A Case Study on Technology Use in Distance Learning

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Abstract

This article reports a study on the actual use of technologies in a graduate-level distance course on information systems analysis and design. The results indicate four conclusions. First, commonly used Internet technologies (e.g., e-mail, Web, FTP, listserv, and IRC) and traditional technologies (e.g., mail, telephone, and fax) are sufficient for delivering a rather technical and hands-on distance course. Second, among these technologies, fax was the favorite method for submitting assignments, and e-mail was the most used method for communications and dialogues. Third, communication related to the submission of assignments accounted for an outstanding proportion of all e-mail messages. And fourth, minimal control of technology use helped the instructor and the students focus on the subject matters, and students achieved high learning performance and satisfaction. Implications for distance education are discussed. (Keywords: distance learning, information systems analysis and design, Internet technologies.)

Distance education is a process that creates and provides access to learning when time and distance separate the source of information and the learners. Technology-assisted distance education (Eddy, Burnett, Spaulding, & Murphy, 1997) has become increasingly common in recent years, owing to the extremely rapid expansion of distance-education technologies. These technologies have been evolving from traditional technologies such as mail, telephone, and fax, to instructional television (Wheeler, Batchelder, & Hampshire, 1997), to VCR-based technology, and computer systems such as the Internet. With the increasing availability of the Internet to most potential distance students, Internet-based distance courses are booming. Although there are many suggestions for how to use the Internet to deliver distance courses, few studies report the actual uses of Internet technologies alone or in combination with other technologies in effective distance learning. Hence, these suggestions are based on minimal evidence. Many distance education practitioners (see Bergen & Kingston, 1994; Neal, Ramsay, & Preece, 1997; Stubbs & Burnham, 1990) have identified the problem of too little data on technology use and its effectiveness. As the number of distance-learning programs increases and the range of delivery techniques grow, it is important to examine the actual use and the effectiveness of distance education technologies in order to best select and deploy these technologies.

Stubbs and Burnham (1990) state that ample evidence exists to suggest that media affect the learning outcomes only as they affect methods (the relationships between an institution and learners) and techniques (instructional relationships between the learner and the material to be learned). It is thus meaningless to discuss pure technology use without putting the discussion in a context of distance course content, learner characteristics, and the instructional design of the course.

In this article, I report a case study on the actual use of distance-education technologies during the design and delivery of a graduate distance course on information ssystems analysis and design. My intention is to observe the actual use of technology by the participants in achieving learning goals. I discuss the technology use in light of the distance course-design philosophies and actual learning results to provide evidence of the effectiveness of technologies in terms of achievement of learning goals, student perception of learning, and student satisfaction.

In the remainder of the article, I first review some theoretical studies on effective learning, which leads to the introduction of our philosophy of distance course design. This philosophy affects the way technologies are studied in distance learning. I then report research methods and procedures on technology use, data collection and categorization, and results. I further discuss implications of our findings to distance education. I then point out future research directions.

PHILOSOPHY FOR EFFECTIVE DISTANCE LEARNING

Alavi (1994) identified three attributes of effective learning processes from cognitive learning theory: active learning and construction of knowledge, cooperation and teamwork in learning, and learning through problem solving. Learners construct meaning from the material studied by processing it through existing mental structures and then retaining it in long-term memory, where it remains available for further processing and possible reconstruction. Studies have pointed out the positive motivational and effective cognitive aspects involved in group-oriented learning processes. Learning is believed to be expedited in challenging problem-solving situations in which mental models are tested, extended, and refined until they are effective and reliable in solving that problem (Alavi). Theories in distance-education research particularly indicate that distant students tend to experience situated learning and problem-based learning (Savery & Duffy, 1995, Streibel, 1991).

I have four principles for designing distance courses (Zhang 1997). First of all, I ground my distance courses in Jerome Bruner's(1979) educational philosophy of discovery learning, which emphasizes intrinsic motivation and self-sponsored curiosity and creative learning. I believe that distant graduate students benefit most from situated learning (Streibel, 1991) and problem-based learning (Savery & Duffy, 1995). Most distance students are motivated and mature adult learners and have working experience. They would prefer to actively construct their own internal representations of knowledge rather than accept what the instructor gives. Thus, they would more likely experience situated and problem-based learning. The challenge for distance educators is to set up a cognitively rich learning environment to facilitate the distant students' construction processes.

Second, I believe that in any education, the ultimate goal is effective learning by the learners. Thus, effective education is learner-centered education. Any course should start with a thorough analysis of potential students in terms of their backgrounds (technical proficiency, work experience, career plans, dis-

tance-learning experience, etc.), learning objectives, and self-assessments of competency on subject topics.

Third, I think that enforcement or control helps distance learners, who play multiple roles in their lives, achieve higher learning performance and satisfaction. Enforcement includes the instructor's control of student effort on different subject topics in the course (workload, iteration or reinforcement, and integration), on student involvement in class activities and collaborative learning, and on learning pace (time scheduling). This facet of my philosophy implies that learning is not completely controlled by the student.

My fourth principle addresses the role technology plays in distance learning. Sherry (1996) notes that "too often, instructional designers and curriculum developers have become enamored of the latest technologies without dealing with the underlying issues of learner characteristics and needs, the influence of media upon the instructional process, equity of access to interactive delivery systems, and the new roles of teacher, site facilitator, and student in the distance learning process" (Sherry, p. 337.) I agree with Sherry and believe that the driving force of a distance course is the effective learning of subject topics, not the enforcement of state-of-the-art distance technologies.

