992, 119) permits a precision and permanence not possible with speech. In addition, the absence of social cues for individual participants tends to reduce the effects of social differences among participants (Dubrovsky et al. 1991). The social cues that are present in face-to-face discussion but absent in synchronous discussion comprise the things about a person that are impossible to ignore when they are conveyed by sight and sound, e.g., the color, shape, and age of one's skin and one's accent. One's name in the logged-on list may convey one's sex and ethnic heritage, but these are not nearly as salient in the absence of the visual cues. Because the lack of face-to-face presence prompts less attention to social cues, there is more opportunity for greater focus on the task (Kiesler 1992), which "challenges participants to become competent" (Davie and Wells 1991, 20). Eliminating the traditional cue of the teacher standing in front of the class also has the potential of prompting greater focus on the group's task (Kiesler et al. 1984). Synchronous discussion may be one of the few opportunities people have to "be judged solely on the basis of achievement" (Davie and Wells 1991, 20).

Because it does not impose the one-speaker-at-a-time sequence required in face-to-face discussions, synchronous discussion has the potential to eliminate the interference of the current speaker's utterances with other participants' thoughts. There is no interference, known as production blocking (Steiner 1972), because participants can compose

[10] An analysis of 17.5 minutes of class dialogue analyzed from a "community of practice" perspective (Lave and Wenger 1991; Wenger 1998) is available in Borthick (2000). The dialogue is from a class session discussing a system development audit plan in which meaning is negotiated for the concept of "fall-through program logic," which is the use of computer programming statements that permit an erroneous branch to be made because not all possible data conditions were anticipated.

their thoughts without interruptions from a speaker. Furthermore, face-to-face discussion limits the amount of participation that is possible. In the worst-case scenario, the only person engaged in the discussion at any one moment is the person speaking.

In the synchronous discussion, every participant gets to contribute without being inhibited or distracted by what others say. Because everyone is composing/editing thoughts at the same time and then releasing them, the limitations of one-speaker-at-a-time discourse disappear—everyone who wants to join the discussion may do so, and one's participation is not hindered by the utterance of the first person to speak, which, in face-to-face discussion, may change the nature of the dialog. The fact that the participation of several persons can occur simultaneously has the potential to allow persons to participate whenever they wish and, thus, be more actively engaged in the discussion. The more active one's participation, the more one is presumed to learn. According to an NTL Institute for Applied Behavioral Sciences study, average retention rates for different modes of engagement are: 5 percent, lecture; 10 percent, reading; 20 percent, audio-visual; 30 percent, demonstration; 50 percent, discussion group; 75 percent, practice by doing; 80 percent, teach other/immediate use (Meister 1998).

Synchronous discussions also overcome the perceived loss of immediacy and interactivity associated with asynchronous discussions, in which participants are not logged on at the same time (Hiltz 1994). In synchronous discussions, participants get the double advantage of immediate responses from others to their questions and contributions and the opportunity to reflect on and edit their comments before releasing them to the conversation.

Resources that Participants Develop in Class

During or after a class session, a group solution to that day's assurance need can be created and loaded on the server for future reference. All class discussions are logged, and the log is made available on the server. The existence of the logs makes note taking during class unnecessary; instead, students, knowing that details are being recorded, can devote all their energy to participating in class. Having a log of class discussions permits students unable to join a class session to catch up.

The platform software also supports email and a bulletin board for participants to communicate with each other. Examinations are administered online, and students can access their scores as well as question solutions online.

Table 2 summarizes the implications, as discussed above, of using synchronous discussion in courses.

The Facilitator's Role

In courses conducted in synchronous discussion, the teacher becomes a facilitator—a guide rather than a dispenser of facts. Rather than presenting knowledge, the facilitator ensures, as unobtrusively as possible during discussion, that relevant knowledge is brought to bear on the group task, that ideas are integrated, that misinformation is attended to rapidly, and that the discussion ends with a summary of the group's progress on the task (Harasim 1987; Harasim et al. 1995). The facilitator's role evolves over the duration of the course. At the beginning, the facilitator has the most prominent role. As participants gain experience with synchronous discussion, they participate more, which permits the facilitator to assume a truly facilitative role.

TABLE 2
Increasing the Effectiveness, Accessibility, and Affordability of Education with an Online Course

Category and Online Course Practice	Implications
Effectiveness	
Synchronous discussion for class	1. Enables collaborative discovery learning in in a community of practice 2. Promotes students' engagement in learning by shifting to active participation modes (discussing and doing rather than receiving lectures) 3. Permits every student to participate at once, avoiding the production blocking associated with face-to-face discussions 4. Encourages students to make reflective, thoughtful comments rather than just saying the first thing that occurs to them 5. Focuses discussion on the task and away from nonverbal cues associated with face-to-face classes 6. Promotes students taking responsibility for their own learning 7. Helps students learn to identify and construct knowledge as they need it to solve problems 8. Prepares students for work environments in which new problems are the norm and groups of professionals work together to solve them 9. Prepares students for work environments in which virtual work groups are common 10. Enables a wider range of professional guests to participate in the course, thereby enriching students' experience
Web-accessible course materials	1. Makes more information from more sources more readily available for problem solving 2. Permits course materials (including the problems to be solved) to be more current and relevant compared to paper-based materials fixed as of the beginning of the course 3. Promotes the use of published materials as sources of information for problem solving rather than just as descriptions of knowledge to be absorbed

(Continued on next page)

TABLE 2 (Continued)

Category and Online Course Practice	Implications
Effectiveness	
Web-accessible discussion logs	1. Makes note taking in class sessions unnecessary 2. Enables the text of class discussions to be used as a source of information, for the current class and for future classes 3. Permits absent students to catch up with class sessions they could not join 4. Gives non-native English speakers a record of class sessions for subsequent study 5. Enables evaluation of the effectiveness of different learning strategies and facilitators' implementations of them
Student-published web documents	1. Prepares students for working in web-enabled environments 2. Permits students to realize the diversity of approaches to solving different problems 3. Makes students' work accessible to other students, who can build on it to solve other problems 4. Permits students to study other students' work before class so that they can make thoughtful comments about such work rather than just hearing or seeing it presented for the first time in class
Web-delivered,-evaluated, and -returned examinations	1. Supports problem-solving contexts for evaluating performance rather than just fact recitation 2. Allows quicker return of performance evaluation to students and avoids using class time for handling exam papers 3. Facilitates assessment of learning outcomes by capturing student performance in machine-readable form

(Continued on next page)

TABLE 2 (continued)

