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Development of an e-learning module and comparison of web-based instruction with face-to-face instruction

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Development of an e-learning module and comparison of web-based instruction with face-to-face instruction

by

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ABSTRACT

In this research a development model for creating an E-learning module (ELM) was proposed and has been adopted to implement a web-based training component focusing on cost justification in manufacturing practice. The cost justification component thereafter served as an instrument to compare the web-based learning environments with its face-to-face counterpart in terms of effectiveness and usefulness.

The purpose of the ELM development model was to provide a clear and systematic mechanism for developing e-Learning modules. It consists of four steps: planning, designing, implementation, and testing. In each step have several subtasks an instructional designer can follow to layout the development plan in details.

To test the usefulness of this development model, a case-study component was created. It covers two topics: monetary time value and cost justification evaluation. The component was pilot tested by 6 participants from different educational backgrounds. At the end of the two-hour training session, the learners were surveyed regarding their perceptive values on the training module and were also tested for performance outcome. For the monetary time value section, the mean of six testers' scores was 92.5, with the lowest being 75, and the highest 100. In the cost justification evaluation section, the mean was 77.5 with the lowest being 55, and the highest 90. The performance test outcomes show that the web-based module was effective for almost all of the pilot users. The participants also favor the training module for its rich content, interactivity, and the ability to enable self-path learning.

Following the pilot test and the modifications based on the pilot users' feedback, the training component was used in a field test that was conducted to compare the web-based

instruction with the face-to-face teaching environments. The purpose of the comparison was to study if there is any difference between these two teaching approaches based on learners' performance outcomes and their perceptive values.

Thirty-seven students were randomly assigned into two distinct groups in the beginning of the semester. Thirty-four responses in the experiment were received for hypothesis test using Student's *t* method. The analysis of the performance test data showed no significant difference in the outcome of the face-to-face group as compared to the web-based group. As to the subjective interpretation, the positive effects of web-based learning may be due to the rich content, different types of interactions (learner-content and learner-self), the presence of learner participation, and the elimination of time and space barriers. But the participants did not have a positive perception when they were asked if the web-based module is able to motivate user learning and if they can learn faster than attending face-to-face lectures.

Along with the performance outcome and perceptions analysis, the research also presents a simplified calculation comparing the costs between two teaching approaches used to deploy the instruction in this study. The scope of this research allows a company to evaluate the web-based alternative as their primary training method with both training outcomes and development costs in mind.

CHAPTER 1. INTRODUCTION

General introduction

In manufacturing practices, traditional learning formats at worksites include observing, learning from coworkers or superiors, on-the-job-training, and applying specific factory guidelines to everyday work (Harun, 2002). While these approaches are valuable for learning in the workplace, there are several problems found in these methods. For instance, some of them lack a systematic approach of compiling the training materials, some fail to provide organized content or consistent delivery measures, and others are too inflexible to update in either format or materials. These drawbacks prevent a factory or a company from implementing their own "just-in-time" solution for training knowledge workers who are crucial in terms of company productivity and product quality.

When existing training measures do not meet the learners' needs, a lot of companies send their employees to expensive and time-consuming courses provided by training centers or schools where the instructional environments rely on traditional face-to-face teaching method. Thus requires rigid academic settings: instructors need to deliver lectures during a scheduled period in an assigned meeting room; learners must physically attend face-to-face training sessions so that lecturers can engage in interpersonal contact, verbal instruction, and non-verbal communication with students. Due to the characteristics of the face-to-face instruction, it is inevitably limited by time and space constraints. Such inflexibility makes outsource training an inappropriate solution because of inconvenient schedules or locations, full-time fees for part-time study, courses or programs that don't reflect practical work needs, or long semesters. In workplaces with limited budgets and resources, these physical and time barriers would become an obstacle due to lack of funds or difficulty in finding replacements for employees who are in training.

Therefore, manufacturing companies have been looking for rapid, efficient, and dynamic solutions for updating workforce skills and knowledge. Such investments and efforts are critical for a company to thrive in an increasingly competitive market as high-performance workers have a substantial economic repercussion: "Raising the proportion of workers trained in an industry by 5 percentage points is associated with a 4 percent increase in value-added per worker and a 1.6 percent increase in wages." (Dearden *et al.*, 2000).

With the popularity of computers and the Internet technology, web-based training delivery has become an exciting medium amongst various instructional technologies. It found its way into the realm of education due to its unique features for instruction delivery. The web supports the delivery and use of multimedia elements such as sound, video and interactive hypermedia (McNeil, Robin & Miller, 2000). Learners who use online instruction are expected to engage in a self-paced learning strategy (Fischer & Scharff, 1998). In addition, online classes meet the needs of working adults and students who have computer experience, including flexible work schedules as well as special interests (Burgess and Strong, 2003). Because of its applicability to several broad areas of workforce training, web-based training delivery has been adopted by many corporations.

Statement of the problem

Although the web-based instruction has the potential to become the primary training method in industries, several factors need to be weighed before it actually happens:

1. Instructional designers who face numerous software and hardware technologies need to have a clear and systematic mechanism to develop e-Learning modules.
2. The effectiveness of the web-based instruction needs to be justified by comparing it with the traditional face-to-face counterpart.
3. The perceptive values learners have in regard to the use of web-based instruction require further study to provide rational information, since the learning process is influenced by the learners' desires to interact with their environments (Michalski, 1989),

Purpose of the study

The purpose of this study is twofold: (1) to propose a development model that can be applied systematically and efficiently to develop an e-Learning component that supports continuous learning in manufacturing practice; and (2) to compare the effectiveness of web-based instruction versus traditional face-to-face instruction, and to investigate the perceptions that students of manufacturing industries have in regard to the use of web-based training components for instructional purposes.

Questions of the study

This study seeks answers to the following questions:

1. Is the e-Learning module built on the proposed development model efficient and useful based on the pilot test results of the learning component?
2. Will there be a significant difference between the outcomes of web-based instruction and face-to-face instruction?

3. Will the learners have positive perceptions of the web-based instruction?

Assumptions of the study

This study was based on the following assumptions:

1. The errors and the student achievement scores were random, independent, and normally distributed.
2. Students were normally and independently distributed in both the experimental and control groups with respect to computer knowledge and ability.
3. The adopted sample size was sufficient for an estimation of population parameters.
4. The instruments such as the pilot test, outcome test, and perceptive value survey have adequate reliability and validity.
5. The instruction time is sufficient to produce a measurable experimental effect on student performance.

Delimitations of the study

This study had several limitations:

1. The participating class for this study was limited to those students who enrolled in I EDT 435 Computer Automated Manufacturing during the fall semester of the 2003 school year at Iowa State University, in the Department of Industrial Education and Technology.
2. The teaching material covered in this study focused on the cost justification approaches in the manufacturing industry.

3. The outcome test measurement instrument was written questions. They belonged to the samples of the knowledge domain and might have errors of measurement which could reduce their sensitivity to the treatments' effects.

Procedures of the study

The procedures of this study consisted of the following:

- Review literatures.
- Propose an online instruction development model.
- Create the web-based training component built on the proposed model.
- Develop the survey instrument with two sections: the first section containing a performance test, and the second outlining perceptive values from the learners.
- Pilot test the training component and the survey instrument.
- Prepare the experimental setup consisting of teachers, learners, hardware, and software systems.
- Conduct the experiment and collect the data.
- Apply statistical analysis and conclude the study.

Definitions of terms

The following definitions are provided to clarify and standardize terms used in this study:

- Web-based instruction: Use of the computer and World Wide Web protocol as the approach of delivering instructional materials.

- E-Learning: Use of the electronic technology to deliver, support, and enhance teaching and learning.
- Just-in-time learning: The acquisition of knowledge or skills as they are needed by a learner.
- Self-path learning: The learning process is based on the learner's self-assessment of his or her own time and space limitations.
- Continuous learning: Learners increase their knowledge via a constant learning process through a given time period.
- Cost justification: Determining if a particular investment in an asset is worth its expense.
- Component: Refers to a topic-oriented constituent element of large-scale instructional materials.
- Flash Movie: An animation format. It can be embedded in a web page and viewed by a common Internet browser. It is created by using Macromedia Flash.

Thesis organization

This thesis is organized into four chapters. Chapter 1 contains the introduction, in which the background and the significance of the research topics are addressed. Chapters 2 and 3 are composed of two submitted papers. Each paper is closely related to the research topics in the area of e-Learning instruction. They are summarized as follows, and their references and appendices are provided immediately following each paper respectively:

- Chapter 2: "Development of an e-learning module: cost justification approaches in the manufacturing industry" was submitted to the Journal of Industrial Technology for publication. It summarizes the value of continuous learning in manufacturing practices and states how e-Learning alternatives are able to improve or replace the current training methods at a worksite. An e-Learning module development model is proposed in the paper that can be applied systematically by instructional designers to develop an e-Learning component supporting continuous learning experiences. Built on the proposed model, a case-study component is developed to test the usability of the model via a pilot test.
- Chapter 3: "Comparison of web-based instruction with face-to-face instruction" was also submitted to the *Journal of Technology and Engineering Education* for publication. It illustrates results for comparing traditional face-to-face instruction and the web-based instruction. Chapter 3 also presents the perceptive values of learners toward the usage of web-based component for instructional purposes.

Following these two papers is the conclusion and discussion in Chapter 4. This chapter summarizes the major findings of the research problems stated in the papers, and also provides discussions of potential research topics.

References

The Future of Corporate Learning. Department of Trade and Industry, Department for Education and Employment, FEDA and Campaign for Learning, 2001.

Mohd Hishamuddin Harun (2002) Integrating e-Learning into the workplace, The Internet and Higher Education 4 (2002) 301-310.

Campaign for Learning. National Learning Forum News, 2001. [Online]. Available at http://www.campaign-for-learning.org.uk/news/elearning.htm.

Dearden, H Reed, and J Van Renen, (2000) Who Gains When Workers Train? IFS

Fischer, G. and Scharff, E. (1998). Learning technologies in support of self-directed learning. Journal of Interactive Media Education, 98 (4). Retrieved February 10, 2000 from the World Wide Web: http://wwww-jime.open.ac.uk/98/4.

McNeil, S. G., Robin, B. R. and Miller, R. M. (2000). Facilitating interaction, communication and collaboration in online courses. *Computers and Geosciences*, 26, p. 699-708.

