Effective Design & Use of Web-Based Distance Learning Environments

By LON FERGUSON and KAY WIJEKUMAR

Distance learning environments are experiencing exponential growth. The effectiveness of these environments continues to be debated, especially in terms of student learning. This issue, as well as the needs of a diverse audience of safety professionals, were central concerns addressed in the development of distance education courses in Safety Sciences at Indiana University of Pennsylvania (IUP). This article describes the methods employed to develop these courses and reviews findings based on course delivery.

Safety sciences is a broad field concerned with the interaction between people and the physical, chemical, biological and psychological forces that affect their well-being (ASSE 2000). Today’s safety professional must be able to develop a systems perspective of the entire organization in order to adequately identify and evaluate hazards and develop cost-effective controls to eliminate or reduce these hazards and their adverse outcomes.

By its nature, safety is a broad field. It is also a dynamic field that is constantly affected by changes in the social, political, regulatory and environmental arenas. Developing skills to address these issues and maintaining currency are essential for both safety professionals and safety educators.

Unfortunately, time constraints and the lack of college-level safety courses makes it difficult for safety professionals to take such courses as a means to remain current in their field. However, as today’s information dissemination process continues to evolve from a paper-based, time-and-place-constrained system to a fast, efficient Internet-based system, educational institutions and environmental, safety and health professionals are presented with new opportunities for training and learning (Castells). These new technologies offer tremendous flexibility and convenience; if designed properly, they can provide a quality learning experience for students (Educause; Jonassen and Reeves; Pea 167+).

To help safety professionals remain current while using these new technologies, IUP developed Internet-based courses that are available to a worldwide audience. Initially, these courses will be part of a four-course “certificate program” in safety sciences, which is currently in the approval process at IUP. The ultimate goal is to convert most of the university’s M.S. in Safety Sciences courses so that a student can complete his/her master’s coursework via the Internet.

**DEVELOPMENT PROCESS**

Course development involved three phases: outcome and content analysis, course design and pilot testing.

**Outcome & Content Analysis**

The first step was to analyze desired learning outcomes, course content and student profiles. To complete this step, IUP faculty:

1) Conducted an online survey of student preferences and backgrounds. A web-based survey instrument was developed and placed on the department website. Visitors to the site were encouraged to identify safety and health topics of interest; describe their educational and professional backgrounds; and state their perceived learning needs.

The survey results were used to develop outcomes and content for each course.
professional backgrounds; and detail their experience with computers and the Internet. This information was used as one factor for developing course content, determining the level of content detail and use of instructional technologies within the courses.

2) Interviewed subject-matter experts. The course designer met on a weekly basis with the course instructor. Course description and overall course objectives were the focus of these initial meetings.

Once objectives were clearly defined, module topics related to those objectives were developed. These topics formed course modules, and specific objectives were then developed for each module. The instructor addressed how faculty would approach the course, with a focus on teaching strategies and technical aspects of the content. The designer interpreted and synthesized this information and developed prototypes within an instructional technology framework. A typical exchange: Instructor: “Here is what I teach and how I teach, as well as some examples of activities and cases I have used.” Designer: “Here are some ways to use technology to present the information on the Internet, as well as activities that will foster the outcomes you have identified.”

3) Interviewed current and former students of the program. Students were asked about experiences in similar courses as well as what types of activities fostered their learning. Many students suggested that case studies and other real-life examples that allow application of material were most helpful.

4) Reviewed existing course materials. Class notes. Based on module objectives, content for course notes was developed; this typically included PowerPoint slides and printed documents (outlines) in Word format. In most cases, notes were reorganized with content added to explain the slides and outlines prior to converting to HTML format. By far, this was the most time-consuming process. Unlike a lecture where the instructor can discuss his/her notes included on the overhead, notes for modules had to be both comprehensive and easy-to-follow. In other words, much of the material discussed in class regarding overheads now had to be included in the module notes, text readings or module activities.

Activities. Module activities often used links to other Internet sites to cover select material or supplement notes. Most activities presented specific assignments to be completed at these sites, which showed students how such sites could be a valuable reference for practicing safety and health professionals.

Quizzes. Quizzes were converted to a WebCT format (the tool IUP uses as a resource for distance education). Quizzes featured true/false or multiple-choice questions, and were intended only as a review; as such, they accounted for only 15 percent of the course grade.

Case studies. To allow students to apply concepts, case studies were included at the beginning of each module. These scenarios were based on actual cases the instructor had encountered as a practitioner. To provide the learner with the information needed to solve these cases and learn from the experience, supporting information—Internet resources, textbooks, course readings and notes—were available.