Category and Online Course Practice	Implications
Accessibility	
Virtual class sessions	1. Avoids the need for physical presence to participate in class sessions, which makes telecommuting feasible 2. Makes the course accessible to students not able to attend physically, e.g., due to work-related travel requirements or mobility impairments 3. Makes the course accessible to visually or hearing-impaired students (with suitable aids) 4. Facilitates participation by professional guests
Affordability	
Leverage across students from multiple universities	1. Makes the course available to students whose home universities do not offer it 2. Enables reciprocal outsourcing of courses to improve utilization of faculty and university resources 3. Makes competency-based assessment of learning outcomes more feasible

Participating in synchronous discussion requires students to have sufficient cognitive maturity to be able to analyze and apply alternative theories or techniques and to develop criteria for judging which responses are relatively better or worse (McCreary and Van Duren 1987; Perry 1970; Hiltz 1994). Upper-level undergraduate and graduate students are generally thought to have attained sufficient cognitive maturity and writing skill to permit their "active and highly readable engagement with ideas and new skills" (Hiltz 1994, 107).

Even with cognitively mature participants, achieving discussion objectives requires the facilitator to make participation expectations clear with respect to, for example, regularity of participation, relevancy of contributions, responsiveness to other participants, analysis and evaluation of the discussion, and timeliness of posting of work (Harasim et al. 1995; Hiltz 1994). Increasing the difficulty of achieving discussion objectives is the fact that until students have practice in synchronous discussion, they are apt to behave much as they do in traditional classrooms—listening but not actively participating for a substantial portion of time.

For example, in traditional classes, students often exhibit the "politeness syndrome," in which they say only polite, nice things about other students' work (Hiltz 1994). This phenomenon is not surprising—it is hard for anyone to make compelling comments about work that is being presented to them for the first time, which is typical of the setting in which groups of students

present their original work to a class orally, with or without visual aids. In the context of an online course, the expectations can be quite different. If participants are expected to load their projects/papers on a web server a few days before the discussion, then other participants can be expected to have examined the work and be ready to analyze it. Achieving this objective in the discussion, however, requires that the facilitator make the expectations clear and that participants learn new behaviors.

Configuration of the Computing Infrastructure

The online course as implemented requires the following web-supported capabilities: chat (synchronous discussion); chat logging (recording of discussion so that session logs can be published to a web site); exam administration and scoring; secure web sites for participant-created materials; email; and web sites for facilitator-provided course materials at different levels of security. WebCT was used for chat, chat logging, exam functions, and secure web sites for materials deemed private to the class, e.g., participant-developed materials for each day's class and solutions to completed exams, and for materials private to individual students, e.g., students' marked exams.[11] Students chose their own email system, from the university or a proprietary Internet Service Provider (ISP).

Unix servers were used for web sites for course materials at different levels of security. The site for the syllabus and pages explaining each session's activities was accessible to anyone. The site containing copyrighted materials was password-protected in accordance with the University System of Georgia Board of Regents' policy that, subject to fair use provisions, a password-protected copy is equivalent to a paper copy in the library.[12]

University personnel at the central computing facility installed, maintained, and upgraded the Unix servers and the WebCT software platform. They also created server accounts and a WebCT account for the course. The instructor received one hour of technical consulting for configuring WebCT pages from a university support group for WebCT.[13] From a technical standpoint, the instructor, who prepared all web-resident materials, was reasonably proficient (but not expert) in web publishing in HTML. The instructor received one course release for course development. PC and Internet access was made available for class sessions for students that had on-campus courses immediately before the online course. Most students joined most of the class sessions from off-campus locations.

Results for the Online Course

This section presents the online participants' reactions to class sessions, a characterization of the pervasiveness of online participation, and a comparison of student performance in the online classes with that in the last face-to-face class.

Three online sections, one per term, were conducted over an 18-month period. In all terms, the class met in synchronous discussion on Thursday evenings in 2.25-hour sessions. Since the first online section, the course has

---

[11] Other proprietary platforms, e.g., Blackboard, Convene, and eCollege, provide similar capabilities.

[12] The *University System of Georgia Board of Regents' Guide to Understanding Copyright and Educational Fair Use* is available at <http://www.peachnet.edu/admin/legal/copyright/>

[13] The one hour was principally devoted to understanding the differences between WebCT and a different platform used in the first two sections.

been taught only online. The same instructor taught all three online sections and the earlier face-to-face section.

Online Participants' Daily Reactions

Students responded at the end of each class to questions about their reactions to that session. A different set of questions was presented for the three kinds of online sessions: daily class discussions, group project/paper discussions, and exam completion. To elicit the full range of student reactions, the surveys included Likert-type questions on a 1 to 7 scale and open-ended questions. Anchors for the Likert-type questions, grouped by the kind of online session, are shown in Table 3 with the means.

The surveys were administered electronically, as emailed attachments in the first two online terms and as web forms in the third online term. They were administered for two purposes: to elicit student reactions to each class session and to acclimatize students to the exam format. For the latter purpose, responses were attributable to individuals.

For daily class discussions, students said they learned more than they expected (all means on item 6 "Learned less/learned more than expected" were 5.0 or greater). They also indicated that they thought the discussion was very productive (all means on item 4 "Unproductive/productive interaction" item were 5.1 or greater).

The effect of students' exhibiting substantive rather than just polite behavior is apparent in the shift in participants' responses for the group project/paper discussions between the first/second and third online terms. In the third online term, the facilitator made clear that the purpose of the discussion of the project/paper was to test its readiness for execution (the project) or for submission (the paper) to the target publication. This focus put the emphasis on improving the project/paper and away from merely saying polite, nice things about it. The difference is evident in the participants' responses. For Item 3 "Other groups' work what/not what I expected," participants in Term 3 were more willing to recognize that other groups' work surprised them. Likewise, Term 3 participants indicated greater presentation anxiety in the electronic environment (Item 7), which could be attributed to the perceived need to make substantive rather than simply perfunctory comments about other groups' work. Similarly, Term 3 participants were less eager to comment (Item 8). But given the prospect that others might make comments that would help them improve their work, participants were much more eager to receive comments (Item 9). These responses are consistent with the need for the facilitator to be explicit about expectations for participation and the belief that participants can learn new behaviors that enhance their learning.

The means for the exam completion sessions indicated that students in all online terms felt greater anxiety for electronic exams than for pencil-paper exams, although the anxiety decreased over time (Item 7 "Anxiety greater for pencil-paper/electronic exam"). This reaction pattern is consistent with students, over a two-year period, becoming more comfortable in virtual environments.