METHOD AND PROCEDURE

Technology selection and actual use closely relate to distance course models and objectives (Sherry, 1996). The distance course I use to conduct this case study is a graduate course on information systems analysis and design (SA&D). This course has a short residency period (3–4 days) for face-to-face intensive meetings, followed by home study on the Internet during the rest of the course (four months). This model of delivery is largely determined by the heavy technical and hands-on emphasis of the course, which would make it difficult to deliver as either a one-week intensive class or completely in a distance format without any face-to-face meeting. In this section, I briefly describe the design of the course in order to provide a context for discussion of technology uses. It is beyond the scope of this article to discuss distance course models. Interested readers can find more details on course models and the design of the SA&D course in Zhang (1997).

Learner-Centered Objectives and Content

SA&D is a complex, challenging, and stimulating organizational process that a team of business and system professionals uses to develop and maintain computer-based information systems (Hoffer, George, & Valacich, 1996). Students often realize that the course is very challenging. It requires them to actually build their analytical skills, communication and collaboration skills, and managerial skills.

Based on the students' profiles, I decided to cover most aspects of SA&D, but to focus on the front end of the system-development life cycle. This focus includes an emphasis on analytical skills and soft skills. Students gain analyti-

cal skills by modeling organizations' information needs using three techniques: Entity Relationship modeling, Data Flow modeling, and Object Oriented analysis. A student's soft skills include oral and written presentation skills, time management, and the ability to interact with peers. The course objectives are accompanied by three learning themes: (1) experiential learning through assignments and projects; (2) collaborative learning of important concepts and techniques through project conduction; and (3) shared learning through peer project evaluations.

One of the major aspects of the course is the requirement that students identify, initiate, specify, and analyze real-world projects. Each student plays different key roles in SA&D in order to learn different perspectives. Thus, each student has to be both the customer (user) of a project and the analyst of another project. A customer of a project identifies a real-world project topic, initiates a project proposal, and then assists the analyst in finishing the analysis by providing details and evaluating the deliverables. An analyst analyzes the proposed project, provides representations of the project using the techniques introduced in class, gets approval from the customer for each deliverable, and revises analysis results based on feedback from the customer, the instructor, and the teaching assistant (TA). Both the customer and the analyst are responsible for the entire project. A very important document for the project is the interaction worksheet. Each party in a project records all the project-related interactions he or she has with either the instructor, the TA, or the other party; the means of communication; the length or duration; the topics; and the major decisions made. Selected peers, the instructor, and the TA assess each student's effort and performance based on the final project report and the interaction worksheets. This implies that each student also has a chance to evaluate other students' projects and, thereby, to learn from others in the class.

Students are evaluated on (1) their performance on several individual assignments (position paper, term paper, three modeling techniques, and project review) and (2) collaborative effort and performance as reflected in project reports.

Instructional Methods and Strategies

As this SA&D course actually has three distinct periods (preresidency, a four-day residency, and a remote home-study period), different strategies were used for each period. For preresidency, students warmed themselves up by writing a position paper on the role of analysts in SA&D and selecting a suitable real-world project. During the residency, the emphases were on the overall picture of the field, the understanding of the three modeling methods, and the initiation of team projects. For the home-study period, students used what they learned to complete individual assignments and the projects. During this period, individual assistance using available technologies became the primary concern. The goal was to ensure that students could get timely assistance and feedback, finish individual assignments on time, and, most importantly, finish projects by integrating their knowledge and skills.

My decisions regarding possible technology selection are influenced by three factors:

1. The perceived effectiveness of all types of distance-learning needs. Perceived technology effectiveness data were collected from the students before the residency. Because the majority of the students in this class had taken other distance courses and, thus, had some distance-learning experience, the survey data were considered predictive.
2. The analysis of the availability of the technology. My goal was to minimize the cost of installing, maintaining, and training, if possible. Availability also means that the technology is familiar to students or the instructor.
3. My intent of little enforcement and loose control over technology uses. Among the suggested technologies, students could decide which one to use for a particular purpose.

Participants

The course was delivered in the spring 1997 semester. Participants included one instructor, one TA, one distance-program director, and 15 enrolled students. Among the students, 1 was from Japan, 1 from Spain, 1 from Canada, and 12 from five states of the United States (LA, NY, PA, SC, and VA). There were nine male and six female students. The students' ages ranged from 26 to 54; the average age was 34, with a standard deviation of 7. Three of them already held masters degrees. Fourteen had a bachelors degree. Nine of the 15 students were taking one other distance course, and one student was taking two other distance courses at the same time. One student stopped performing toward the end of the semester and eventually failed the class because of family problems.