CHAPTER 2. DEVELOPMENT OF AN E-LEARNING MODULE: COST JUSTIFICATION APPROACHES IN THE MANUFACTURING INDUSTRY

(A paper submitted to the *Journal of Industrial Technology*)

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1. Introduction

In the manufacturing industry, the importance of continuous learning at the manufacturing workplace cannot be overemphasized. Continuous learning prepares enterprises for the rapid pace of change, with knowledgeable employees helping companies thrive in an increasingly competitive market. Although employee knowledge is only one factor contributing to the overall performance of a company, it has a critical impact on company productivity and product quality. It also has an economic impact: "Raising the proportion of workers trained in an industry by five percentage points is associated with a 4 percent increase in value-added per worker and a 1.6 percent increase in wages." (Dearden et al., 2000).

Accordingly, the rapid pace of change creates a constant need to train people rapidly to be high-performance workers or better decision-making managers in new technologies, manufacturing processes, machinery, tooling, materials, and services found within the factory. The trend of increasing employee knowledge and skill level has led to a growing demand for training programs that focus on the existing workplace.

The need for such programs is based primarily on strategies to cope with two learning barriers identified in K. Patricia Cross' book *Adults as Learners* (1982), a leading publication on adult learning. This book categorizes the foremost barriers to learning and success, two of which are situational barriers and institutional barriers. Situational barriers arise from one's situation in life at a given time. In a factory or a company with a limited budget and resources, a situational barrier could be a lack of funds or difficulty in finding replacements for employees who are in training. Institutional barriers are those practices and procedures that exclude or discourage individuals from participating in educational activities. Sometimes, even when employees have access to training, existing teaching environments will fail to deliver the skills employees really need. Examples of this are inconvenient schedules or locations, full-time fees for part-time study, courses or programs that don't reflect practical work needs, or long semesters.

Hence, these factors need to be minimized before learning can take place (Campaign for Learning, UK, 2001). One way to overcome these barriers is to turn the existing workplace into a vital arena and primary channel for on-site learning.

Traditional learning formats at worksites include observing, learning from fellow-workers or superiors, on-the-job-training, and applying specific factory guidelines to everyday work (Harun, 2002). While these approaches are still valuable for learning in the workplace, some of them lack systematic and organized content, some lack uniform and consistent delivery measures, and others are inflexible in either format or materials. These drawbacks of current training methods fail to meet individuals' needs or discourage just-in-time learning experiences. Companies are looking for more rapid, efficient, and dynamic methods to update workforce skills and knowledge. E-learning has established itself as one of the most efficient solutions available.

E-learning has been adopted by many corporations because of its capabilities in several broad areas of workforce training, and because of its many advantages, which include:

- Lowering the cost of faculty-student communication (Agarwal & Day, 1998),
- Eliminating the need for classroom time
- Dramatically reducing costs and improving real-time access to information (The Future of Corporate Learning, 2001)
- Shortening the development cycle
- Simplifying the processes of implementing just-in-time training modules, and
- Enabling employees to learn at their own pace.

This study introduces systematic approaches for developing a small, component-oriented e-learning module. Furthermore, this study will discuss a pilot-tested, Web-based learning module for cost justification approaches used in the current manufacturing practice.

2. E-learning module (ELM) development model

To simplify the developmental procedure of a small, component-oriented multimedia e-learning module (ELM), a sequence of steps and their corresponding tasks can be followed. As illustrated in figure 1, there are four developmental stages including planning, designing, implementation, and testing.

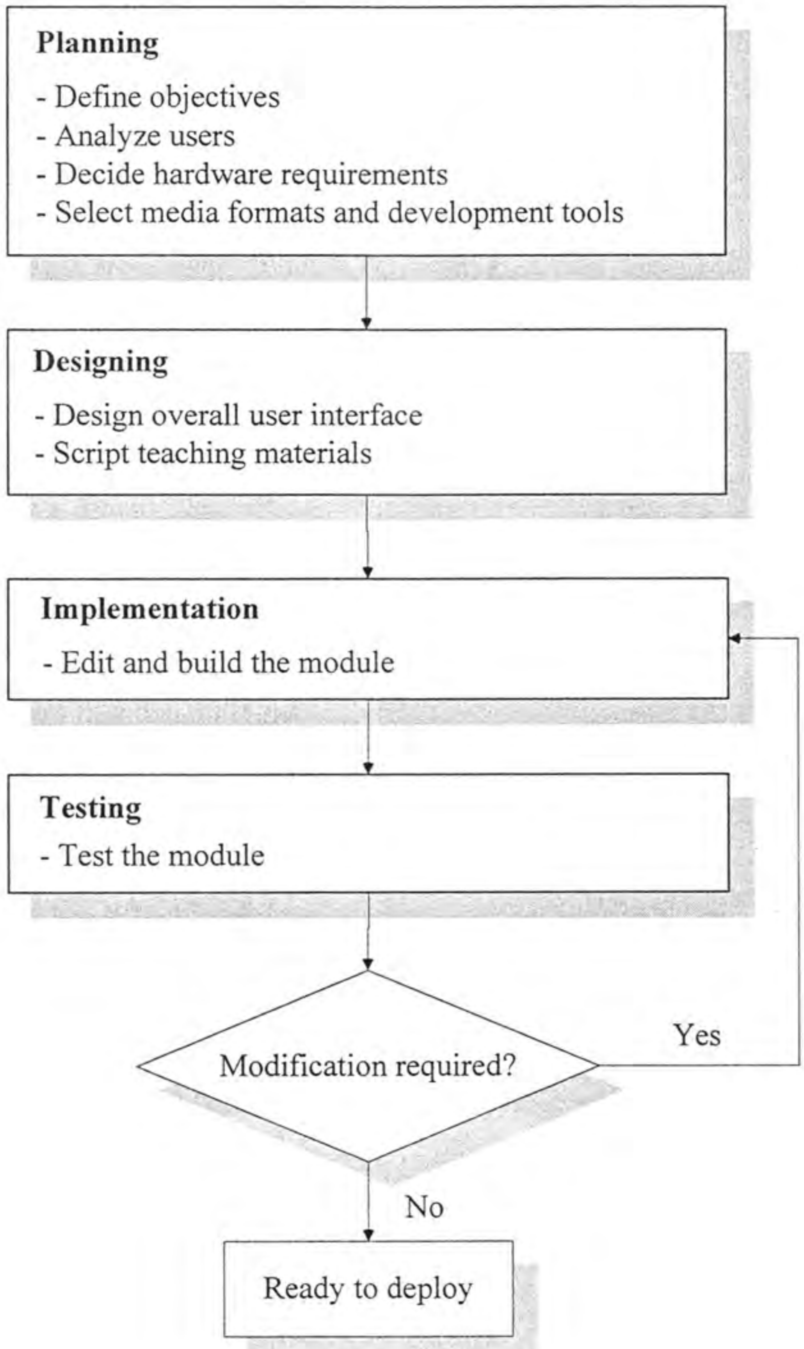


Figure 1. ELM developmental model

Planning ELM

Planning includes collecting important aspects about the objectives of a training module, user characteristics, and hardware requirements. During this stage, designers decide which media format to adopt and which developmental tools to use. The planning stage consists of the following four tasks:

- Define Objectives: provide clear descriptions of the overall goals. Objectives should be as specific as possible, including the user (who), behavior or knowledge change (what), circumstances (where, how and how long), and degree of effectiveness (how much).
- Analyze Users: describe the characteristics of people to whom the training module is directed. Results of the analysis assist in determining the difficulty level of the program, the rate at which the program will progress, the user interface, and other factors that influence the module design. Useful information includes age, gender, race, religion, language fluency, handicaps, education level, background knowledge, attitude toward the topic, and any additional information that makes each user unique.
- Decide hardware requirements: collect information about facilities that can be leveraged to support the training environment. To support e-learning, facilities should be able to support appropriate technology, including fast computers equipped with sufficient hard drive space in addition to a CD-ROM or DVD-ROM, speaker or headset, and high-bandwidth network connection.
- Select the media and development tools: choose the most appropriate combination of educational media and development tools. Choosing the right media and

development tools for your enterprise is crucial to the success of your e-learning initiative. Media formats include static text, graphics, sound, animation, film, and even interactive e-learning modules. The selection could be affected by specific training topics, the budget for the project, the development tools, and the designers' skill in using various media. The deployment platform—CD, DVD, standalone computer program, or a Web-based module—also affects the choice of media and tools. Finally, designers also must consider existing technologies and ease of updating the modules.

The information collected in the planning stage should provide clear direction for the course designer to begin designing the training module.

Designing ELM

Designers handle the process of sketching out the solutions: designing the user interface, arranging topics into a logical sequence, and writing actual teaching materials. If audio or video is part of the content, designers should prepare the scripts or narrations in as much detail as possible. The following are some of the major steps in designing an ELM.

- Design the user interface: employ a user-case diagram to visually direct designers on how the topics should be organized and presented. An example of the diagram will be presented in a later case study.
- Script teaching materials: write down a storyboard and scripts including the visuals, narration, sound effects, and music.

Implementing ELM

In the implementation stage, media designers will:

- Design and edit graphics to display training contents. Graphics can also act as elements of animation.
- Shoot scenes and edit movies for showing on-site scenarios and effectively explaining and conveying concepts.
- Create animations to illustrate concepts that are difficult to teach through static media.
- Record narrations and synchronize them with text, pictures, movies, and animations.
- Write codes and debug the program.
- Create a Website to host the Web-based materials.

Testing ELM

Designers have two means of testing an ELM: peer reviews or pilot tests. Testing and modification should continue until the enterprise can be sure that the ELM is free of errors, in line with its objectives, and useful to users.

After repeated testing and modification, training modules are ready to be deployed. Depending on the various module formats, users can access the contents of a module from a CD or DVD, they can use Web-based technologies, or they can simply install the module as a standalone program on their computer workstation.

3. Case study: develop a training module for cost justification approaches

This section presents a case study for an ELM titled "Cost Justification Approaches in the Manufacturing Industry", developed according to the principles described in this article. The Cost Justification Approaches module (CJAM) consists of two topics. The first topic seeks to familiarize learners with the concepts of the monetary value of time and essential manufacturing economics. Based on these concepts, the second topic introduces four approaches for evaluating investment proposals. Appendix A depicts the stages and their corresponding tasks involved in creating CJAM. They consist of:

- Planning CJAM
- Designing CJAM
- Implementing CJAM
- Testing CJAM

Planning CJAM

The first step of planning a module is defining objectives. For this module, the objective is to use interactive multimedia to create a Web-based training module. This goal of the module is to teach learners the monetary value of time in addition to cost justification methods, within a two-hour session.