In responding to the open-ended question "What most surprised you about today's discussion?" students indicated that they really liked the choice they had of where to be during class sessions and the existence of the discussion logs that freed them from taking notes. Non-native English speakers

TABLE 3
Attributable Reactions
Means of Student
Responses to Online Class Sessions

Response Anchor	Online Terms 1 n = 6	2 n = 14	3 n = 12	All n = 32	Response Anchor
Daily Online Class Discussions	**Means**				
1. 1 = Unprepared for class	5.1	5.0	5.0	5.0	7 = Prepared for class
2. 1 = Mundane class	5.4	5.7	5.4	5.5	7 = Enlightening class
3. 1 = Uncomfortable with software	6.0	6.2	5.9	6.0	7 = Comfortable with software
4. 1 = Unproductive interaction	5.1	5.3	5.5	5.3	7 = Productive interaction
5. 1 = Reluctant to participate	4.9	5.5	4.8	5.1	7 = Eager to participate
6. 1 = Learned less than expected	5.1	5.3	5.0	5.1	7 = Learned more than expected
7. 1 = Hostile discussion	5.5	5.8	6.1	5.8	7 = Friendly discussion
8. 1 = Pace too fast	4.1	3.9	3.8	3.9	7 = Pace too slow
9. 1 = Good ideas at beginning	4.8	5.0	5.1	5.0	7 = Good ideas throughout
Group Project/Paper Discussions					
1. 1 = More comfortable commenting orally	4.1	4.2	4.2	4.2	7 = More comfortable commenting electronically
2. 1 = Unprepared for discussion	4.7	5.0	5.0	4.9	7 = Prepared for discussion
3. 1 = Other groups' work not what I expected	4.5	4.5	3.6	4.2	7 = Other groups' work what I expected
4. 1 = Oral discussion easier	4.0	3.9	3.7	3.9	7 = Electronic discussion easier
5. 1 = My participation lower than I expected	3.7	4.0	3.5	3.7	7 = My participation higher than I expected
6. 1 = Better feedback orally	4.4	4.3	3.8	4.2	7 = Better feedback electronically
7. 1 = Presentation anxiety greater orally	2.7	2.8	4.0	3.2	7 = Presentation anxiety greater electronically
8. 1 = Reluctant to comment	4.0	4.5	3.7	4.1	7 = Eager to comment
9. 1 = Reluctant to receive comments	5.1	5.0	5.9	5.3	7 = Eager to receive comments
Exam Completion					
1. 1 = Prefer pencil-paper exam	3.4	3.4	3.9	3.6	7 = Prefer electronic exam
2. 1 = Unprepared for exam	5.1	5.6	5.5	5.4	7 = Prepared for exam
3. 1 = Exam not what I expected	3.4	5.0	4.5	4.3	7 = Exam what I expected
4. 1 = Pencil-paper exam easier	3.7	3.6	4.3	3.9	7 = Electronic exam easier
5. 1 = Score lower than expected	3.0	3.1	3.2	3.1	7 = Score higher than expected
6. 1 = Better feedback for pencil-paper exam	4.3	3.9	3.6	3.9	7 = Better feedback for electronic exam
7. 1 = Anxiety greater for pencil-paper exam	4.9	4.8	4.2	4.7	7 = Anxiety greater for electronic exam
8. 1 = Greater worry about losing pencil-paper exam	4.4	5.1	4.1	4.5	7 = Greater worry about losing electronic exam
9. 1 = Greater worry about confidentiality of pencil-paper exam	4.2	4.4	3.9	4.2	7 = Greater worry about confidentiality of electronic exam

commented that they appreciated having access to discussion logs. The comments of one student after reading the log of a class session that she missed illustrate the utility of the logs:

> I wish more classes were offered online. It's amazing how many different ideas are offered during the discussion. In reading the log, I would try to come up to an answer to your question before reading the responses. It was amazing how many times there were answers that were very different (both from my answer and one another's) and yet all valid and helpful in analyzing the situation. It was nice being able to objectively see the comments made by the other students.

Pervasiveness of Participation

In the dialogue from one class session analyzed in Borthick (2000), half (four of eight) logged-on participants entered the discussion. This proportion is more than the few "talkers" commonly answering most of the questions in traditional classrooms (Hiltz 1986) and more than the one-fourth to one-third active participants that was the instructor's informal measure in earlier face-to-face sections of the course. It is also consistent with others' finding of more equality of participation in computer-mediated than in face-to-face communication (Hiltz and Wellman 1997). Increased student participation is important because it is associated with the development of personal power (Jones 1968). Several self-proclaimed shy students participating in each term of the online course stated they believed their participation in the synchronous discussion was greater than it would have been in face-to-face discussion, primarily because they could edit their comments before submitting them.

The facilitator was responsible for 43 percent of the comments. This proportion is less than the 60 percent to 80 percent generally ascribed to instructors in face-to-face classes (Duncan and Biddle 1974) and less than the proportion occurring in the facilitator's face-to-face courses at the same level. Increased participant talk is important because increases in learning are associated with participation (Flanders 1970).

Across the three online terms, two students said they disliked class sessions conducted as synchronous discussion because they missed the nonverbal cues associated with face-to-face communications. A strategy for helping these students participate is to encourage them to prepare beforehand the questions they might ask during the discussion, e.g., a question about the meaning of a specific concept or its application in a specific situation. It is important for facilitators of online courses to help students develop participation strategies because of the evidence that once impediments arise with electronic communication channels, it may be difficult for participants to overcome them (Jarvenpaa et al. 1998; Hallowell 1999). Not only is it important for facilitating learning in online courses, but being skillful with electronic communication is becoming a more important organizational skill as more organizations become increasingly dependent on the productive functioning of virtual work groups (Barua et al. 1995; Apgar 1998; Jarvenpaa et al. 1998; Malone and Laubacher 1998).

Comparison with a Traditional Course

An analysis of variance, adjusted for student GPA, was performed on final exam scores between students in the last face-to-face term and in the three online terms. (The last face-to-face term occurred

before the first online term.) The final exams were a combination of equivalent objective questions and questions that required the development of audit plans for specific information systems. There was no statistically significant difference ($F(1,48) = 0.248$; $p = 0.621$) between performance of students in the last face-to-face term and in the three online terms. This outcome is consistent with the online students having mastered as many "facts" and their application as face-to-face students.

Table 4 shows students' anonymous mean responses to college-administered student evaluations of instructor performance in four sections of the course, one section per term: in the last face-to-face term and in all three online terms. This evaluation instrument is administered to all students in all courses in the college every term. The numbers at the left margin indicate the order of the items as they appear on the instrument. The items appear exactly as they are worded on the instrument. The category and item list in the left column show how the college groups the items, a configuration that was arrived at through factor analysis. The columns with student response means appear in chronological order: means for the last face-to-face term followed by means for three consecutive online terms. The school mean is the average for all graduate sections during the same term as the second online term.