DATA COLLECTION AND CATEGORIZATION

There are two data-collection stages in the study. The first stage was about predicted effectiveness of technologies provided by students on a precourse questionnaire before the class started. Based on the data collected, a set of technologies was suggested for the course, as summarized in Table 1. All participants were required to subscribe to the class listserv. The listserv was to function as a broadcast facility and classwide discussion vehicle. The instructor's personal e-mail address, the TA's personal e-mail address, and the class account e-mail address were available to the students. Although some e-mail utilities can attach a binary file, which can be used as a way of distributing some course materials or assignments, not everyone uses the same e-mail utility. A class FTP site was thus set up for distributing class materials and collecting students' assignments; the use of FTP was optional. A class Web page was designed to function as a map that included links to the class FTP site, all e-mail addresses, and course materials such as syllabus, class handouts, as-

Table 1
Intended Purpose of Suggested Technology for SA&D Distance Learning

	Students to Students	Students to Instructor (&TA)	Instructor (&TA) to Students
Web	• Share information	• Submit assignments	• Provide a unified class map for sources of info, standard course materials (syllabus, assignment descriptions, handouts, and help info), general feedback (current grades and solutions to assignments)
FTP	• Share documents	• Submit assignments	• Deliver ad hoc, rich-format course materials
Listserv	• Seek help from peers	• Ask questions/ Receive answers that may be of interest to other students	• Broadcast • Conduct classwide discussion
IRC	• Exchange ideas • Conduct in-depth discussion	(not supported)	(not supported)
Private E-mail	• Exchange ideas • Discuss in-depth	• Discuss any course-related issue individually	• Discuss any course-related issue individually
Mail	• Share information • Get approval for project	• Submit assignments	• Return graded assignments • Deliver assignments
Fax	• Share information • Get approval for project	• Submit assignments	• Deliver assignments • Use in case of failure of other online technologies
Phone	• Exchange ideas • Conduct in-depth discussion	• Discuss any course-related issue individually	• Discuss any course-related issue individually

signments and solutions, coursework evaluation summary, students' current grades, and help instructions for using the class listserv and FTP. Students were encouraged to develop their own Web pages for this class or use Internet Relay Chat (IRC) if they deemed it necessary. However, the course did not technically support IRC. Other technologies that could be used included fax, mail (e.g., FedEx, priority mail, and first-class mail), and telephone.

The second stage of data collection occurred during and after the course. Data regarding actual technology use were collected from the following sources. A computer server captured the FTP data. The instructor's accounts (personal and class accounts) stored all the e-mail messages between the instructor and the students, the instructor and the TA, and the instructor and the program director. The accounts also captured all the listserv posts. Web counters showed the total access times of the Web pages (including outside parties and the instructor's access). The instructor kept records of phone calls, mail, faxes, and class handouts. Except for the listserv, the data on communications between students are from the students' interaction worksheets in project reports. Thus, these data are student-reported technology use for projects only.

A content analysis of the approximately 500 e-mail messages in the instructor's and the course accounts shows three primary purposes for communication: subject or topic related, general administration related, and submission related. The appendix on page 417 shows examples of these three types of e-mails. Subject or topic related e-mail messages include the questions, confusions, and difficulties with the topics. They also include brainstorming for assignment ideas (such as term-paper topics) and inquiries about assignment requirements. General administrative e-mail messages concern course pace, students' performance and progress, team issues or difficulties, and general comments to the class. Submission related e-mail messages are considered outside of general class administration because the number of e-mail messages for this purpose is surprisingly large. This type of e-mail deals with the status of assignments, signals for sending or receiving an assignment submission, and sometimes the submissions themselves as e-mail attachments. For the rest of the article, I use "submission" to indicate subject or topic related submissions such as individual assignments or project reports. Course survey responses are not included as submissions.

Between the students and the TA, the main communication medium was e-mail. There were a total of 25 e-mail messages regarding submission (15), subject topics (4), and administration (6). Between the instructor and the TA, most of the 46 e-mail messages were about course administrative issues such as downloading assignments, grading, and distribution of graded assignments. A total of 10 e-mail messages between the instructor and the program director concerned administrative issues. Figure 1 depicts the e-mail communication among all the people involved in the class. Because the communications involving the TA and the program director are much less frequent than other communications, as indicated in Figure 1, our analysis focuses mainly on the communication involving the instructor and the students.