5) Performed activity theory analysis of the functions of safety professionals. When creating a learning environment, one must identify how professionals may react in particular situations. For example, if a safety professional is conducting an accident investigation, s/he must complete specific tasks and collect certain information. These tasks must become second nature to the professional because at an accident scene, s/he will not have time to review a text on accident causation or reread a policy about what types of accident reports must be filed.

Activity theory analysis documents the steps that must be taken to solve problems (investigate an accident); tools available (internal accident reports, a database and spreadsheet to store and analyze information); and types of information that must be collected to solve the problem (identify accident causes and develop control measures). Figure 1 shows how activity theory analysis was used to walk students through the process of completing an accident analysis.

Design Phase

After analyzing the audience and content, and evaluating methods of delivery, courses were designed using a modified cognitive flexibility theory approach.

Cognitive Flexibility Theory

In response to growing evidence that students were concentrating on the surface features of subjects, thereby reducing complex knowledge into compartmentalized objects, and not understanding the inter-relatedness of concepts, Spiro, et al developed cognitive flexibility theory. This approach calls on instructors to use a large number of small cases that allow students to apply their knowledge to real-life cases; understand the complexity of these cases; see the inter-relatedness of issues; understand that each case has multiple perspectives; and present domain-related (e.g., safety sciences) concepts and principles in the context of the cases (Spiro, et al 24+).

For example, one learning module in the IUP course presents a case where the student plays the role of a safety manager of a facility where an employee has had a finger amputated while operating a mechanical press. Unfortunately, this accident was not reported to OSHA, and an OSHA inspector has just arrived.

To complete this assignment, the student must react to this situation. This requires him/her to learn the inspection process; understand the safety manager’s rights and responsibilities during the inspection; comprehend applicable regulations; and consider a variety of perspectives, including those of plant management, employees and the inspector. The student must then apply this knowledge to the problem at hand.
TABLE 1
Learning Strategies & Web-Based Tools

| Case Study | Cognitive flexibility theory states that multiple short cases allow students to learn complex knowledge. Each module started with a real-life case with all the supporting materials available to solve it. In many cases, these situations have no single correct answer; instead, justification for the suggested answer was more important. |
| Embedded Activities | For students to practice real-life problem solving, they must proceduralize activities. For example, in Module 2, students analyze trends in accidents for planning purposes. A database tool was available for data storing and spreadsheets were used for analysis. It was critical for the instructor to provide timely feedback to the students while completing the activities. |
| Information-Searching Activities | Module activities often use links to other Internet sites to cover selected material. Most of these activities had specific assignments at the sites, which allowed the student to learn how the site could be a valuable reference for the practicing safety and health professional. |
| Chat Rooms | Structured chat rooms were conducted by the professor to provide group discussion on module concepts and activities. Questions were designed to assess whether students had learned the theoretical basis, facts and concepts surrounding each module. |
| Bulletin Board | Collaborating, sharing thoughts, perspectives and resources are other learning techniques well-suited to the Internet. In this course, the bulletin board was used primarily to post good examples of student work and as a means for students to share information. |
| Quizzes | Multiple-choice questions that focused on major theoretical constructs within each module. |
| Projects | Projects fostered group work and reflected the challenges professionals face when working with others. Students were not able to physically meet, so much of the communication between group members occurred via e-mail and the bulletin board. |
| Notes | Notes were linked directly to the case study and followed a logical sequence to solving the case. |
| Course Reference Packet | Additional assignments and articles to supplement the text and notes were provided in a course reference packet. For example, the accident analysis included 40 accident reports to be reviewed by the student in order to complete the analysis. |

(OSHA inspection). Figure 2 shows the presentation of this case in the course.

Cognitive flexibility theory adapts well to hypertext environments because of the nature of hypertext (Jonassen and Reeves). Hypertext is an approach to managing information (text, graphics, video, sound) where data are stored in a network of interconnected nodes that allows links to different perspectives and allows the student to respond to the situation interactively (Smith and Weiss). In a learning environment, hypertext is said to mimic the human mind in allowing multiple connections and allowing the learner to see the complex interactions of situations (Jonassen).

In the case of the finger amputation and OSHA inspection, the student clicks on the image shown in Figure 1 and receives pop-up windows that allow him/her to review the perspectives of the safety manager and OSHA inspector. The student may also click on questions and notes pertaining to this module, and use “Safety Pays” from the OSHA website to calculate an estimated cost for this injury. The student must then answer questions regarding rights and responsibilities. This case will ultimately lead the student through the process of handling an OSHA inspection. Table 1 summarizes the learning strategies and web-based tools used to implement this theory in these safety courses.