The means in the first online term were generally lower than they were in the face-to-face term that preceded it, but the online course means increased in subsequent terms. It is unlikely that this response pattern across terms is associated with changes in students' performance because, as explained above, student performance on examinations did not differ in the face-to-face and online terms. It is more likely that the increases over online terms are a function of improvements in the course over time.

Consistent with Alavi's (1994) results for computer-mediated collaborative learning, the course appears to be as effective as the traditional offering with respect to traditional learning objectives. In addition, the course is designed to impart skills that are not embraced in traditional educational settings, such as working in collaborative groups to identify and solve problems, considering more information and more alternatives for solving problems, cultivating the continuous renewal of skills, functioning in virtual teams that form and disband as work dictates, and creating "communities of practice" (Wenger 1998) that enable organizations to develop their own collective intelligence (Lévy 1997).

The online course helps students learn to function in a workplace in which professionals collaborate with electronic tools to achieve team objectives but rarely see each other due to time or distance constraints (Gundry 1992; Jarvenpaa and Ives 1996; Dennis et al. 1998; Fritz et al. 1998). These students will be ready to participate in the "temporary, self-managed gathering[s] of diverse individuals engaged in a common task" (Malone and Laubacher 1998, 146) that has been proposed as the model for knowledge work in the future (Laubacher et al. 1997).

Impediments to Synchronous Discussion

The two most significant impediments to synchronous discussion were students' initial unease at following multi-threaded discussion, i.e., discussion with more than one conversation occurring at a time, and occasional lapses in connectivity that interrupted discussion momentum. A few students wished they had better typing skills.

TABLE 4
Anonymous Reactions
Means of Responses to Student
Evaluations of Instructor Performance

Category and Item	Face-to-Face Term[a]	Online Terms[b] 1	2	3	School Mean at Term2[c]
Number of Respondents	16 of 18	4 of 6	10 of 14	8 of 12	
Presentation Ability	**4.6**[d]	**4.3**	**4.7**	**4.8**	**4.4**
19. Cares about quality teaching	4.7	4.0	4.5	4.9	4.4
20. Genuine interest in students	4.5	4.0	4.8	4.9	4.4
22. Dynamic and energetic person	4.5	4.0	4.6	4.9	4.2
23. Interesting presentation style	4.3	3.7	4.6	4.9	4.2
24. Enjoys teaching	4.7	4.3	4.7	5.0	4.4
25. Enthusiastic about subject	4.9	5.0	5.0	4.8	4.5
26. Self confident	4.6	5.0	4.7	4.6	4.6
27. Varies speed and tone of voice	4.4	4.7	4.6	4.5	4.3
Organization/Clarity	**4.6**	**3.7**	**4.5**	**4.5**	**4.2**
5. Well prepared	4.9	4.3	4.7	4.6	4.4
6. Easy to understand	4.6	4.0	4.3	4.5	4.3
11. Explains clearly	4.7	3.7	4.3	4.3	4.2
12. Lectures easy to outline	4.5	3.0	4.5	4.3	4.2
13. Answers questions carefully	4.6	3.7	4.5	4.8	4.2
14. Summarizes major points	4.5	3.3	4.6	4.4	4.3
15. States objectives of each class	4.5	3.7	4.8	4.6	4.3
18. Knows if class understands	4.5	4.0	4.0	4.3	4.0
Grading/Assignments	**4.5**	**4.5**	**4.5**	**4.6**	**4.3**
1. Follows plan in syllabus	4.8	5.0	4.6	4.8	4.5
2. Assignments related to goals	4.5	4.7	4.6	4.8	4.4
3. Explains grading clearly	4.3	4.3	4.6	4.4	4.4
4. Accessible outside class	4.8	4.0	4.7	4.8	4.3
31. Returns exams/papers quickly	4.8	5.0	4.7	4.8	4.4
32. Reasonable assignments/exams	4.2	4.3	4.0	4.1	4.1
33. Fair and impartial grader	4.4	4.7	4.6	4.5	4.3
Intellectual/Scholarly	**4.7**	**4.3**	**4.5**	**4.6**	**4.3**
7. Discusses other viewpoints	4.7	3.7	4.5	4.6	4.2
8. Contrasts theories	4.6	4.3	4.4	4.5	4.3
9. Discusses recent developments	4.9	5.0	4.7	4.8	4.4

(Continued on next page)

TABLE 4 (Continued)

Category and Item	Face-to-Face Term[a]	Online Terms[b] 1	2	3	School Mean at Term2[c]
10. Presents origins of ideas	4.8	4.3	4.3	4.4	4.4
Student Interaction	**4.6**	**4.0**	**4.6**	**4.7**	**4.3**
16. Encourages class discussion	4.8	5.0	5.0	4.8	4.5
17. Invites criticism of own ideas	4.6	3.0	4.4	4.6	4.2
21. Treats students as individuals	4.5	4.0	4.3	4.8	4.2
Student Motivation	**4.5**	**4.6**	**4.5**	**4.3**	**4.2**
28. Made me work harder	4.6	4.0	4.7	4.3	4.3
29. Motivates me to do best work	4.5	4.7	4.3	4.4	4.1
30. Creative thinking on exams	4.5	5.0	4.5	4.4	4.2
Overall					
34. Effectiveness of instructor	4.6	4.0	4.0	4.5	4.1
35. Relative worth of course	4.7	4.7	4.4	4.1	4.1

[a] The face-to-face term preceded the first online term.
[b] The online terms appear in chronological order.
[c] The school mean is the average for all accounting sections (n = 45) occurring during the same term as the second online term.
[d] Students responded to each item on a 1–5 scale with higher numbers associated with better performance. Category means appear in boldface.

Some students found it difficult at first to follow multi-threaded discussion, in which there might be two or more simultaneous conversations. Multiple conversations are unavoidable in synchronous discussion because a response to a specific comment may not appear until after other comments on different topics have been interspersed in the dialogue. When students commented on the apparent disjointed nature of the discussion, the facilitator suggested some practices to make the conversations easier to follow. The practices included making an explicit reference to an antecedent comment, especially if a long time had elapsed since the antecedent, and ending a comment with a "continued next post" (cnp) tag when the author was intending to continue the comment. After participants began observing these practices during discussion, comments about disjointed discussions ceased.