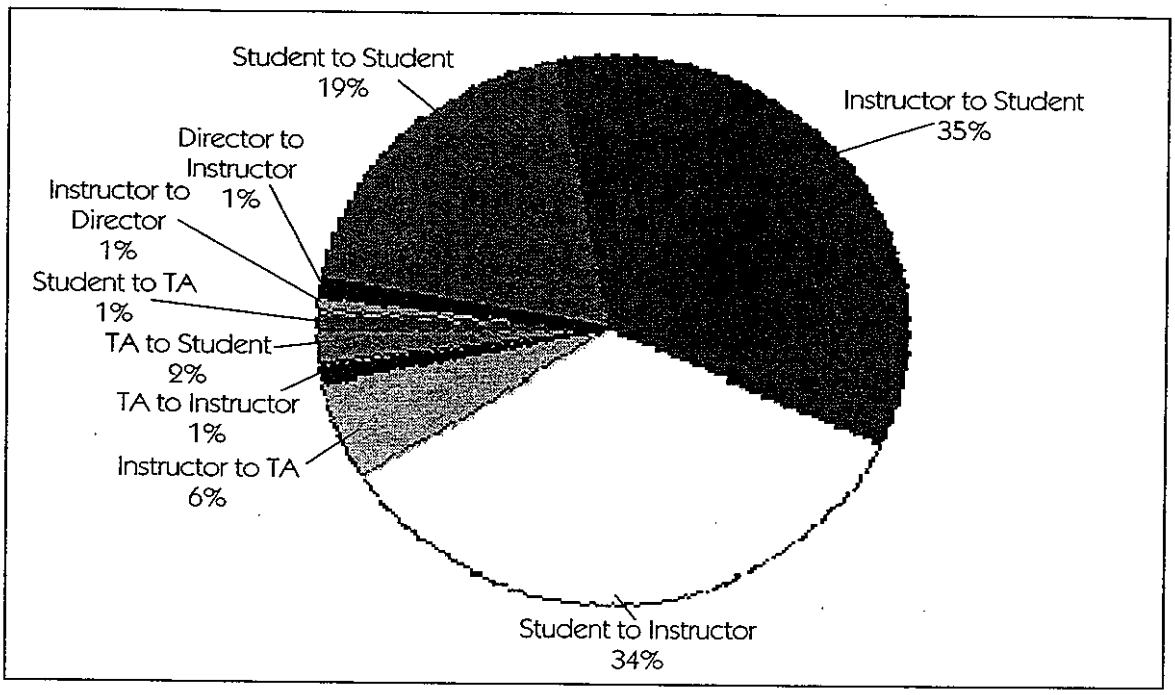


Figure 1. Distribution of number of e-mail messages by source (a total of 659 e-mail messages)

Using the same layout as in Table 1, Table 2 reports the number of people who used a particular technology, total number of times the technology was used, and, where possible, a breakdown of the use according to purposes (administration, subject topic related, submission related, or other). It also includes the volume or duration of usage when such data are available. For example, number of pages for faxes and FTP and number of hours for IRC are listed in Table 2.

RESULTS

Teaching and Learning Evaluation

By the end of the course, the instructor and most of the students felt that the class helped the students achieve the learning objectives. Among the 14 students who passed the course, 11 achieved A's, two A–'s, and one B+, the best performance among three SA&D courses the instructor taught (the other two were traditional on-campus courses) over three semesters. The self-assessed learner achievement measure shows that on average, the class achieved competencies that are two levels higher than at the beginning of the class on 9 of 10 subject topics assessed (that is a competency of 4.28 over the initial competency of 2.22, with the highest competency of 5. For more details, see Zhang, 1997).

The school's formal course evaluation uses a scale in which 1 = outstanding, 2 = above average, 3 = average, and 4 = poor; this instrument includes five items that are related to course design and delivery, which is scored as follows:

Table 2
Statistics of Technology Use in SA&D Distance Learning

	Instructor to Students	Students to Instructor	Students to Students
Web	Web access as of last day of class: • 989 times to class homepage • 307 times to syllabus • 217 times to project descriptions	• 9 students had a Web page • 12 project reports by 7 people • 29 out of 89 classwide other assignments by 9 people	• 7 students used the Web • 7 final reports delivered • 26 exchanges of info before projects were finished
FTP	• 7 documents in total of 10 pages	• 10 students used FTP • 6 submissions/20 pages • 14 other materials in 40 pages	

Listserv	• 26 posts in total
	  • 10 subject/topic related
	  • 15 administrative matters
	  • 1 submission related
			• 4 students used listserv
			• 4 posts in total
			  • 2 messages for help
			  • 1 response
			  1 greeting

IRC			• 4 students in 2 groups • 10 times in total • 13 hours in total

Private E-mail	• 15 students received e-mail
	• 261 e-mail messages in total
	  • 63 subject/topic related
	  • 92 administration
	  • 106 submission related
		• 15 students used
		• 255 e-mails in total
		  • 42 subject/topic related
		  • 64 administration
		  • 149 submission related
			• 15 students used
			• 143 total e-mails

ability to involve students in materials (1.8), provokes and stimulates critical thinking (1.8), course provides intellectual challenge (1.5), course provides new viewpoints (1.5), and quality and frequency of feedback (1.3).

Table 2 cont.			
	Instructor to Students	Students to Instructor	Students to Students

Mail	• 13 students received mail
	• 81 mail in total
	  • 70 feedback to assignments/ projects
	  • 11 projects reports for peer reviews
		• 6 students used mail
		• 8 submissions in total
		  • 6 project reports
		  • 2 other assignments
			• 3 students used
			• 3 mails in total

Fax	• 7 students received faxes
	• 12 faxes in total of 86 pages
	• 3 grading remarks in total of 28 pages
	• 2 project reports for peer review in total of 40 pages
	• 7 other materials in total of 18 pages
		• 14 students used
		• 70 faxes in total of 545 pages
		  • 10 projects in 336 pages
		  • 45 other assignments in total of 179 pages
		  • 15 other materials in 30 pages
			• 7 students used
			• 26 faxes in total

Phone	• 1 student received
	• 1 call for solving team problems
		• 1 student used phone
		• 4 calls in total
		  • 2 subject/topic related
		  • 2 administration grading
			• 10 students used phone
			• 32 calls in total

Following are some of the students' informal statements that appeared in their project reports, course surveys, and e-mail messages to the instructor. More statements can be found in Zhang (1997).

> I have learned a great deal in this class and this exercise (the project) in particular. I had NO experience in SA&D. While I found the course very challenging I feel that I will take with me a plethora of skills that I will be able to use in my new vocations.

> As a person who is employed full-time in the information technology field, I have received substantial job-related benefits from this experience. Already I have put the knowledge I've gained to good use evaluating and planning information management projects at work.

> I am glad to know that my employer (who is paying my tuition) is getting its money's worth. More importantly, I'm pleased that my investment of time and effort is paying tangible professional dividends.
>
> I felt I learned a significant amount in this course. The workload was heavy, and deadlines were enforced, but this improved learning.