After determining objectives, the next step is to conduct a user analysis. In this case study, our user analysis showed that potential users could be either current or prospective employees. They might be designers, programmers, operators, or managers who are in need of the benefits conveyed in the topics of CJAM. These users could be male or female, with or without computer and Internet skills. Most of them may have worked in the manufacturing industry for a while and gained experience in machinery and tooling. Furthermore, some users may have greater accounting and finance backgrounds than others.

To ensure smooth user experiences, client computers should have a 300 MHz or faster CPU, at least 256 MB memory, a sound card, and a headset or earphone. Since it is a Web-based module, the computer must connect to the Internet with a Web browser with Macromedia Flash Player 5 or above installed. To host CJAM, a Web server capable of concurrently supporting all learners is also required.

The last step of planning is selecting the appropriate media format and development tools. To enhance the richness of the content, CJAM consists of various media formats such as text, graphics, background music, narrations, and animations. With tight cost and time budgets, only one media designer and one narrator were hired to work on this project. The designer, based on expertise and available software, decided that Macromedia Flash, Fireworks, and Microsoft FrontPage were the optimum tools to create animations, graphics, interactive hands-on examples, and Web pages. The narrator works in a quiet room with a computer, which is equipped with a microphone and the Microsoft Encoder software package.

At this point, the designer has sufficient information to design the module in detail. All of the required equipment and software packages are ready for the design phase, which is described in the next section.

Designing CJAM

The first task in designing CJAM is creating the user interface. To ensure that learning topics are well-organized and that navigation is straightforward, the module designer must compose a user case diagram and treat this diagram as a blueprint to organize the overall structure. Figure 2 depicts such a diagram showing all of the topics and their relationships. It also describes the usage flow of how users access these topics. Finally, the diagram detailed content design for each topic.

After laying out the user interface, the module designer then draws programming flow charts for hands-on examples. Furthermore, the designer creates storyboards and detailed scripts of both the visual and audio components to be used during the implementation stage, which is described in the next section.

Implementing CJAM

With the user interface layout, program flow charts, a storyboard, and scripts in hand, it is time for the designer to carry out the plans and build the module. The implementation tasks include designing and editing graphics, making animations, creating hands-on exercises and accompanying programs that give users instant feedback, recording narrations, and orchestrating the smaller components. Finally, a Web page to host the Flash movie is created and this prototype is ready for testing. The finished CJAM is pictured in Figure 3.

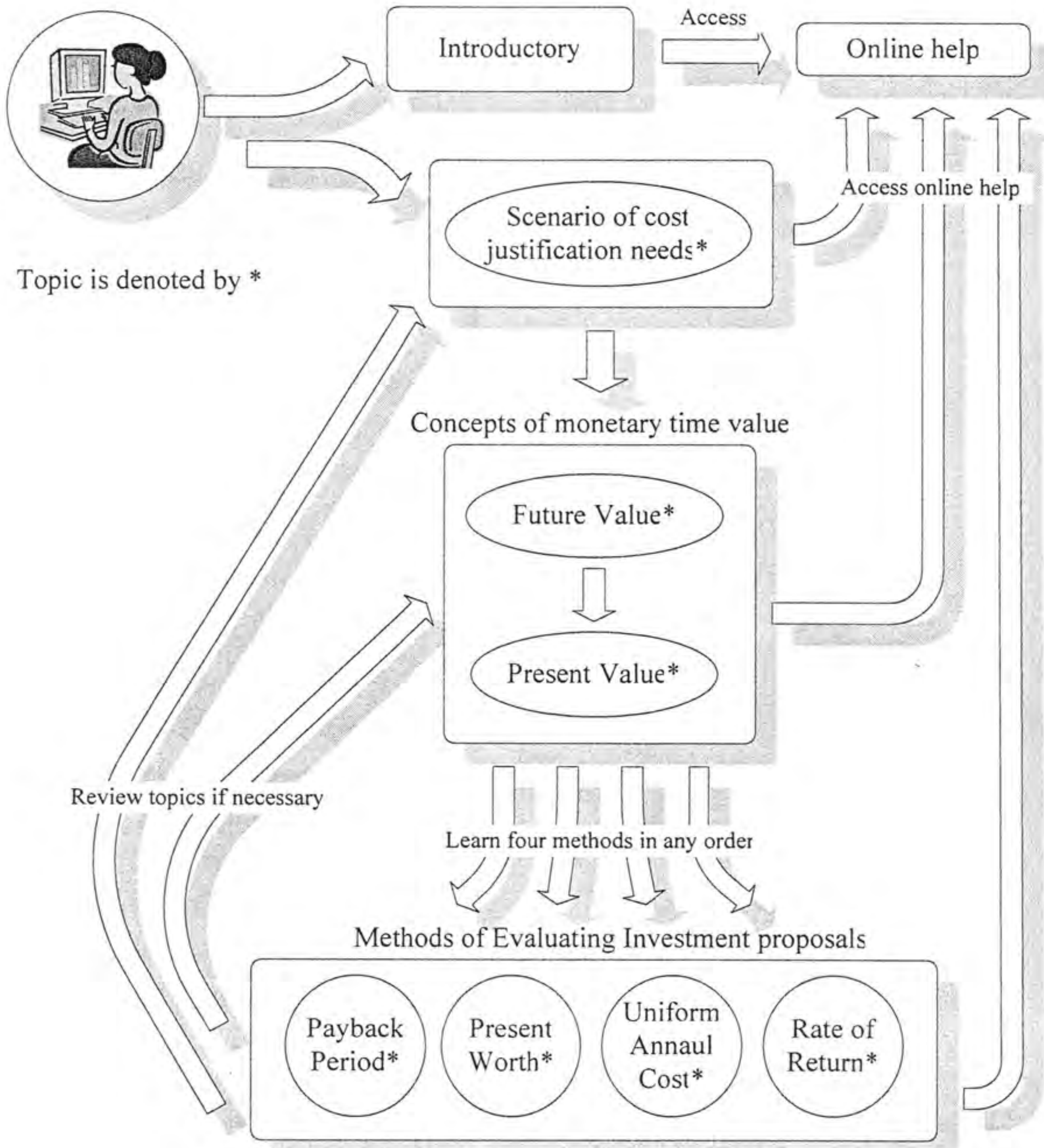


Figure 2. User case diagram (continued on next page)

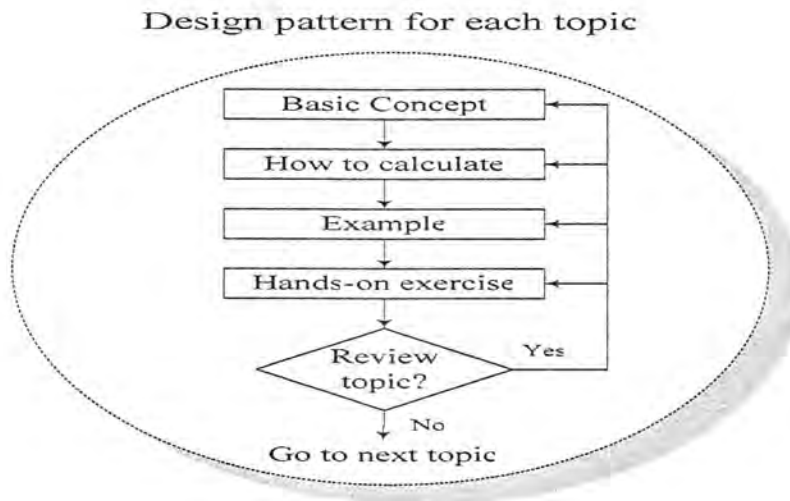


Figure 2. User case diagram (continued)

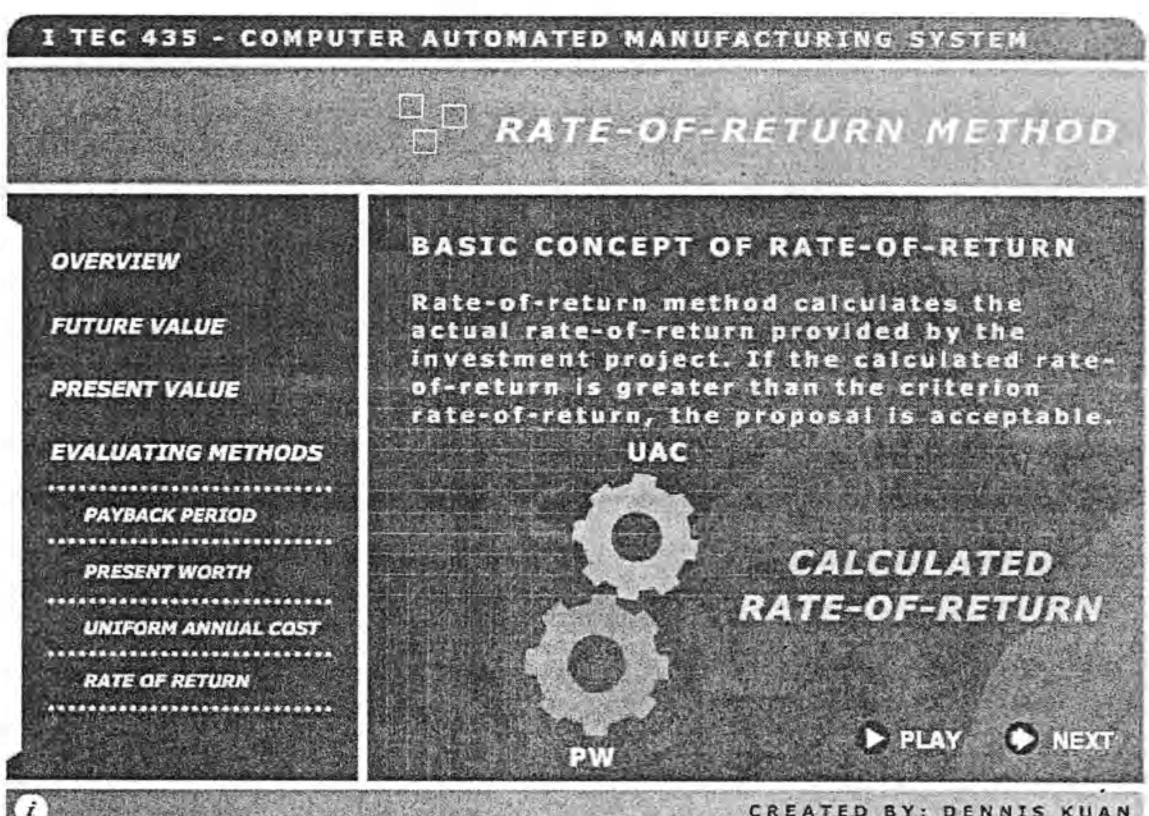


Figure 3. Cost justification approaches module

Testing CJAM

After implementing the first prototype, the module was pilot tested. To represent real users from different educational backgrounds, six participants were invited taking the pilot test: two graduate students, three undergraduate students, and one high school student. During the two-hour training session, test subjects were exposed to the prototype module and asked to take a post-test survey measuring the outcome and their satisfaction. To establish validity, the survey was created by a panel with expertise in e-learning and in the subject-matter.