In the authors' opinion, multi-threaded discussion seems much less disjointed when the facilitator helps the participants implement a strategy for achieving a session's objectives. For example, if the objective for a session is to develop an assurance plan in a particular context, then one strategy might be to verify that participants understand new concepts that are germane to the assurance need and the context, prompt participants to characterize individual assurance objectives, point participants in the direction of insufficiently treated aspects (and ensure that they are addressed), ensure that assurance

procedures are appropriate for the corresponding assurance objectives, and help participants reach closure in the development of the assurance plan.

In every term, there was an occasion on which all participants lost connectivity for more than 15 minutes. In these instances, it seemed difficult for participants to regain the momentum in discussion they had achieved before they lost connectivity. After shorter outages of the whole class or after short outages of just a few individuals, discussion momentum seemed unaffected. Regardless of the cause of an outage (likely unknown when it occurs), participants seemed appreciative of learning, after the fact, what the cause was and what steps were taken to avoid a recurrence.

Limitations

Omitted Learning Objectives

No discussion of learning objectives in assurance would be complete without treatment of interviewing and oral presentation skills. In the short run, these objectives were included in other required master's courses in auditing, financial accounting, and management accounting. In the long run, students' interviewing and oral presentation skills could be incorporated into an online course through videotaping of student performance, individually or in groups. Students could have the opportunity to re-tape segments that they, their peers, or their coaches deem deficient. Streamed video of these performances could then be made available to class participants, who could evaluate the effectiveness of the interviewing behavior or oral presentation. If the evaluation were conducted in a synchronous class session, an objective of the session could be to identify ways the interviewers/presenters could improve their effectiveness for the intended purpose. Although streaming video capabilities are available now, their widespread use will likely depend on the general availability of high bandwidth communications links.

Limitations Associated with Studying These Online Classes

The small numbers of students in the online terms (6, 14, and 12) increase the difficulty of generalizing the results to much larger class sizes. Seven same-college M.B.A. courses that have been taught online with significant synchronous discussion components have been successful. The largest section had 35 students, and there was no indication that the presence of that many students was an impediment to the discussion or to learning. In fact, the instructors of the M.B.A. courses reported lively and stimulating discussions.

Generalizability to other instructors and courses is hindered by the fact that all terms of the course were taught by the same instructor. In particular, instructors viewing themselves as performers are probably not good candidates for implementing pedagogy in which instructors become coaches and facilitators. Overcoming decades of socialization in the "sage on the stage" model in favor of a "guide at the side" model could require more personal investment than some instructors would be willing to make.

Limitations Associated with Collaborative Discovery Learning Online

To instructors considering implementing their courses as collaborative discovery learning, a significant impediment is likely to be the start-up time required on their part to transform courses, to develop proficiency with the software platform, and to integrate use of software tools into the

courses. Because transformed courses are so different from their predecessors, it is likely that significant course changes will continue into multiple terms. There are two reasons for ongoing attention to course design. First, it is unlikely that instructors would be able to create the perfect design with no experience with the approach. Second, even if instructors got the design right immediately, business contexts change rapidly, which implies the need to update activities and problem contexts in the course.

MAKING EDUCATION MORE ACCESSIBLE WITH INFORMATION TECHNOLOGY

Conducting class sessions with synchronous discussion makes the online course more accessible to students because the discussion space is accessible from anywhere through the Internet. Because students do not have to be together physically, the course is accessible to those working or living elsewhere, temporarily or permanently (Harasim et al. 1995). Professionals can take the course regardless of their work locations, and students can take it even if it is not available from their home institutions. Most students joined the class discussions from off-campus locations.

The synchronous discussion of the online course makes it easier for professional guests to participate in classes. Information systems assurance is a course for which there is a ready supply of accountants and auditors willing to enrich student learning by sharing their experiences and counsel. Having online classes makes it easier for them to join a class and make relevant materials about the accounting profession and business and their organizations available to students.

The professionals joining online class sessions were uniformly very enthusiastic about the experience and the potential of synchronous courses to satisfy learning needs of students and professionals. Analogous to the situation of professionals in face-to-face class sessions, the professionals' comments in the synchronous sessions were accorded a credibility that is hard for instructors' comments to equal (Nickles and Runde 1997). Professionals are currently engaged in practice, whereas professors, even though they may have practiced in the past, are not perceived to be as immediately situated in practice.

MAKING EDUCATION MORE AFFORDABLE WITH INFORMATION TECHNOLOGY

From a societal perspective, the online course makes education more affordable to the extent the development effort and delivery expense could be leveraged across students from multiple universities. Not all accounting programs currently offer a master's information systems assurance course. The course, a direct descendant of EDP auditing and information systems auditing courses, has typically been a specialization course, and, analogous to the situation for many specialty courses in accounting, not every accounting program in a university has a faculty member able and willing to conduct it. By default, a specialty course not offered by a student's home institution is usually simply unaffordable because students are unlikely to be able to spend the time and expense of physically attending multiple universities.

The accessibility afforded by synchronous discussion over the Internet would, however, permit qualified students at any university to enroll in the course. If accounting programs offered their specialty courses over the Internet, all parties could be better

off: students would have access to a greater variety of specialty courses taught by faculty with the skills and interest in doing so; accounting programs could ensure their students' enrollment in courses that were not offered locally; faculty efforts could be less fragmented across multiple subjects, which could permit more effective use of faculty time; and employers could hire more graduates with preparation in the specialty areas demanded in their practices. "[F]ace-to-face classroom interaction limits the reach of each instructor" (Blustain et al. 1999, 51), but use of technology in alternative delivery methods such as synchronous discussion could open up new possibilities for making education more affordable.

ASSESSING COLLABORATIVE DISCOVERY LEARNING ONLINE

This article has argued that collaborative discovery learning online has the potential to make learning more effective, accessible, and affordable. The argument has been illustrated with the example of an information systems assurance course.

Certainty about the extent of benefits associated with collaborative discovery learning online awaits research comparing results for specific learning objectives. An informal assessment of the effectiveness of this approach will be the speed with which organizations such as professional service firms adopt collaborative discovering learning online (or variants of it) for continuing education of their employees and problem solving in virtual teams.

For low-enrollment courses like information systems assurance, there may not be sufficient numbers of students to warrant the development effort of competency testing that could yield criterion-based comparisons. Instead, it might be desirable to calibrate performance on principal learning objectives, e.g., develop an assurance plan for a highly automated application, by enlisting the aid of professionals to help develop standardized scoring keys for specific contexts. Performance instruments could then be administered online to students in traditional *and* online information systems assurance courses worldwide. Subject to being kept current with respect to context, standardized scoring could be used within an institution to compare the relative performance of its students across time. Administering performance instruments to students worldwide seems much more feasible for high-enrollment courses. A group of educators and professionals could establish competencies for which performance measures are designed, validated, and administered to students. Adjusted for systematic sources of variation across students, the results could help faculty evaluate the success of their efforts to enable learning.