Technology Uses

Using descriptive data analysis, I focus on each of the suggested technologies and draw some preliminary conclusions and practical applications. Among all these technologies, e-mail was most used for communication and will be discussed at the end of this section.

Web page. The class Web page served very well as a unified map for the class. Students seemed to refer to it first when they had uncertainties or had misplaced any handouts or materials. Nine out of 15 students, or 60%, set up their own Web pages specifically for the class. Some encountered difficulty putting drawings on the Web during the first half of the class. This affected their use of the Web for submitting assignments that required drawings. Among the students who had Web pages, the common use of the Web was for submitting position papers, term papers, and project proposals, which required no graphs. The majority of these people, however, managed to put their projects on the Web by the end of the class. This made the review process much easier and less expensive for the instructors, the TA, and other students acting as reviewers. According to the students' reports, there was also considerable use of the Web to exchange project information between group members.

A class Web site is definitely very helpful and should be considered a necessary part of the instructional material. It can also serve as a unified organization of all other Internet technologies, such as FTP, listserv, and IRC. The class Web site can be the only interface between the students and the instructional materials and methods. When students use their Web pages, both teaching and learning are enhanced. Students can communicate with peers using supporting documents, and the instructor's downloading burden is reduced. As more and more people know how to write HTML documents, it is reasonable to require students to have their own Web pages for distance courses. Administrative support may be needed in case a student does not have an Internet carrier for the Web page.

FTP. FTP was used primarily to distribute and collect course surveys. Because the survey questionnaires had a very rich format in Microsoft Word (1983–1998), the instructor uploaded it to the FTP site and suggested that students download it, use Word to complete it, and then upload it back to the FTP site. Three students also used FTP to submit assignments. No one used FTP to share documents with each other during the project. In general, FTP was not extensively used. There were very few reported difficulties associated with using it.

FTP can be used primarily for collecting online documents from students. In our case, we could put the rich format questionnaires at the class Web site for students to download. If there are other ways to collect online documents from students, then FTP can be removed from the technology set for distance courses. Other ways for collecting online documents from students include student Web pages and attachments in e-mail messages.

Listserv. Of the 30 posts, only 4 were from students. Two of them (one seeking help and the other responding) occurred when the instructor was on vacation during spring break and a deadline was approaching. One was a greeting from a student. One sought help from other students. In general, there was very little classwide discussion initiated by students, particularly over the listserv. A possible explanation is that in this class, students were not required to contribute to the listserv, nor were they evaluated on how much contribution they provided to the class listserv. Without this pressure, the classwide listserv seemed very quiet. No student complained about this, although one student pointed it out to the instructor as an interesting fact. The posts from the instructor were mostly for administrative purposes and responses to individual questions on subject topics when the instructor felt other students might benefit from the discussion. The average post frequency was 4.2 days, with a standard deviation of 3.8. The instructor felt that the listserv worked well for timely broadcasting.

Listservs are critical for immediate broadcasting of information. Although documents or messages can be posted on the class Web site, students may not be aware of the post right away. E-mail, however, has become part of everyone's life. People check their e-mail more often than they would purposely visit the class Web site. This immediate nature of the listserv based on e-mail can make listservs favorable tools for distance teaching.

IRC. Although the class did not technically support IRC, four students used it for their projects. These students were taking another distance course that supported IRC. According to these students, IRC served them very well in clarifying confusions and formulating important decisions. Without using IRC, however, the other 10 students also finished the projects on time with satisfactory quality.

IRC can be very useful to satisfy synchronous communication needs in a distance-learning mode. There are, however, issues concerning how to use IRC effectively and questions of whether IRC is more effective than other communication methods, such as e-mail. Discussion control and sufficient practice affect the effectiveness of IRC. The number of participants is another important factor. Duin and Archee (1996) conducted a preliminary study on how collaborators working across distance perceive and use e-mail and IRC to facilitate their collaboration and decision-making processes. Students from the United States and Australia worked in pairs to respond to four decision-making scenarios over a 4-week period. The study found that using e-mail, students came to a decision more quickly than when using IRC, and when IRC was slow, students reverted to a series of rapid-fire e-mail messages to facilitate their work.

Regular mail. FedEx and first-class and priority mail were used during the class. These methods of communication were used to provide the feedback on students' assignments. Mail was also the primary method of sending students' final projects for peer review. Thirty-nine percent of packages to be reviewed (11 out of 28; each person reviewed two packages, and 14 projects were finished) were sent through priority mails. Except the final projects, for which students were required to submit multiple copies for other students to review, students did not use mail extensively to submit their assignments (only two instances) or to share information (three instances) with each other. The instructor used mail when context was needed for feedback comments. For example, each element of an Entity Relationship Diagram may need to be commented upon. The comments would be very difficult to make and comprehend if the diagram itself were not included with the comments.

When time is not a major concern, regular mail is still effective and favored. People are used to reading on paper, and most people still prefer to read on paper. Meanwhile, mail can carry something that is more personal, such as handwriting or the binding of the package. FedEx can be timely but too costly for most distance students. It is hard to say if regular mail will disappear from distance learning.