For satisfaction measurement, the survey measured six perceived value items (see Table 1). For each item, testers were asked to circle their responses on a scale ranging from Strongly Agree to Strongly Disagree. Table 1 represents the results of the satisfaction survey. Data shows that users appreciate CJAM because it features interactive examples, multimedia contents, and flexible times and places for learning.

Table 1. Result of satisfaction survey

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Overall satisfaction	0	0	0	2	4
Help a user understand topics	0	0	0	2	4
Multimedia motivates learning	0	0	0	1	5
Online help is instructional	0	0	1	3	2
Interactive example is useful	0	0	0	1	5
Can learn anytime, anywhere	0	0	0	1	5

For outcome measurement, the questions were divided into two sections: a monetary time value test and a cost justification evaluation test. The former section contained three questions and the latter contained five. For each question, test takers were asked to write down the key layout of the calculations and then to actually compute the numbers. The scores of the two sections were calculated separately and computed on a scale from 0 to 100. Figure 4 presents the test results. For the monetary time value section, the mean of six testers' scores was 92.5, with the lowest being 75, and the highest 100. In the cost justification evaluation section, the mean was 77.5 with the lowest being 55, and the highest 90. The performance test outcomes show that CJAM was effective for almost all of the pilot users.

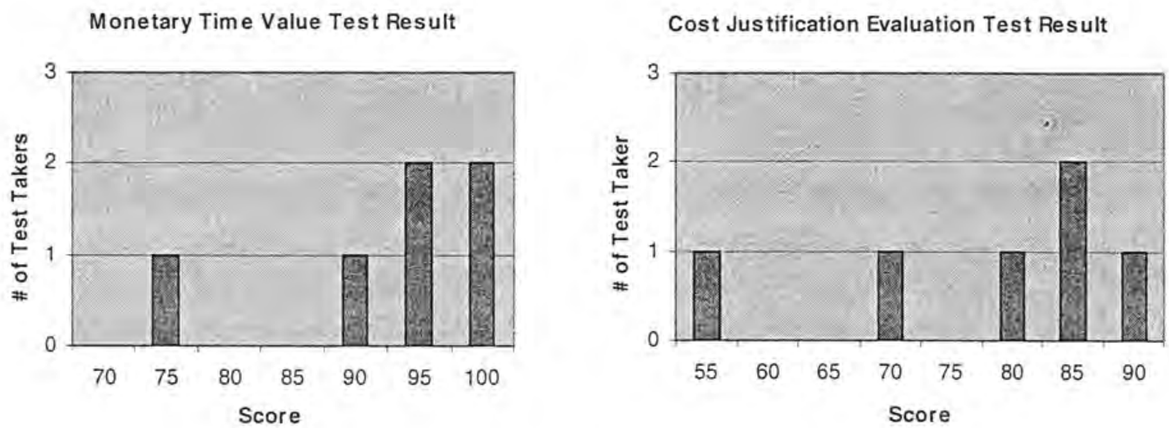


Figure 4. Result of outcome measurement

In addition, the comments and feedback from users suggested the following improvements:

- Provide more instant feedback on interactive examples
- Increase narration speed
- Improve global consistency of navigational buttons and instructional messages
- Give users the option to turn off background music
- Add more examples and scenario animations

Based on the information collected from the pilot test, designers then are able to go back to the implementation stage for any modifications. Depending on time and cost constraints, this modification-test cycle could repeat several times until CJAM is ready for field use.

4. Conclusion and research implication

By following the proposed ELM development model, a designer can systematically create an e-learning module that addresses the just-in-time need for continuous training in the workplace. As demonstrated in the case study, users favor an ELM because of its rich content, interactivity, and ability to enabling self-path learning. The performance test in the case study also indicates that users can effectively acquire concepts and knowledge from an ELM.

Nonetheless, while an ELM has the potential to become a powerful tool for continuous learning, one important question needs to be answered before it actually happens: "Is there a difference in the outcome of learners who receive traditional, face-to-face instruction as compared to those who learn from an ELM?" Further research in measuring the outcomes of these two diverse training approaches would put the effectiveness of ELM under inspection from a different perspective, and the comparison would provide rational information that could help a company make a decision on whether to adopt ELM as its primary training solution.

Appendix A. CJAM development cycle

Planning

Define objectives

Create an interactive, multimedia, web-based training module to teach learners concept of monetary time value and cost justification methods within a two-hour session class.

Analyze users

- Mixed male and female students
- Some students may have accounting or finance background
- Comfortable with working on computers and Internet

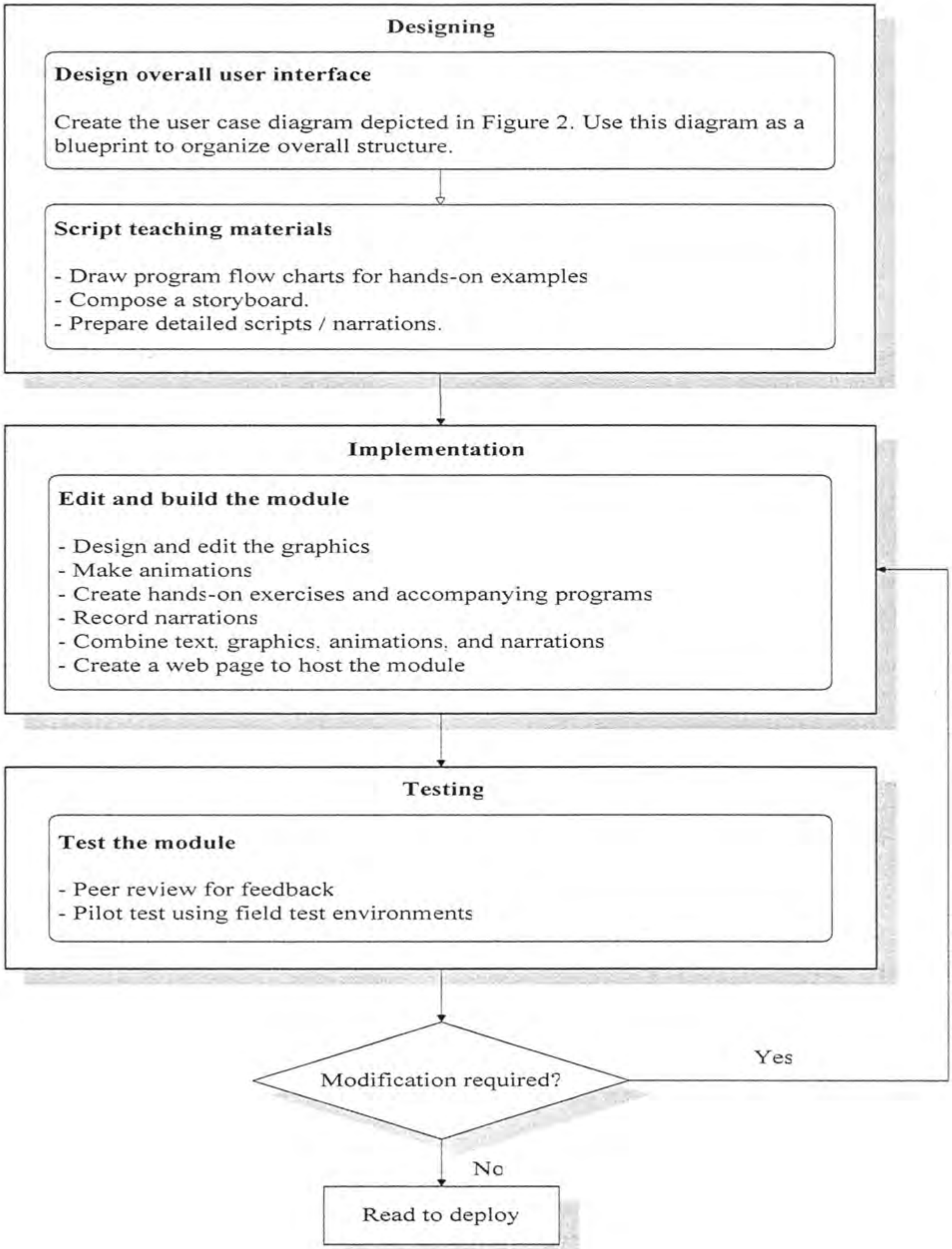
Decide hardware and software requirements

- Each client computer is equipped with the following configurations:
  - 300 MHz CPU and at least 256 MB Memory
  - Sound card and headset
  - Network card and connecting to Internet
  - Web browser with Macromedia Flash player 5 or above installed
- A web server hosting the module

Select media formats and development tools

- Formats: text, graphics, background music, narrations, and animations
- A media designer and a narrator work together
- Software
  - Macromedia Flash MX: for creating animations and hands-on examples
  - Macromedia Fireworks MX: for graphics editing
  - Microsoft Encoder: for narration recording
  - Microsoft FrontPage: for webpage composing
- Hardware
  - A quiet room and a microphone for narration recording

Go to Designing stage


Designing
Design overall user interface
Create the user case diagram depicted in Figure 2. Use this diagram as a blueprint to organize overall structure.
Script teaching materials
- Draw program flow charts for hands-on examples
- Compose a storyboard.
- Prepare detailed scripts / narrations.
Implementation
Edit and build the module
- Design and edit the graphics
- Make animations
- Create hands-on exercises and accompanying programs
- Record narrations
- Combine text, graphics, animations, and narrations
- Create a web page to host the module
Testing
Test the module
- Peer review for feedback
- Pilot test using field test environments
Modification required?
Yes
No
Read to deploy

References

The Future of Corporate Learning. Department of Trade and Industry, Department for Education and Employment, FEDA and Campaign for Learning, 2001.

Mohd Hishamuddin Harun (2002) Integrating e-Learning into the workplace, The Internet and Higher Education 4 (2002) 301-310.