The automatic capture of the dialogue of synchronous class sessions creates an opportunity for the analysis of participant and facilitator behaviors and the learning that emerges. For example, the dialogue could be examined as a function of the design dimensions for a community of practice: participation and reification, designed teaching and emergent learning, local and global practice, and identification and negotiability (Wenger 1998).[14]

[14] Borthick (2000) analyzed one dialogue segment this way with the conclusion that the dialogue achieved the facilitator's specific objectives for the session (participants developing an understanding of (1) the meaning of fall-through logic, (2) how fall-through logic caused the erroneous printing sequence, and (3) how auditors could detect fall-through logic) and a general course objective (participants gaining an understanding of the need for systems auditors to have competence in information systems).

Applying Wenger's (1998) design dimensions constitutes one approach to evaluating learning from the sociocultural perspective (Vygotsky 1978, 1986). Other lenses for analyzing dialogues from the sociocultural and constructivist viewpoints include:

- Tharp and Gallimore (1988) and Tharp's (1993) seven means of providing learning assistance: modeling, contingency management, feeding back, instructing, questioning, cognitive structuring, and task structuring, as refined by Meloth and Deering (1994) to include Vygotsky's (1978, 1986) concept of scaffolding as an explicit facilitator activity. In "scaffolding," an expert or more capable peer provides support or assistance that lets the learner achieve learning goals that would not have been possible without the support. Important issues are the identity of essential elements of the scaffolding and how soon these elements can be removed without threatening learning.
- Selman's (1980) degree of perspective taking, a developmental theory of social cognitive skills, especially Stage 3, in which individuals interpret others' perspectives and can assume a third-person role, and Stage 4, in which individuals take on neutral third-party and multidimensional perspectives. The purpose of examining students' perspectives, as reflected in discussion, would be to devise new ways to help them move from their egocentric views to multidimensional views of the world that permit them to collaborate with others.
- Rogoff's (1990) categorization of scaffolded learning as an implementation of zones of proximal development (ZPD) (Vygotsky 1978, 1986). A ZPD is the difference between what an individual may accomplish on a task alone and what he or she may accomplish with guidance or in collaboration with others. ZPDs are a function of the learner and the learner's interaction with others and the tools available in common activity. Characterizing ZPDs might permit the development of strategies for helping learners internalize skills and capacities as independent self-regulatory processes, which would enable learners to enlarge their ZPDs.
- Walther's (1996) framework for examining the development of interpersonal qualities among computer-mediated communication (CMC) users. The framework comprises a three-level matrix of the interpersonal effects of electronic inter-activity: impersonality, interpersonality, and hyperpersonality. Although it has been associated with impersonality, CMC has also been associated with greater task focus. With respect to interpersonal effects, use of CMC may be conducive to increasing interpersonal effects longitudinally. The hyper-personality effect concerns CMC users' tendency to generalize other participants into social categories rather than attempting to understand the attributes of individual participants. The interpersonal perspectives are worth investigating because of the potential for learning how to enhance group coherency and effective task performance.
- Zhu's (1998) synthesis of Hatano and Inagaki's (1991) theory of group interaction and Graesser and Person's (1994) theory of question analysis to focus on horizontal interaction among peers and vertical interaction in which participants

concentrate on more capable participants' answers. The implication for assessment is that sorting out the circumstances when horizontal interaction and vertical interaction might be more effective might lead to better strategies for guiding synchronous discussion.

- Bloom's (1956) taxonomy as a means of characterizing the level of individuals' statements and questions. Using the taxonomy is a useful way or organizing participants' questions by their cognitive skill level. Comparing average cognitive skill levels across different discussion session might be helpful in determining whether participants are attaining higher cognitive levels.

Except for Bloom (1956) and Selman (1980), these theories arose after electronic communication became commonplace. Theories arising after the mid-1980s explicitly recognize the possibilities inherent in electronic communication to foster learning in social contexts (Bonk and King 1998). No single one of these approaches is likely to answer all the questions about learning through electronic communication, but, applied together, they and theories-in-the-making may guide course designers in realizing the learning potential discussed in this article.

REFERENCES

Alavi, M. 1994. Computer-mediated collaborative learning: An empirical evaluation. *MIS Quarterly* (June): 159–174.

American Institute of Certified Public Accountants (AICPA). 1997. *Assurance Services. Report of the Special Committee on Assurance Services.* New York, NY: AICPA. http://www.aicpa.org.

Anzai, Y., and H. A. Simon. 1979. The theory of learning by doing. *Psychological Review* 86 (2): 124–140.

Apgar IV, M. 1998. The alternative workplace: Changing where and how people work. *Harvard Business Review* (May/June): 121–136.

Barua, A., C.-H. S. Lee, and A. B. Whinston. 1995. Incentives and computing systems for team-based organizations. *Organization Science* 6 (4): 487–504.

Bloom, B. 1956. *Taxonomy of Educational Objectives: The Classification of Educational Goals, By a Committee of College and University Examiners.* New York, NY: Longmans, Green.

Blustain, H., P. Goldstein, and G. Lozier. 1999. Assessing the new competitive landscape. In *Dancing with the Devil: Information Technology and the New Competition in Higher Education*, edited by R. N. Katz and Associates. San Francisco, CA: Jossey-Bass.

Bonk, C. J., and K. S. King, eds. 1998. *Electronic Collaborators: Learner-Centered Technologies for Literacy, Apprenticeship, and Discourse.* Mahwah, NJ: Erlbaum.

Borthick, A. F. 2000. Analysis of design from a community of practice dialog: Negotiating the meaning of auditing information system development. *Journal of Information Systems* 14.

Brandt, D. S. 1997. Constructivism: Teaching for understanding of the Internet. *Communications of the ACM* 40 (10): 112–117.

Brown, J., and P. Duguid. 1991. Organizational learning and communities of practice: Toward a unified view of working, learning, and innovation. *Organizational Science* 2(1): 40–57.

———, and ———. 1993. Stolen knowledge. *Educational Technology* (March): 10–15.

———, and ———. 1998. Organizing knowledge. *California Management Review* 40 (3): 90–111.

Castells, M. 1996. *The Rise of the Network Society*. Boston, MA: Blackwell.