Fax. Students seemed to favor faxes for sending timely materials to the instructor (such as project reports or other assignments before deadlines) or other students (project documents). Ten out of 28 (36%) of the project reports (each project has an intermediate report and a final report) were submitted by fax, despite the fact that these submissions were usually long, with an average of 34 pages per fax. Students also used fax to submit a total of 45 out of a classwide 89 (51%) individual assignments. During the project, half of the class sent an average of 3.7 faxes to their partners. The other half did not use fax at all.

The instructor found that fax was the most efficient way of receiving assignments. It saved the effort of downloading online submissions, which could be very frustrating and time consuming because of variations in the platforms, software, and software versions that the students and the instructor used. There were, of course, instances where pages or entire submissions were lost during fax transmission. Sometimes the quality of the faxed pages was not good.

Fax will continue to be an effective technology for distance learning. It has both timely and personal features, and it is easy to use and widely available. The course also raised these additinal issues and suggestions. Students complained that the only fax machine was busy most of the time, the faxed documents were missing completely or by pages, and the faxed documents were not put in the instructor's mailbox in a timely manner. The instructor found similar problems. It was suggested that the program director have a fax machine that is used for distance education only, and that the director should take care of the faxed documents by putting them together and in the instructor's mailbox in time. Although this may not be the only solution, further administrative support is definitely needed to make fax an effective technology for distance education.

Telephone. This traditional two-way communication was the only method of simultaneous communication available to everyone in the class (except those four students who used IRC). It was, however, almost completely unused by the instructor and the students for subject- or topic-related discussions. The five phone calls between the instructor and the students were all administrative. The student who made four calls to the instructor seemed to prefer to use the phone and initiated four phone calls in the project. Nine other students used 28 phone calls for the projects (average three calls per person). Five students did not use phone at all during the project.

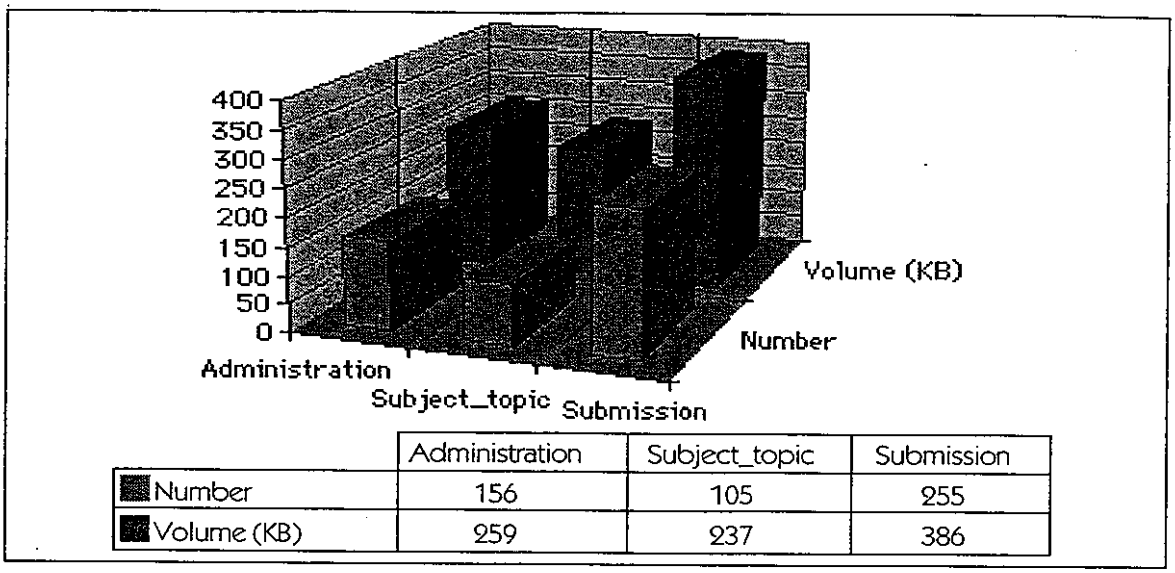
It may be owing to the nature of this course that so few phone calls were made, but this still is a bit surprising. More empirical studies are needed to find out the roles telephone plays in distance learning.

E-mail. E-mail was the most popular communication method. There were a total of 516 e-mail messages between the instructor and the students, and 143 reported between students during the project. Of the 516 e-mail messages, 34 (6.6%) had multiple purposes. For the analysis, each e-mail message was counted only once based on its primary purpose. For example, if in a message the student notifies the instructor about the delivery of the final project (submission) and also asks about the feasibility of a potential term paper topic (subject topic), then the e-mail is counted as a submission e-mail. The volume was the number of characters in the body of the message. Attachments were not counted toward volume.

Figure 1 shows the distribution of the 659 e-mail messages by source, or whom the e-mail was from. From the students to the instructor, the average number of e-mail messages per student was 17.1, with a standard deviation of 6.1. The average volume of e-mail was 1.8kb. The average frequency of e-mail was 0.5 per day, with a standard deviation of 0.9 per day. The highest number of messages received on one day was 11. From the instructor to the students, the average frequency was 0.5 messages per day, with a standard deviation of 1.2 per day. The highest number of messages sent to the students on one day was 19.

The distribution of number of e-mail messages and e-mail volume seem consistent with each other. Figure 2 shows the distribution of number and volume of the 516 messages (excluding student-to-student e-mail, owing to the unknown contents of these messages) by purpose. On average, each message was about 1.75 KB long. Subject-or topic-related e-mail messages were the longest (about 2.3 KB), submission messages the shortest (1.5 KB), and general administration average about 1.75 KB.