Campaign for Learning. National Learning Forum News, 2001. [Online]. Available at http://www.campaign-for-learning.org.uk/news/elearning.htm.

Agarwal, R., & Day, A. E. (1998). The impact of the Internet on economic education. *Journal of Economic Education*, 29(2), 99-100.

Dearden, H Reed, and J Van Renen, (2000) Who Gains When Workers Train? IFS

CHAPTER 3. COMPARISON OF WEB-BASED INSTRUCTION WITH FACE-TO-FACE INSTRUCTION

(A paper submitted to the Journal of *Technology and Engineering Education*)

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Abstract

Based on the E-learning module (ELM) development model, a web-based training component focusing on cost justification was created, where a set of multimedia and interactive online instructions were implemented and pilot tested. The training component consists of features such as text, images, animation, voice recordings, hands-on examples, and instant feedback. Students can take the online course via the Internet instead of attending teacher-student lectures. In the study, the traditional face-to-face instruction was compared with its web-based counterpart in terms of effectiveness and usefulness. The responses were gathered from 34 industrial technology students with proficient computer skills, and the collected data was analyzed through statistical methods including histograms, frequency distributions, and hypothesis tests using Student's *t*-test method. The paper also includes a simplified calculation table comparing the costs between the two teaching approaches used to deploy the case-study instruction in this study. The comparison result allows a factory or a company to evaluate the web-based alternative as the primary training method with both training outcomes and costs in mind.

Introduction

In manufacturing practices, traditional learning formats at worksites include observing, learning from coworkers or superiors, on-the-job-training, and applying specific factory guidelines to everyday work (Harun, 2002). While these approaches are valuable for learning in the workplace, some of them lack systematic and organized content or uniform and consistent delivery measures, and others are inflexible in either format or materials. When current training measures do not meet the learners' needs, many companies send their employees to expensive and time-consuming courses or seminars provided by training centers or schools. The major problem with this outsourcing of education is that the existing teaching environments still rely on traditional face-to-face teaching method which requires rigid academic settings. For instance, instructors need to deliver lectures during a scheduled period and assigned meeting room. Learners must physically attend face-to-face training sessions. Lecturers must engage in interpersonal contact, verbal instruction, and non-verbal communication with students. In a factory or a company with a limited budget and resource, these physical and time barriers would become an obstacle because of lack of funds or difficulty in finding replacements for employees who are in training. The outcomes of face-to-face instruction also vary widely because teaching styles vary between instructors, and learning methods vary between students.

Therefore, manufacturing companies have been looking for rapid, efficient, and dynamic solutions to update workforce skills and knowledge. Such investments and efforts are critical for a company to thrive in an increasingly competitive market, since high-performance workers significantly impact company productivity and product quality.

With the popularity of computers and Internet technology, web-based training has grown increasingly popular as a job training tool because its unique features surpass many limitations of traditional media. For example, the web supports the delivery of multimedia such as sound, video, and interactive hypermedia (McNeil, Robin, & Miller, 2000). Learners who use online instruction are expected to engage in a self-paced learning strategy (Fischer & Scharff, 1998). In addition, online classes meet the needs of working adults and students who have computer experience, flexible work schedules, and special interests (Burgess & Strong, 2003). Because of its applicability to several broad areas of workforce training, web-based training has been adopted by many corporations.

Nonetheless, while web-based instruction has the potential to replace the traditional face-to-face approach and become a powerful tool for continuous learning in worksites, one important question needs to be answered before it can actually occur: "Is there a difference in the outcome of learners who receive traditional, face-to-face instruction compared to those who learn from web-based instruction?"

Purpose of study

This study measures the outcomes of these two diverse training approaches based on a web-based training component that focuses on cost justification approaches in the manufacturing industry. This study also attempts to investigate the perceptions that manufacturing students have in regard to the use of web-based training for instructional purposes. If web-based instruction proves to be at least equally as efficient as its counterpart, companies could use it as a major training solution.

Literature review and research methodology

This study compares the quantitative outcomes of two different instructional approaches and also investigates the learners' perceptive values toward the web-based instructional component. The following sections review the literature of comparative design and highlight the methodology employed in this research.

Literature review of comparative design

In an experimental designed to observe the effectiveness of virtual versus traditional class formats, Schutte (1996) reported that web-based delivery of social statistics was more effective than face-to-face. Research data also showed that students spent more time online completing their class work in the virtual environment than did the traditional group, and had positive attitudes toward the course subject, materials, and participating in the new instructional technology.

Similar to this is the development of a distance-learning computer course at the University of New South Wales, Australia. The comparison group in this study consisted of full-time workers enrolled as part-time students participating in a distance-learning course. Results from this study showed that the distance-learning group performed as well as the control group, who attended face-to-face lectures and tutorials (Lambert, Shepherd, Ngu, Ho, Whale, & Geissinger, 1996).

Conducted from the closely related comparative design, an interactive learning environment for teaching computer programming was configured to evaluate the students' learning performance. During the research, students received multimedia lecture notes and interactive hands-on exercises to write, compile, and run computer programs. In the final examination, the experimental group performed slightly better than other students who did not participate in the program (Catenazzi & Sommaruga, 1999).

To replace the correspondence version of a second-year Biology course, Collins (2000) compared the course evaluations from web, correspondence, and lecture versions of the course over four different semesters. The data revealed that students in the web version were satisfied with the online approach, although they did not outscore students in the correspondence or lecture course on the final test.

By contrast, Smith and Taylor (1995) indicated no significant difference in a physics course that was presented to students both on the web and in classroom lecture. In an English writing course, Ngu (2000) also reported that students who received conventional teaching outperformed those who went through the web lesson created by a program named CALL because the design of the web content did not support self-regulated learning that is normally highlighted in a multimedia learning environment.

Based on this research, it is worth noting that several studies adopted an evaluation strategy focusing on the learners' perceptive values toward the web-based instruction and the learning outcomes, while others compared the effectiveness of an online course with a conventional face-to-face counterpart in order to replace the traditional course with the online version if the latter superseded the former. These important perspectives are combined and consolidated in the research methodology of this study.

Research methodology

Similar to the studies that adopted a comparative design, this study focuses on learning in the manufacturing workplace, and includes face-to-face instruction as a control to test whether the learning outcomes of online instruction would equal those in face-to-face instruction. Furthermore, this study examines data about the students' experience with web-based instruction to assess their perceptions and values about this learning method. The methodology of this study consists of four steps:

- Randomly assign participants into two groups
- Conduct the field test
- Collect data from the field test
- Analyze and interpret data

Development of the training component and its survey instrument

Prior to the experiment, the authors developed and pilot-tested a web-based training course titled "Cost Justification Approaches in the Manufacturing Industry". This module was part of a "Computer Automated Manufacturing System" course taught to the students enrolled in an industrial technology curriculum. All of the teaching materials closely resembled the course package compiled from the lectures of an award-winning professor with more than ten years of experience in this area.

The development process of the training component was built on the E-learning module (ELM) development model (Kuan & Chen, 2003) suggesting sequential steps from Planning, Designing, and Implementation to Testing. The finished module consisted of Flash movies embedded in a webpage created with Macromedia Flash MX and Microsoft FrontPage XP. The webpage was hosted on a Microsoft IIS server so that learners could access the instruction via the Internet.

As shown in Figures 1 and 2, the component contained a menu bar allowing students to choose a topic according to their own learning path. Multimedia contents, including text instruction, graphics, and animation, were utilized to explain the subject. In each topic, several interactive exercises were catered for hands-on experiences and the correction check button gave learners prompt feedback. The design emphasized a student-centered and activity-based learning environment (Carr-Chellman & Duchastel, 2000). Utilizing the rich contents of the web-based medium, the design of the online learning environment emphasized learner-content interaction (Moore, 1989), and learner-self interaction (Soo & Bonk, 1998). The frequency of the hands-on examples aimed to help students reflect on the content (Soo & Bonk, 1998). At the end of each topic, a self-evaluated exercise provided instant feedback allowing the learner to determine whether or not to advance to the next topic.