Christensen, C. R., D. A. Garvin, and A. Sweet. 1991. *Education for Judgment: The Artistry of Discussion Leadership*. Boston, MA: Harvard Business School.

Davie, L. E., and R. Wells. 1991. Empowering the learner through computer-mediated communication. *American Journal of Distance Education* 5 (1): 15–23.

Davis, S., and J. Botkin. 1994. *The Monster Under the Bed*. New York, NY: Simon & Schuster.

Deibert, R. J. 1997. *Parchment, Printing, and Hypermedia: Communication in World Order Transformation*. New York, NY: Columbia University.

Dennis, A. R., S. K. Pootheri, and V. L. Natarajan. 1998. Lessons from the early adopters of web groupware. *Journal of Management Information Systems* 14 (4): 65–86.

Downes, L., and C. Mui. 1998. *Unleashing the Killer App: Digital Strategies for Market Dominance*. Boston, MA: Harvard Business School Press.

Drucker, P. F. 1992. The new society of organizations. *Harvard Business Review* 70 (5): 95–104.

———. 1993. *Post-Capitalist Society*. New York, NY: HarperCollins.

Dubrovsky, V., S. Kiesler, and B. Sethna. 1991. The equalization phenomenon: Status effects in computer-mediated and face-to-face decision-making groups. *Human Computer Interaction* 6: 119–146.

Dunbar, K. 1993. Concept discovery in a scientific domain. *Cognitive Science* 17: 397–434.

Duncan, M., and B. Biddle. 1974. *The Study of Teaching*. New York, NY: Holt, Rinehart and Winston.

Farrington, G. C. 1999. The new technologies and the future of residential undergraduate education. In *Dancing with the Devil: Information Technology and the New Competition in Higher Education*, edited by R. N. Katz and Associates. San Francisco, CA: Jossey-Bass.

Flanders, N. A. 1970. *Analyzing Teacher Behavior*. Reading, MA: Addison-Wesley.

Fritz, M. B. W., S. Narasimhan, and H.-S. Rhee. 1998. Communication and coordination in the virtual office. *Journal of Management Information Systems* 14 (4): 7–28.

Garrison, D., and D. Shale. 1990. *Education at a Distance: From Issues to Practice*. Melbourne, FL: Krieger.

Graesser, A. C., and N. K. Person. 1994. Question asking during tutoring. *American Educational Research Journal* 31(1): 104–137.

Gundry, J. 1992. Understanding collaborative learning in networked organizations. In *Collaborative Learning Through Computer Conferencing*, edited by A. R. Kaye. 167–178. Berlin, Germany: Springer-Verlag.

Hallowell, E. M. 1999. The human moment at work. *Harvard Business Review* (January-February): 58–66.

Harasim, L. 1987. Teaching and learning online: Issues in computer-mediated graduate courses. *Canadian Journal of Educational Communication* 16 (2): 117–135. Cited in Hiltz, S. R. 1994. *The Virtual Classroom: Learning Without Limits via Computer Networks*. Norwood, NJ: Ablex.

———, S. R. Hiltz, L. Teles, and M. Turoff. 1995. *Learning Networks: A Field Guide to Teaching and Learning Online*. Cambridge, MA: MIT Press.

Hatano, C., and K. Inagaki. 1991. Sharing cognition through collective comprehension activity. In *Perspectives on Socially Shared Cognition*, edited by L. Resnick, J. Levine, and S. D. Teasley, 331–349. Washington, D.C.: American Psychology Association.

Hayes, R. H., S. C. Wheelwright, and K. B. Clark. 1988. *Dynamic Manufacturing: Creating the Learning Organization*. New York, NY: Free Press.

Henri, F. 1992. Computer conferencing and content analysis. In *Collaborative Learning Through Computer Conferencing*, edited by A. R. Kaye, 117–136. Berlin, Germany: Springer-Verlag.

Hiltz, S. R. 1986. The "virtual classroom": Using computer-mediated communication for university teaching. *Journal of Communication* 36 (2): 95–104.

———. 1994. *The Virtual Classroom: Learning Without Limits via Computer Networks*. Norwood, NJ: Ablex.

———, and B. Wellman. 1997. Asynchronous learning networks as a virtual classroom. *Communications of the ACM* 40 (9): 44–49.

Jarvenpaa, S. L., and B. Ives. 1996. Introducing transformational information technologies: The case of the World Wide Web technology. *International Journal of Electronic Commerce* 1 (1): 95–126.

———, K. Knoll, and D. R. Leidner. 1998. Is anybody out there? Antecedents of trust in global virtual teams. *Journal of Management Information Systems* 14 (4): 29–64.

Jonassen, D., M. Davidson, M. Collins, J. Campbell, and B. B. Haag. 1995. Constructivism and computer-mediated communication in distance education. *The American Journal of Distance Education* 9 (2): 7–26.

Jones, R. M. 1968. *Fantasy and Feeling in Education*. New York, NY: New York University Press.

Katz, R. N., and Associates. 1999. *Dancing with the Devil: Information Technology and the New Competition in Higher Education*. San Francisco, CA: Jossey-Bass.

Katzenbach, J. R., and D. K. Smith. 1993a. The discipline of teams. *Harvard Business Review* 71 (2): 111–120.

———, and ———. 1993b. *The Wisdom of Teams*. Boston, MA: Harvard Business School Press.

Keegan, D. 1993. Reintegration of the teaching acts. In *Theoretical Principles of Distance Education*, edited by D. Keegan. London, U.K.: Routledge.

Kiesler, S., J. Siegel, and T. W. McGuire. 1984. Social psychological aspects of computer-mediated communication. *American Psychologist* 39 (10): 1123–1134.

———. 1992. Talking, teaching, and learning in network groups: Lessons from research. In *Collaborative Learning Through Computer Conferencing,* edited by A. R. Kaye, 147–165. Berlin, Germany: Springer-Verlag.

Kulkarni, D., and H. A. Simon. 1988. The processes of scientific discovery: The strategy of experimentation. *Cognitive Science* 12: 139–175.

Laubacher, R. J., and T. W. Malone, and the MIT Scenario Working Group. 1997. Two scenarios for 21st century organizations: Shifting networks of small firms or all-encompassing "virtual countries"? MIT Initiative on Inventing the Organizations of the 21st Century Working Paper No. 001, Massachusetts Institute of Technology. http://ccs.mit.edu/21c/21CWP001.html.

Lave, J. 1991. Socially shared cognition. In *Perspectives on Socially Shared Cognition*, edited by L. B. Resnick, J. M. Levine, and S. D. Teasley. Washington, D.C.: American Psychological Association.