At first glance, there was a surprisingly large number of e-mail massages on submission-related matters, 255 out of 516, or 49.4%. A detailed analysis shows that on average, however, each assignment from each student took only two e-mail massages. The class had a policy for late submissions. Students were told to be responsible for informing the instructor about the delivery of their assignments. Thus the number of e-mail messages was in proportion to the number of students in the class and the number of assignments they needed to turn in.



	Administration	Subject_topic	Submission
Number	156	105	255
Volume (KB)	259	237	386

Figure 2. Distribution of e-mail messages by purpose (based on 516 e-mail messages between the instructor and the students)

Summary of Technology Use

With the exception of subscribing to the listserv, no technology use was mandatory. Students used their own preferred technologies for communication and submissions. Means of submitting assignments when there was no hard-copy requirement included fax (51%), Web (33%), e-mail attachment (8%), FTP (7%), and regular mail (2%). Means of submitting assignments when there was a hard copy requirement were Web (43%), fax (36%), and regular mail (21%). E-mail messages include all submission-related issues. Primary means for class administration-related issues were e-mail and listserv.

Because there was a four-day face-to-face meeting covering all the subject topics to a certain depth, as described in earlier sections, there was no need to have a classwide synchronous discussion on topics that were new to the students. There was no such a need for smaller subgroup of students, either. This unique feature determined that this course did not demand a synchronous discussion facility, and a less expensive facility (such as a listserv that does not demand participants to attend at a specific moment for communication) would be sufficient. This feature also determined some of the technology-use patterns. For example, very few posts to the listserv were about subject topics. This may not be the case for other distance courses on different subject topics or with different delivery formats.

DISCUSSION

There are three aspects that seem to deserve more discussion and from which we can draw further implications. In this section, I focus on interaction patterns, administrative load, and distance technology selection.

Interaction Patterns

When there was a need for help, students tended to seek assistance directly from the instructor. This may have to do with the perceived turn-around time, the accuracy of the information from peers, and the low level of personal relationships among the students. Most of them did not know each other before they started this class, and they had only limited opportunity to become acquainted with each other face to face (four days). With no obligation to participate in listserv discussions, students e-mailed the instructor first when they had difficulties. They also demanded fast responses from the instructor. Most of the instructor's responses to students' e-mail messages were within one day. Turn-around time for feedback on students' assignments was within a week in most cases. Students seemed satisfied with the speed of feedback.

The implication of the interaction patterns is that distant instructors should use certain mechanisms to facilitate interactions among students, thus enhancing collaborative learning. The fact that students were forced to have a partner for their projects in this class helped them interact with each other. Project reports seemed to indicate that many students collaborated on the project ideas initially to make sure they were on the same track and then went on their own to complete them.

Bates (1991) notes that the main advances in distance education will come from technologies that allow increased learner interaction, not from those based on relaying lectures. The important point, he contends, is not merely to use interactive technologies to connect people, but to maximize social interaction. In our study, we found minimal evidence regarding social interaction among students in general, although students involved in one group seemed to have some social interaction apart from course-related interaction. It seems that this maximum interaction among students needs to be fostered by careful consideration in the instructional design, that is, a built-in intention to increase students' social interaction. It may also be the case, as Moore (1989) pointed out, that there is a relationship between types of interaction (learner–content interaction, learner–instructor interaction, and learner–learner interaction) and the control of that interaction upon different types of learning. On the other hand, this minimum social interaction among students that are not involved in one group did not seem to have much negative impact on students' learning performance. Social interaction among students becomes important when it is closely linked to learning objectives, as in our case of the groups for projects.

Distance Course Administrative Load

The outstanding proportion of submission-related e-mail messages confirmed the claim that distance teaching has a much heavier administrative load than conventional teaching during the course delivery. Together with other administrative e-mail messages in this class, these two types of e-mail accounted for

almost 80% of the e-mail. Although assignments and feedback are very important to learning, the implications of this fact are that first, the size of a distant class needs to be carefully considered to ensure manageable course administration. Second, additional course assistance should be provided to distant instructors to reduce their course administration workload. Because distance learning is truly independent study that emphasizes individualization, distant instructors should be supported to focus on one-to-one guidance of student learning.

Some studies on costs of distance education conclude that distance education is a cost-effective alternative to resident education (see for example Phelps, Wells, Ashworth, & Hahn, 1991). We would like to point out that researchers need to use caution when capturing cost factors and must not overlook or underestimate the administrative cost during the delivery of a distance course.

Distance Technology Selection

There was little effort expended in installing, maintaining, or training on the technologies used. Except for the listserv, no technology was required. The loose control of technology made the students feel comfortable about using their own preferred and available technologies. There were times, however, when various technologies did not function properly. For example, an FTPed document was not accessible by the receiver, a mailed package was lost, and a faxed document was missing pages, to name just a few. In general, however, technology did not function as a distraction; thus, the instructor and the students could concentrate on the subject matter. As a result, the combination of the available Internet technologies (Web, e-mail, FTP, listserv, and IRC) and some traditional technologies (fax, mail, and phone) are effective in supporting this rather challenging distance course. The implication of this result is that distance education, especially Internet-based distance education, can be delivered effectively using existing technologies (some of them are traditional and some of them are Internet based). One caution is that the selection of technologies for a particular course is dependent on the nature of the course, students' characteristics, and other factors, such as the size of the class.