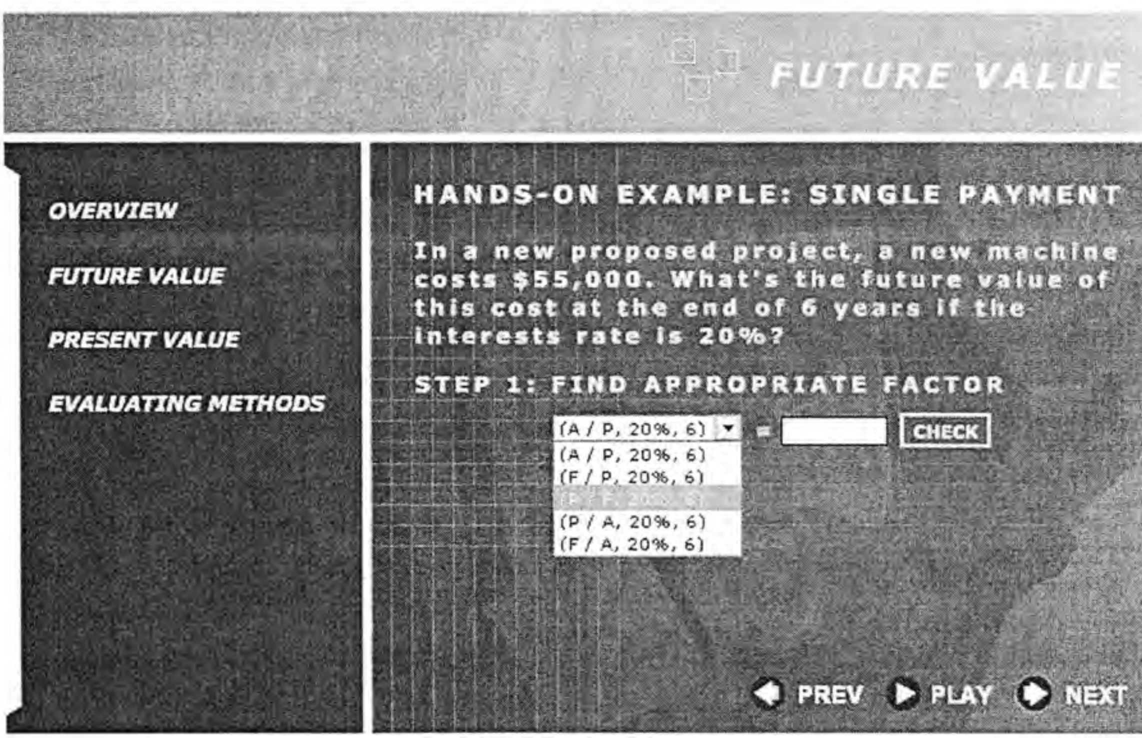

Figure 1. Learning component includes menu bar and hands-on exercises

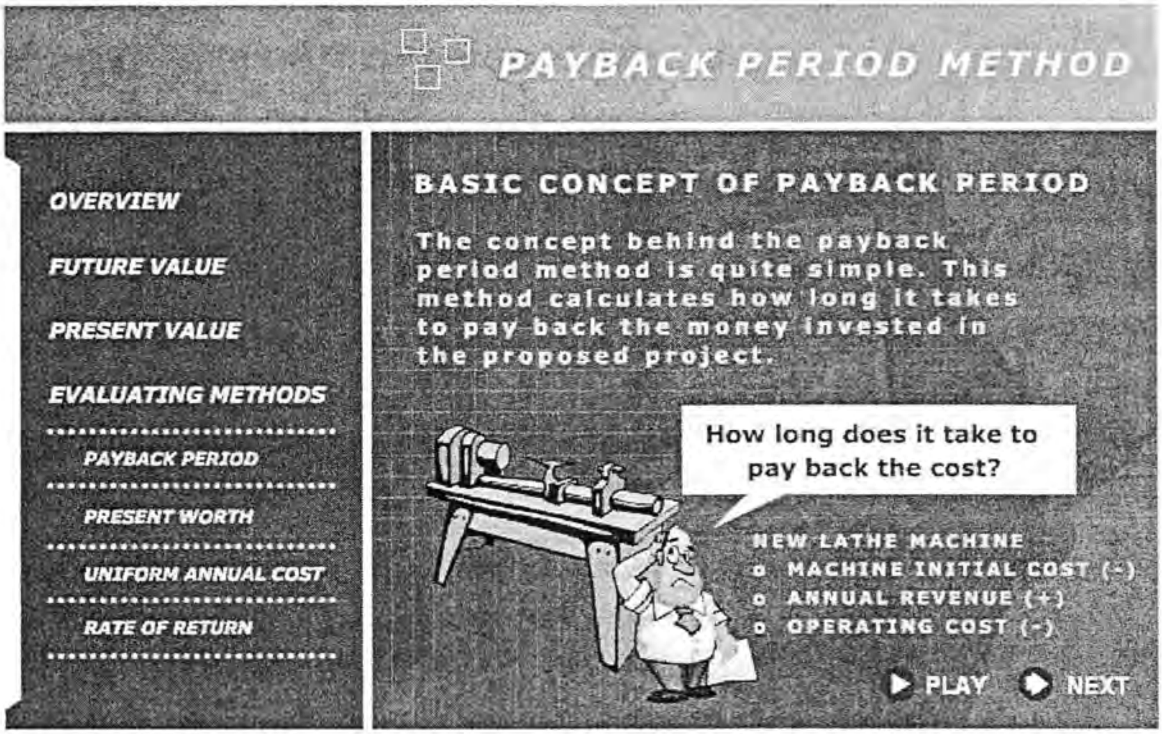

Figure 2. Multimedia contents including text, graphics and animations

The survey instrument (See Appendix A) of this research was composed of questions for objective evaluation and subjective interpretation. The former included an outcome test with eight written questions. The later contained eight multiple-choice questions related to the perceived values associated with the usefulness and the satisfaction of using a web-based training module for instructional purposes. To establish validity, the survey was created by a panel with expertise in e-learning and in the subject-matter.

Before conducting the field test, the training component and the survey instrument were pilot tested by six participants: two graduate students, three undergraduate students, and one high school student. They were selected in order to significantly represent real users from different educational backgrounds. The results of the pilot test showed that the method of instruction was effective for almost all participants. Furthermore, a few subsequent modifications and improvements were suggested and made to the module and instrument to prepare it for the field test.

Preparation and protocol for the field test

Participants were full-time undergraduate students in the industrial technology curriculum of a major university, who were enrolled in the Computer Automated Manufacturing System class during the fall semester of 2003. The field test involved in the following tasks:

- Randomly assign participants into two distinct groups: the web-based group and the face-to-face group.
- Prepare the hardware and software environments required for deploying the learning module. The client was equipped with a multimedia- and Internet-enabled computer that had an Internet browser installed.
- Conduct the test for the web-based group. Students in the web-based group were assembled in a computer lab while the control group was learning the same curriculum via face-to-face lecture. After the researcher briefed the participants about the course, its goals, and the procedures of the experiment, each student was asked to begin with the learning component by opening the Internet browser and visiting the component site. Following the thread of the learning component, students were engaged in the course at a self-determined pace. After completing each of the topics, each student was given thirty minutes to complete a questionnaire and an outcome test.

- Conduct the test for the face-to-face group. Students in this group attended a two-hour lecture delivered by a professor who had ten years of teaching experience in these subjects. The lecture materials and transparency slides were consistent with the web-based content, and the hands-on exercises matched the online counterparts. Finally, students were also given thirty minutes to complete an outcome test after the instructor finished teaching the subjects.

Collection of data

Data collection was based on 34 students who participated in the study. The semester began with 37 participants, but two students in the face-to-face group and one in the web-based group dropped the course within the first two weeks. It also happened that one student in the face-to-face group unintentionally joined the web-based group when the online program was delivered during the experimental lecture. Therefore, the final data came from 19 students in the web-based group and 15 students in the other.

For objective evaluation, every student in both groups completed an outcome test consisting of eight written questions. Based on the difficulty level of the question, a different score was awarded for the correct answer. The highest score on the entire test a participant could receive was 25 points.

As to the subjective interpretation, only the 19 students in the web-based group were asked to circle eight multiple-choice questions. The survey questions were related to perceived values associated with the web-based training module for instructional purposes. Participants rated their response for each item using a scale from Strongly Disagree (1) to Strongly Agree (5). Therefore, on the scale of 1 to 5, a value of 3 indicated neutrality to a question. Each one of the eight value items implied a statistical hypothesis that participants would hold neutral responses regarding the perceived values.

Analysis and interpretation of data

Based on the collected data, two hypotheses were tested to address the research questions in this study.

Hypothesis I

There is no significant difference between the quantitative performance outcomes of the web-based group and face-to-face group, i.e.,

Ho: $\mu_{\text{web-based}} = \mu_{\text{face-to-face}}$

Ha: $\mu_{\text{web-based}} \neq \mu_{\text{face-to-face}}$

μ is the mean of students' quantitative outcomes calculated as $\mu = \frac{\sum_{i=1}^{n} S_i}{n}$, where S_i is the score achieved by the i^{th} participant and n is the sample size.

After calculating the outcome means of the two groups, the Student's *t*-test was utilized to test this hypothesis and 0.05 α level was selected to test the statistical significance.

Hypothesis II

For the web-based group, respondents would hold neutral perceptions regarding the usefulness and satisfaction of receiving the web-based training programs for instructional purposes, i.e. for each of eight questions,

Ho: $m = 3.0$

Ha: $m \neq 3.0$

- m = sample mean of perceived value (8 perceived value items)
- 3.0 is the neutral value based on the 1 to 5 scale where quantitative values were assigned to Strongly Agree (5) / Strongly Disagree (1) scale.
- t value of the hypothesis test can be calculated as $t = \frac{m - 3.0}{SD / \sqrt{n}}$, where the standard deviation, SD, indicates the extent of dispersion of scores about the mean and n is the sample size.

The multiple (eight comparisons) Student's t-tests were utilized to test this hypothesis for each perceived value item and 0.05 α level was selected to test the statistical significance.

Comparison result of the outcome test

The analysis of the performance test data showed no significant difference in the outcome of the face-to-face group as compared to the web-based group. Figure 3 illustrates the histograms of the scores from both groups.

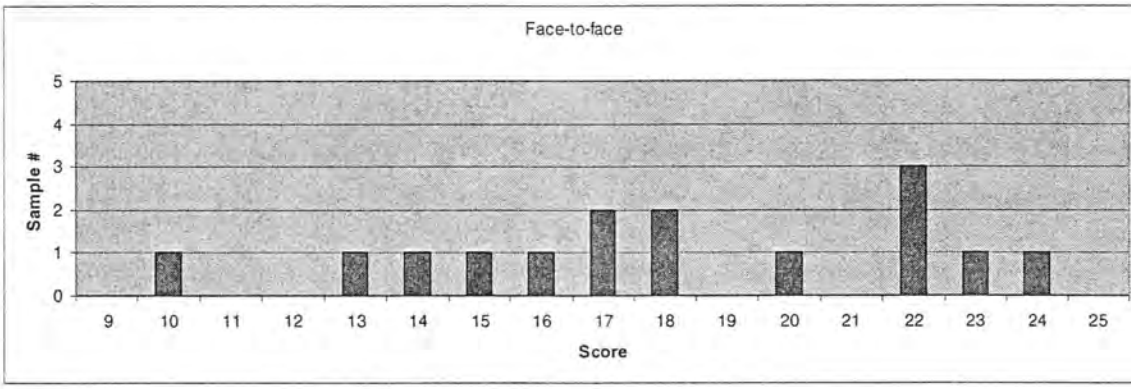

Figure 3. Histograms of performance test scores

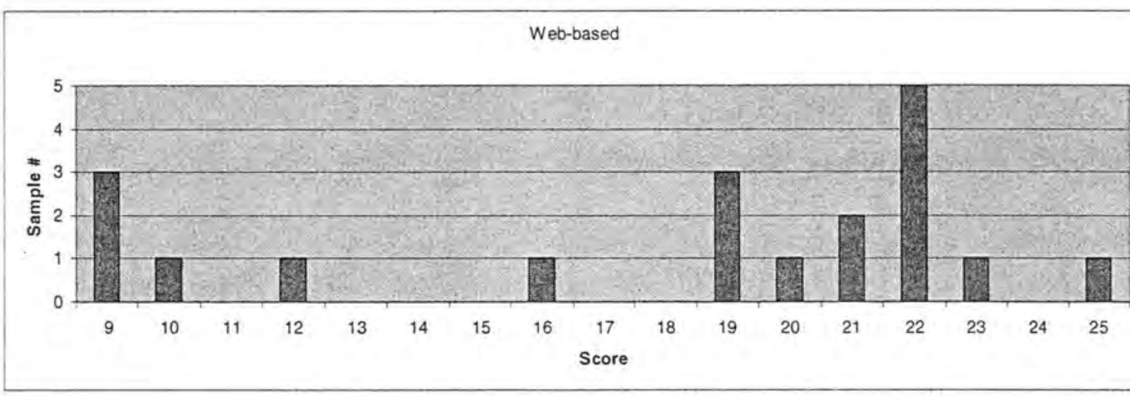

Figure 3. Histograms of performance test scores (continue)

Table 1 in the next page presents the mean, standard deviation, and 95% confidence of these data. A *t*-test result in Table 2 also indicates that the face-to-face group barely outperformed the web-based group on this case study with the *t* value being 0.04 and *P* (T <= *t*) two-tail 0.97, which fails to reject the null hypothesis, Ho: $\mu_{\text{web-based}} = \mu_{\text{face-to-face}}$. That is to say, there is no significant difference between the quantitative performance outcomes of the web-based group and the face-to-face group.