———, and E. Wenger. 1991. *Situated Learning: Legitimate Peripheral Participation*. Cambridge, MA: Cambridge University Press.

Leidner, D. E., and M. Fuller. 1997. Improving student learning of conceptual information: GSS supported collaborative learning vs. individual constructive learning. *Decision Support Systems* 20: 149–163.

Lévy, P. 1997. *Collective Intelligence: Mankind's Emerging World in Cyberspace.* Translated from the French under the title *L'intelligence Collective: Pour Une Anthropologie du Cyberspace* by R. Bononno. 1995. New York, NY: Plenum.

Macdonald, S. 1995. Learning to change: An information perspective on learning in the organization. *Organization Science* 6 (5): 557–568.

Mallach, E. G. 1996. Education and training aren't the same. *Computerworld* (October 7): 37.

Malone, T. W., and R. J. Laubacher. 1998. The dawn of the e-lance economy. *Harvard Business Review* 76 (5): 144–152.

Mathews, R. G. 1999. Steelmakers face online threat from auto industry. *Wall Street Journal* (November 26): B4.

McCreary, E. K., and J. Van Duren. 1987. Educational applications of computer conferencing. *Canadian Journal of Educational Communication* 16 (2): 107–115. Cited in Hiltz, S. R. 1994. *The Virtual Classroom: Learning Without Limits via Computer Networks.* Norwood, NJ: Ablex.

McDermott, L. C., N. Brawley, and W. W. Waite. 1998. *World-Class Teams: Working Across Borders.* New York, NY: Wiley.

McWilliams, G., and J. B. White. 1999. Dell to Detroit: Get into gear online! *The Wall Street Journal* (December 1): B1.

Meister, J. C. 1998. *Corporate Universities: Lessons in Building a World-Class Work Force.* New York, NY: McGraw-Hill.

Meloth, M., and P. Deering. 1994. Task talk and task awareness under different cooperative learning conditions. *American Educational Research Journal* 31 (1): 138–165.

Moore, T. E. 1997. The corporate university: Transforming management education. *Accounting Horizons* 11(1): 77–85.

Nickles, S. H., and C. Runde. 1997. Collaborative legal education. In *The Learning Revolution: The Challenge of Information Technology in the Academy*, edited by D. G. Oblinger, and S. C. Rush, 129–137. Bolton, MA: Anker.

Nonaka, I. 1994. A dynamic theory of organizational knowledge creation. *Organization Science* 5 (1): 14–37.

Norman, D. A., and J. C. Spohrer. 1996. Learner-centered education. *Communications of the ACM* 39 (1): 24–27.

Okada, T., and H. A. Simon. 1997. Collaborative discovery in a scientific domain. *Cognitive Science* 21 (2): 109–146.

Perry, W. G., Jr. 1970. *Forms of Intellectual and Ethical Development in the College Years.* New York, NY: Holt, Rinehart and Winston.

Peters, R. 1966. *Ethics and Education*. London, U.K.: Allen & Unwin.

Raelin, J. A. 1997. A model of work-based learning. *Organization Science* 8 (6): 563–578.

Rogoff, B. 1990. *Apprenticeship in Thinking: Cognitive Development in Social Context*. New York, NY: Oxford University Press.

Rorer, S. 1997. A case of catastrophic system failure. *EDPACS* (January): 11–15.

Roschelle, J. 1992. Learning by collaborating: Convergent conceptual change. *The Journal of the Learning Sciences* 3 (3): 235–276.

Sabelli, N. H. 1998. We are no longer a priesthood. *Communications of the ACM* 41 (1): 20–21.

Sangster, A., and A. Lymer. 1998. How to survive a new educational era. *Issues in Accounting Education* 13 (4): 1095–1109.

Scardamalia, M., and C. Bereiter. 1994. Computer support for knowledge-building communities. *The Journal of the Learning Sciences* 3 (3): 265–283.

Schank, R. C. 1998. Horses for courses. *Communications of the ACM* 41 (7): 23–25.

Schrage, M. 1990. *Shared Minds: The New Technologies of Collaboration*. New York, NY: Random House.

Selman, R. 1980. Taking another's perspective: Role-taking development in early childhood. *Child Development* 42: 1721–1734.

Senge, P. M. 1990. *The Fifth Discipline: The Art and Practice of the Learning Organization*. New York, NY: Doubleday.

Stecklow, S. 1994. Virtual U.: At Phoenix University, class can be anywhere—even in cyberspace. *Wall Street Journal* (September 12): A1.

Steiner, I. D. 1972. *Group Process and Productivity*. San Diego, CA: Academic Press.

Taylor, J., and D. Laurillard. 1995. Supporting resource based learning. In *Information Technology and Society*, edited by N. Heap, R. Thomas, G. Einon, R. Mason, and H. Mackay, 237–248. London, U.K.: Sage.

Tharp, R., and R. Gallimore. 1988. *Rousing Minds to Life: Teaching, Learning, and Schooling in Social Context*. New York, NY: Cambridge University Press.

———. 1993. Institutional and social context of educational reform: Practice and reform. In *Contexts for Learning: Sociocultural Dynamics in Children's Development*, edited by E. A. Forman, N. Minnick, and C. A. Stone, 269–282. New York, NY: Oxford University Press.

Vedder, R. 1998. Higher education at lower cost. *Wall Street Journal* (August 31): A18.

Vega, G., and J. W. Lacey. 1996. The new social contract: 10 suggestions for change. *Social Policy* (Summer): 56–63.

Vygotsky, L. S. 1978. *Mind in Society: The Development of Higher Psychological Processes*. Edited by M. Cole, V. John-Steiner, S. Scribner, and E. Souberman. Cambridge, MA: Harvard University Press.

———. 1986. *Thought and Language*. Cambridge, MA: MIT Press.

Walther, J. B. 1996. Computer-mediated communication: Impersonal, interpersonal and hyperpersonal interaction. *Communication Researcher* 23 (1): 3–43.

Wenger, E. 1998. *Communities of Practice*. Cambridge, MA: Cambridge University Press.

White, G. L. 1999. How GM, Ford, think Web can make splash on the factory

floor. *Wall Street Journal* (December 3): A1.

Womack, J. P., D. T. Jones, and D. Roos. 1990. *The Machine That Changed the World*. New York, NY: HarperCollins.

Zhu, E. 1998. Learning and mentoring: Electronic discussion in a distance-learning course. In *Electronic Collaborators: Learner-Centered Technologies for Literacy, Apprenticeship, and Discourse*, edited by C. J. Bonk, and K. S. King, 233–259. Mahwah, NJ: Erlbaum.