CONCLUSION

This article discussed in detail the actual use of technologies in the distance teaching of a graduate course. It is intended to provide evidence rather than speculations on distance technology selection, use, and effectiveness. This study shows that distance technologies do not need to be expensive or fancy to be effective for distance teaching and learning. Traditional technologies, such as fax, phone, and mail, are still effective for some purposes and will not disappear from distance education in the near future. Minimal control of student technology use during distance learning may reduce students' technology anxiety. Strong administrative support should be provided to distance instructors.

There are several areas that we believe are important for future research. First, there is a need for more in-depth empirical study of the relationship between technology support and the nature of the subject matter of a distance-learning course. In this study, the SA&D course is a technical and hands-on course rather than a management and discussion-based course. For the latter, examples or cases are important for discussions and exchange for viewpoints, and answers to questions are not just right or wrong. The nature of the course determines the learning tasks and may affect the selection and use of technologies in distance education. Empirical studies can provide insight into this relationship so that better technology selection and deployment can occur in practice.

Second, the size of a distant class can affect the selection, use, and effectiveness of technology in facilitating teaching and learning. A class for hundreds is quite different from a class of 15. In the former, certain technologies, such as video- or audioconferences, might be more effective than IRC or e-mail. Empirical evidence is needed to justify selection of different technologies. On the other hand, instructors also must be careful in designing the course delivery and evaluation. A colleague of mine is distance-teaching a class of 51 and is flooded with hundreds of e-mail messages from individual students almost every day. In this class, 50% of a student's grade is based on student participation.

Contibutor

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Appendix A
Sample E-Mail Messages

Note: To protect the privacy of the students and the instructor, the identities are removed. Students' spelling is used throughout.

Subject/Topic Related

From aaa@aaa
Date: Mon, 21 Apr 1997 16:29:55 -0400
Subject: Term paper

Prefessor,

Since the topic of my term paper is somewhat different than the suggestions you outlined on the Web page, it occurred to me over the weekend that I should run it by you to be sure it is acceptable. If it is not, I still have a few days to come up with something else.

About a month ago, I was presented with a request at work to help one of our divisions come up with a way to track information about certain procedures. Because of what I have learned in your class, my approach to this project is completely different than my approach to similar projects before this semester. I am using some of the diagramming skills we learned, and my overall project management and documentation is completely different. My paper is a discussion of the change in approach and effectiveness achieved by using standard Systems Analysis procedures, as contrasted to a similar project undertaken before I learned these techniques. While I am finding this fascinating, I want to be certain that it will meet your requirements for a term paper. Certainly, I will not have the same kinds of references that would appear in a standard "term paper" b" ause much of my work is drawn from personal experience and investigation.

Let me know your feelings. I will abide by your decision either way.

Thank you,

From bbb@bbb
Date: Thu, 13 Mar 1997 16:59:00 -0500
Subject: Questions

Professor,

I have a couple of questions regarding signatures and the proposal/specification.

First as far as the signature goes, since Steve is in Japan and I am here could we use a "signature on file" to mean that it is approved by the parties involved? This would mean that He approved the work I did and then I would physically sign the work myself. Is this okay?

Secondly, is the proposal and the specification the same thing? In your e-mail you address them as 2 separate entities. If they are could you elaborate on what exactly the specification paper is? Am I to do the specification for my proposed product or do I write the specs for Steve's project.

General or Administration Related

From ddd@ddd
Date: Sun, 27 Apr 1997 20:19:38 -0900
Subject: Re: peer review of projects

Dear professor,

If the caliber of the reviews is high, then I for one wold love to see the reviews of my work. I think it would give me great background and more understanding. I do strongly agree we need to make sure that all is kept anonymous. Just my 2 cents worth.

Best regards,

From yyy@yyy
Date: Wed, 19 Feb 1997 11:38:42 -0500 (EST)
Subject: Re: mid-semester class feedback

Professor,

In response to your request for feedback on IST552:

I feel that the course is going well. I enjoyed the residency portion of the class. I also read and re-read the System Analysis text book and really liked it. I found the OOA book very difficult, however. I have put a lot of hours into my project already and am feeling pretty good about my progress thus far. I wish to present my project report on my Web site rather than use hardcopy. Is this OK? If so, how can I have Kevin (my customer) sign it? Can I possibly have him send me an e-mail that I post on the site? Hope all is going well with you.

Thank you.

Submission Related

From fff@fff
Date: Mon, 27 Jan 1997 08:47:19 -0500
Subject: Assignment one

Professor,

I am faxing my results from assignment one this morning to 315-443-5806)

I have really struggled with this assignment and at this point I'm rather confused. I used to do this kind of work about 6 years ago, but this class has made me realize that I have forgotten almost everything I knew!!!!!

I look forward to your and Anna's input, before I continue with the project assignment.

Please acknowledge the receipt of the fax.

Thanks

From *zzz@zzz*
Date: *Fri, 25 Apr 1997 18:45:54 -0400*
Subject: *Term paper*

Professor,

I just faxed you my paper. I'm afraid it is a bit longer than you requested. I shortened it as much as I could without losing the meaning. I found writing it to be a cathartic and beneficial experience. Sometimes reviewing our actions is as important as the actual doing of them.

Have a good weekend