Student learning was assessed in several ways. The first course featured a combination of case studies, quizzes, homework activities, group projects and chat room participation. This range of evaluation tools helped faculty better gauge student learning and evaluate what techniques and strategies worked best. The bulk of a student’s grade was based on case studies because it was believed the student’s ability to apply knowledge and solve the case was the primary objective of the learning experience.

Pilot Test

A pilot test of the course was then conducted over a three-week period. Four graduate-level students participated; they were given access to the course on the Internet and received a guide that included written instructions for accessing and navigating the course. They were asked to document time spent on each module as well as any problems encountered while completing a module. After completing each module, the students were asked the following questions:

1) Were instructions in the student guide helpful?
2) What did you believe were the objectives of the module?
3) Did you have any problems understanding directions within the module?
4) Did all the links and activities work as described?
5) Can you identify features that helped you learn the content?
6) Did you have the necessary information/resources to complete case studies within the module?
7) How long did it take you to complete the module?

Based on this feedback, the course was revised. All four participants suggested that the case studies in each module were the most-helpful element in terms of organizing content and helping them apply the concepts.
It quickly became clear that students were receiving a good educational experience—comparable to that of a live-lecture-based course.

COURSE DELIVERY

The first course was delivered via the Internet; supplemental materials included a CD-ROM, selected readings, accident reports and an orientation guidebook.

Two weeks before the first class, a voluntary student orientation session was held on campus. The objective was to introduce students to the new technologies, discuss course format and answer questions. Faculty members felt this session was critical since this was IUP’s first Internet-based course and because some students were unfamiliar with the technology involved. Six of the 10 registrants attended this session.

The student guide (received during orientation) detailed how to access the class and navigate through the modules. Basic information on use of e-mail, chat rooms and bulletin boards was also provided, as were some common Internet navigational tools. The guide also outlined learning strategies employed to develop the class and offered suggestions designed to facilitate student learning.

Each student also received a CD-ROM of the course. This resource provided flexibility because students could review materials even when traveling (provided they had a computer equipped with a CD-ROM drive). However, in this mode, it was not possible to interact with the professor or other students.

For the first course, the instructor allotted two weeks for each module. All student work for each module was due during that two-week period, with the module quiz available online Friday and Saturday of the second week.

Student work for each module was due during that two-week period, with the module quiz available online Friday and Saturday of the second week. Other grading alternatives were not used due to the length of assignments and the need for detailed feedback. After grading student work, the instructor posted two good examples on the bulletin board for other students to review. The goal was to provide students with a benchmark against which to judge their own work.

FINDINGS FROM DISTANCE LEARNING COURSES

Lessons learned from the development and delivery of this course can be best classified in three major categories: student learning, instructor learning and long-term goals.

Student Learning

This was the instructor’s first opportunity to teach a distance education course, so it was essential to critically evaluate course delivery. On a weekly basis, chat sessions were initiated by asking a general question regarding module content as well as any technology problems encountered.

At both the mid-term and conclusion of the class, evaluation instruments used by IUP for distance education courses were administered. Responses were received from nine of the 10 students. These evaluations assessed course instruction, content and technology. Specific questions related to instruction and content received very favorable ratings, with 75 percent very sat-
Through this experience, students gained more than just an ability to recall and recite information. They learned how to seek, analyze, synthesize and apply knowledge to real-life safety issues.


Lon Ferguson, Ph.D., CSP, is an associate professor and chair of the Safety Sciences Dept. at Indiana University of Pennsylvania (IUP). Ferguson holds a B.S. and an M.S. in Safety Sciences from IUP, and a doctorate from the University of Pittsburgh. Prior to joining IUP, Ferguson was an assistant professor in the Occupational Safety and Hygiene Management Program at Millersville (PA) University. In addition, he has 12 years’ experience as a safety consultant for Liberty Mutual and the Pennsylvania OSHA Consultation Program. A professional member of ASSE’s Western Pennsylvania Chapter, Ferguson is the Society’s representative on the Accreditation Board for Engineering and Technology.

Kay Wijekumar is director of distance education development at IUP. She holds a B.S. in Electronics Engineering Technology from Franklin University and an M.S. in Computer Science from the University of Pittsburgh. Wijekumar will receive her Ph.D. in Instructional Systems from Pennsylvania State University in December 2000. In addition to developing technology-based learning environments, she has served as a senior consultant for Andersen Consulting and has taught computer science and instructional technology courses at the college level.

**References**


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