Table 1. Performance test scores

Student	Face-to-face	Web-based
1	10	9
2	13	9
3	14	9
4	15	10
5	16	12
6	17	16
7	17	19
8	18	19
9	18	19
10	20	20
11	22	21
12	22	21
13	22	22
14	23	22
15	24	22
16		22
17		22
18		23
19		25
Mean	18.07	18.00
SD	4.08	5.41
95% CI	(16.00, 20.13)	(15.57, 20.43)

Table 2. *t*-test: two-sample, assuming equal variances

	Face- to- face	*Web-based*
Mean	18.07	18.00
Variance	16.64	29.22
Observations	15	19
Pooled Variance	23.72	
Hypothesized Mean Difference ($\mu_{\text{web-based}} - \mu_{\text{face-to-face}}$)	0	
Degrees of freedom	32	
t calculated	0.04	
P(T<=t) one-tail	0.48	
t Critical one-tail	1.69	
P(T<=t) two-tail	0.97	
t Critical two-tail	2.04	

Interpretation of the perceptive values

To investigate the perceptions that students have in regard to the use of web-based training components, the second hypothesis served to test whether or not respondents had neutral perceptions regarding the usefulness and satisfaction of receiving the web-based training and instruction. Summarized in Table 3, comparing the respondents' mean values to a value of 3.0 for a test of the respondent's means being different from a neutral response revealed significant difference from neutrality for the following perceived values of using web-based components: overall satisfaction, help understanding topics, interactive examples are intriguing, learn at any time, learn at any place, and provide student participation. Respective p-values for these t-tests are: 0.0016, 0.0006, <0.0001, <0.0001, <0.0001, and 0.0169 respectively. Also, the respondents did not have a positive perception of two items: motivate user learning and learn faster than face-to-face, with p-values of 0.6507 and 0.1677, respectively.

Table 3. Analysis of the respondents' perceptions of using the web-based module

	Mean	Std Dev	t-value	p-value
Overall satisfaction	3.78	0.88	3.76	0.0016
Help understand topics	3.89	0.9	4.19	0.0006
Motivate user learning	2.89	1.02	-0.46	0.6507
Learn faster than face-to-face	2.61	1.14	-1.44	0.1677
Interactive examples are intriguing	4.22	0.73	7.08	< 0.0001
Learn at any time	4.06	0.73	6.17	< 0.0001
Learn at any place	3.94	0.54	7.43	< 0.0001
Provide student participation	3.61	0.98	2.65	0.0169

Sample size = 19, $\alpha = 0.05$, degree of freedom = 18

Conclusion and cost justification of web-based instruction

The comparison of the outcome tests reveals that students in the web-based group performed as well as students in the face-to-face group. The positive effects of web-based learning may be due to the rich content, different types of interactions (learner-content and learner-self), the presence of learner participation, and the elimination of time and space barriers. These features contribute to a self-directed learning experience rather than face-to-face instruction. As a consequence, web-based instruction in terms of effectiveness and usefulness is suitable for continuous learning of certain manufacturing practices such as cost justification attempted in this study.

Before companies invest in web-based instruction, corporations must evaluate the cost-effectiveness of the web-based solution compared to the face-to-face setting, because many companies' training budgets are susceptible to loss when budget cuts must be made (Deeny, 2003). Table 4 compares costs between the two teaching approaches used to deploy the case-study instruction in this study.

Table 4. Comparing costs of two instructional solutions

	Web-Based	Face-to-Face
Fixed Cost		
Media designer cost ($25.0 per hour, working 3 weeks)	*$3,000.0*	*N/A*
Narrator cost ($20.0 per hour, working 10 hours)	*$200.0*	*N/A*
Variable Cost		
Training session cost (per employee, assuming 2-hour session)	*N/A*	*$200.0*
Traveling Cost (per employee based on 100 mile distance in one way)	*N/A*	*$20.0*
Substitute Employee cost (per session, assuming $20 per hour)	*$40.0*	*$120.0**

* $120.0 is calculated by $20.0× 4 Hours (2-hour training session plus 2 hours traveling)

For this simplified comparison scenario, the web-based solution has the linear cost equation:

$$Cost_{web\text{-}based} = \$3{,}200.0 + \$40.0 \times employee\ number \qquad (1)$$

The face-to-face solution also has a linear cost equation, but with a different slope:

$$Cost_{face\text{-}to\text{-}face} = \$340.0 \times employee\ number \qquad (2)$$

By drawing two cost lines together as displayed in Figure 4, it is not difficult to tell that the web-based solution has higher a initial cost (for the one-time component design), while face-to-face solution has a steeper slope that climbs much faster when the number of employees needed for training increases. The two lines intersect roughly at the point where the employee number lies between 11 and 12.

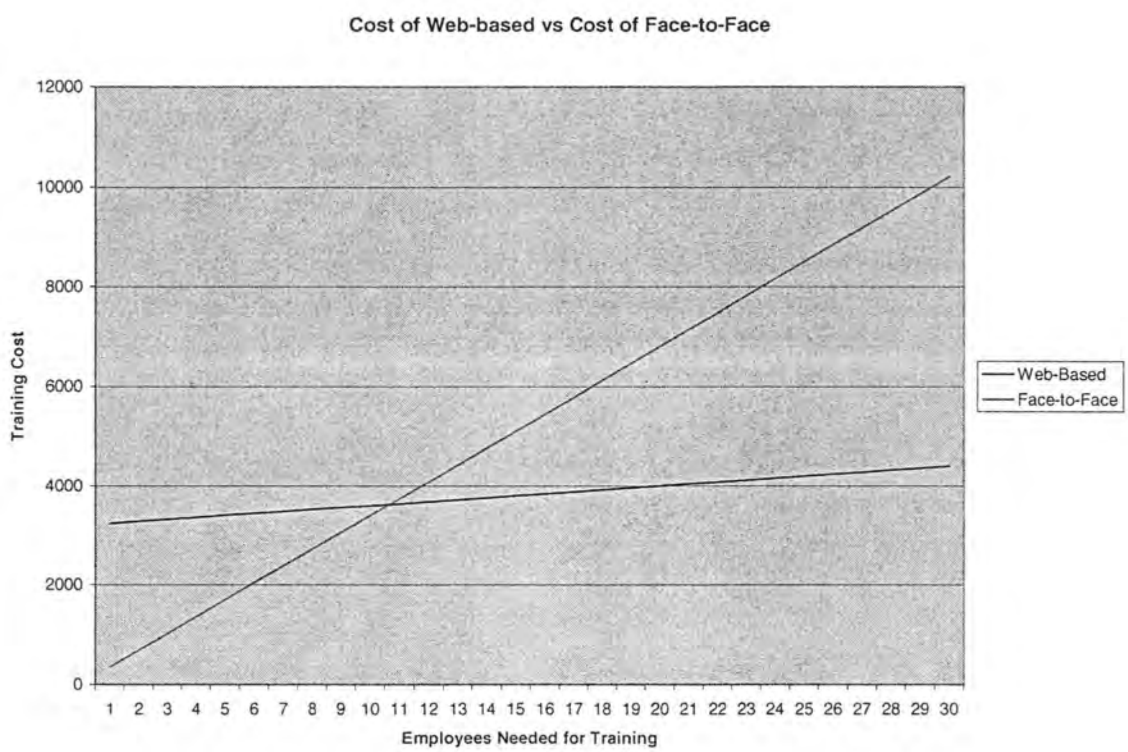

Figure 4. Cost equations of web-based instruction versus face-to-face instruction

Therefore, if a company of one hundred employees is planning to upgrade 10% of its workforce every year by pursuing the knowledge delivered in this study, at the end of the second year, the web-based solution will cost $2,400 less than the face-to-face solution. From the third year on, $2,660.0 will be saved annually if the web-based instruction is the primary solution, due to its reusable nature.

Research implication

To put web-based instruction into practice, more research needs to be done to ensure the quality of the web-based course. In addition, since web-based instruction utilizes information exchange media, other research may need to be conducted to probe the opportunities of initiating web-based collaborative learning environments into a workspace. Finally, research on the real economic value of web-based courses may draw the attention of companies weighing the costs of web-based courses.

References

Harun, M. H.. (2002). Integrating e-Learning into the workplace, The Internet and Higher Education. 4, 301-310.

Fischer, G. and Scharff, E. (1998). Learning technologies in support of self-directed learning. Journal of Interactive Media Education, 98 (4). Retrieved February 10, 2000 from the World Wide Web: http://wwww-jime.open.ac.uk/98/4.

Catenazzi, N., and Sommaruga, L. (1999). The evaluation of the Hyper Apuntes interactive learning environment. Computers & Education. 32, 35-49

Lambert, T., Shepherd, J., Ngu, A., Ho, P., Whale, G., & Geissinger, H. (1996). Bridging the Gap: Computer Science meets Distance Education at UNSW. School of Computer Science and Engineering, University of New South Wales.

Schutte, J. G. Virtual Teaching in Higher Education: The new intellectual superhighway or just another traffic jam? Retrieved February 10, 2003 from the World Wide Web: http://www.csun.edu/sociology/virexp.htm

Smith, R. C., Taylor, E. F. (1995). Teaching physics online. American Journal of Physics 63(2), 1090-1095.

Collin, M. (2000). Comparing web, correspondence and lecture versions of a second-year non-major Biology course. British Journal of Educational Technology. 31 (1), 21-27.

Bing Hiong Ngu (2000). The effect of computer aided language learning on the learning of English prepositions: A study in the Kelabit highlands of Bario, Borneo. Retrieved April 13, 2003 from the World Wide Web: http://www.unimas.my/ebario.

Carr-Chellman, A., & Duchastel, P. (2000). The ideal online course. British Journal of Educational Technology. 31(3), 229-241.

Soo, S. -K., & Bonk, C. J. (1998). Interaction: What does it mean in online distance education? Paper presented at the EDDMEDIA & ED-TELECOM 98, Freiburg, Germany.

Moore, M. G., & Kearsley, G. (1996). Distance education: A system view. Belmont: Wadsworth.

McNeil, S. G., Robin, B. R. and Miller, R. M. (2000). Facilitating interaction, communication and collaboration in online courses. Computers and Geosciences, 26, p. 699-708.

CHAPTER 4. CONCLUSION AND DISCUSSION

For web-based instruction to become the primary training method in the manufacturing practice, three fundamental questions need to be answered before the investment decision of a company is made: (1) How should the online training component be created systematically yet efficiently while plenty of diverse computer technologies are available? (2) Do the learners take in the knowledge or skill as effectively out of web-based instruction as they would from face-to-face approach? (3) How the users feel about using the web-based component for instructional purpose? The conclusions and major findings from the two research papers are summarized as follows:

- The pilot test of the case study component in the paper, "Development of an e-Learning Module: Cost Justification Approaches in the Manufacturing Industry," demonstrated that by following the proposed e-Learning Module development model, not only could an instructional designer could create an e-learning module in a systematic and consistent style but this component could also efficiently convey the cost justification concept to almost all participants. The survey of the pilot test also showed that users favored an e-Learning module because of its rich content, interactivity, and ability to enable self-paced learning.
- The learners' quantitative outcome comparison between the web-based instruction and its face-to-face counterpart was barely different on the topic chosen in the paper, "Comparison of Web-based Instruction with Face-to-Face Instruction". Furthermore, the analysis of perceived values towards the web-based component showed that the positive web-based learning effects may be due to its rich

contents, its different types of interactions (learner-content and learner-self), its ability to allow learner participation, and the elimination of time and space barriers. The last feature was particularly useful for training in the workplace for today's manufacturing environment.

Recommendations for future studies

In addition to the three major questions that this study attempted to answer, more research on web-based instruction is encouraged in the following areas: searching for different methods to evaluate the outcomes of web-based components, measuring the economic value of deploying e-Learning instruction as the primary training approach in the company, initiating web-based collaborative learning environments into workspace and evaluating its outcomes, preparing employees for web-based instruction in terms of computer skills and psychological or conceptual preparation, and using the real-time audio and video delivery technology such as online chatting and video conference to eliminate the difference between the web-based instruction and the face-to-face instruction.

APPENDIX A. INFORMED CONSENT DOCUMENT

Title of Study
A study of online web-based course – methods of evaluating investment proposals.

Investigator
Chung-Liang Kuan
Graduate Student
Department of Industrial Education and Technology
Iowa State University
(515)294-3815
dkuan@iastate.edu

This is a research study. Please take your time in deciding if you would like to participate. Please feel free to ask questions at any time.

INTRODUCTION

The purpose of the study is to compare the traditional face-to-face teaching environment and web-based online training program.

DESCRIPTION OF PROCEUDRES

If you agree to participate in this study, your participation will last for fall 2003. During the study you may expect the following study procedures to be followed. You will be asked to take pretest at the beginning of the fall 2003 before the course instruction are given. You will be asked to fill a questionnaire at the end of online training course is given. You may skip any question that you do not wish to answer or that makes you feel uncomfortable.

RISKS

The collection of questionnaire and test scores contains only your reflections and gains from this course. You will not be placed in risk or incur discomfort.

BENEFITS

This study seeks to investigate, and document the effect produced by applying of online web-based course. I also seek to understand what students think about the web-based teaching environment and how they react to it. The results should help teachers decide the alternatives to teach students on certain topics.

COST AND COMPENSATION

You will not have any costs from participating in this study. You will not be compensated for participating in this study.

PARTICIPANT RIGHTS

You participation in this study is completely voluntary and you may refuse to participate or leave the study at any time. If you decide to not participate in the study or leave the study early, it will not result in any penalty or loss of benefits to which you are otherwise entitled. Your test score and questionnaire answers will not be used if anytime during this study you decide not to participate.

CONFIDENTIALITY

Records identifying participants will be kept confidential to the extent permitted by applicable laws and regulations and will not be mad publicly available. However, federal government regulatory agencies and the Institutional Review Board (a committee that reviews and approves human subject research studies) may inspect and/or copy your records for quality assurance and data analysis. These records may contain private information.

To ensure confidentiality to the extent permitted by law, students' name will be removed as soon as the different pieces of information are matched up (e.g. questionnaires, test scores). Once the names are removed, no one will be able to match your responses to you. Your identity will not be revealed in any presentations or publications of information collected. Published articles or presentations will consist of summaries and statistical analyses of the students' reactions. If any student is quoted, a pseudonym will be used. As the principal researcher, I will be responsible for deleting names and any other identifying characteristic that may inform readers of your and other students' identity.

QUESTIONS OR PROBLEMS

You are encouraged to ask questions at any time during this study. For further information about the study contact Chung-Liang Kuan at (515)294-3815 dkuan@iastate.edu. You may also contact my major professor, Dr. Joseph Chen at 221 Industrial Education II (515) 294-8040 cschen@iastate.edu. If you have any questions about the rights of research subjects or research-related injury, please contact the Human Subjects Research Office, 2810 Beardshear Hall, (515)294-4522; meldrem@iastate.edu or the Research Compliance Officer, Office of Research Compliance, 2810 Beardshear Hall, (515)294-3115; dament@iastate.edu.

SUBJECT SIGNATURE

Your signature indicates that you voluntarily agree to participate in this study, that the study has been explained to you, that you have been given the time to read the document and that your questions have been satisfactorily answered. You may wish to make a copy of this document for your records.

Subject's Name (printed)____

Subject's Signature ______________________________ ______________
(Date)

____ ______________
(or Signature of Parent/Guardian or Legally Authorized Representative) (Date)

INVESTIGATOR STATEMENT

I certify that the participant has been given adequate time to read and learn about the study and all of their questions have been answered. It is my opinion that the participant understands the purpose, risks, benefits and the procedures that will be followed in this study and has voluntarily agree to participate.

______________________________________ ______________________
(Signature of person Obtaining Informed Consent) (Date)

APPENDIX B. COST JUSTIFICATION ONLINE COURSE QUESTIONNAIRE

Introductions and Instructions

1. Thank you for participating in this online web-based training course, "Evaluating Investment Proposal" created by Dr. Joseph Chen and Dennis Kuan. It contains an online course and a post-test.

2. Some of you will likely become manufacturing engineers after getting your degrees. One of the most important tasks manufacturing engineers face is evaluating investment proposals to improve current manufacturing process. Therefore, understanding fundamental concepts of manufacturing economics and learning skills to evaluate investment proposals is important for your future job. This form evaluates your understanding of manufacturing economics and skills to evaluate proposals.

3. There will be a post-test conducted at the end of the training course to see how much you have learned from this online course.

4. For each survey item, please carefully choose one and **only one answer** that best describes your situation and fill the corresponding circle.

5. You can now turn to the next page and begin.

Post-test

Before you take this post-test survey, please indicate the finish time when you are done with the online course.

Finish Time: ___________________

Please read each question and circle the number which most closely reflects your agreement with the statement based on your participation in this online course. All responses and information provided will be kept confidentially.

Please check **only one** number for each question.

① = Strongly Disagree ② = Disagree ③ = Neutral ④ = Agree ⑤ = Strongly Agree

I. Overall Satisfaction

①②③④⑤ A. Overall, I am satisfied with this online course.

Comment:

①②③④⑤ B. The training modules are generally helpful to understand the topics.

Comment:

①②③④⑤ C. I found web-based training material motivated me to learn.

Comment:

①②③④⑤ D. The web-based materials are easy to understand.

Comment:

①②③④⑤ E. I found web-based training material effective for educational use.

Comment:

①②③④⑤ F. I could learn faster using web-based training material than attending the face-to-face lecturing classroom.

Comment:

II. Instruction Satisfaction

①②③④⑤ A. The usage of the technology to create the instruction materials is appropriate.

Comment:

①②③④⑤ B. I am satisfied with the computer facilities (including hardware and network speed) used to host this online course.

Comment:

①②③④⑤ C. The sequence of the topics is logical and it's organized for me to learn the main concept.

Comment:

①②③④⑤ D. The instructions of how to use this online course is clear and explanatory.

Comment:

①②③④⑤ E. The level of computer proficiency that the course requires is appropriate.

Comment:

①②③④⑤ F. Those hands-on examples included are easy to follow and are useful to understand corresponding topics.

Comment:

①②③④⑤ G. More topics of I Tec courses should be created as web-based materials like this training program.

Comment:

①②③④⑤ H. I would appreciate the interaction with the web-based courses.

Comment:

①②③④⑤ I. The animations in the training program help understand the topics.

Comment:

①②③④⑤ J. The web-based feature of this training course allows me to learn whenever I want to.

①②③④⑤ K. I can take this web-based instruction at home or workplace without attending the lectures in classroom.

III. Other Comment

Please indicate any changes needed to be made for improvement:

IV. Performance Test

A. From the given interest table, find the factor of calculating the present value when the annual value is given. The interest rate is 15% and the period is 7 years.

B. You invested $100 in a savings account with the term of annual interest rate 20%. How much you can receive from the bank after **ten** year? Please indicate your calculation in the following empty space.

C. To receive $1,000 from the bank **seven** year from today, how much do you need to deposit in your savings account today if the annual interest rate is 15%? Please indicate your calculation in the following empty space.

D. A project is proposed to improve the current manufacturing process by replacing the current machine with a new one. It takes initial cost $12,000 for purchasing and installation. For each year, the new machine can generate $5,000 revenue but also costs $1,200 for operation. After 10 years, when the new machine gets old, it will have $1,000 salvage value. The current rate-of-return policy is 15%. Use the information to answer the following questions.

a. Draw the cash flow diagram.

b. What is the payback period of this proposal?

c. Use the present worth method to evaluate if this proposal meets the rate-of-return criterion.

d. Use the uniform annual cost method to evaluate if this proposal meets the rate-of-return criterion.

e. For simplicity, use **zero** salvage value. What is the actual rate-of-return of this proposal? You don't need to calculate the exact number. Just indicate the appropriate range, for example between 10% and 15%.