Integrating Distance Learning with Traditional Delivery in a Graduate Certificate Program for IT Professionals

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Abstract

In this paper we compare our experience with two distance education models for teaching professional graduate students. The first is a synchronous video conferencing delivery model and the second is a blended Web-based and traditional learning model. The former was used for beaming out graduate courses to the Foxboro Company, and the latter was within the context of a graduate database & client/server certificate program where we successfully delivered four graduate courses to employees of Keane, Inc. Both are technology companies with offices in the US and UK. Research results and student evaluations demonstrate that the blended model was more successful than the pure model as it combined the advantages of traditional learning with distance education very well. The blended approach provided students what they wanted--a unique continuing education experience—flexible asynchronous education and some face-to-face classroom instruction. The professors also got the satisfaction of seeing students and evaluating their progress within the context of classroom sessions. The university was also satisfied with the blended approach as it provided a better experience for the students via quality student-teacher and student-student interactions. This paper provides details about the unique technology used in both the models. The strengths and limitations of using such technology distance education are also discussed.

1. Introduction

The American Council on Education estimates that 85% of traditional colleges and universities offer distance-accessible courses.[1] Some disciplines more than other are well suited to leverage distance learning. Opportunities for distance learning are especially timely in the information technology (IT) arena. The explosive growth of the Internet and the related development of web technologies for engineering, science, business, and virtually every field of human endeavor have dramatically increased the need for education and training in the field of information technology.[2] As comments from some of our students will reveal, distance learning has provided them an opportunity to take classes and pursue higher education, which they might not have otherwise. With computing technology evolving at a rapid pace students in the IT field students need to

take courses to improve job skills and at the same time juggle a full time job and family. Here distance learning provides an additional avenue to help busy students.

With the popularity of WWW and Web-Based Instruction (WBI), a new model to deliver courses on the Internet has emerged. WBI allows us to effectively administer course material, tutorials and quizzes, or to communicate with the students. More important we have a powerful mechanism to teach the class—using the web for communication with the student. Web technology has matured significantly today to allow voice and graphics including video to be effectively transmitted at a distance.

In this paper we compare our experience with two distance education models for teaching professional graduate students. The first is a synchronous teleconferencing delivery model and the second is a blended Web-based and traditional learning model. We provide research results of surveys and student evaluations.

2. Education for Working Adults

For over twenty years, the Computer Science (CS) Department at Boston University's Metropolitan College (MET) has focused on the delivery of graduate and undergraduate education for working adults on a part-time basis. Currently, the Department offers MS degrees in Computer Science, Computer Information Systems and Telecommunications, several graduate certificates, as well as a BS in Computer Science degree. Enrollments increased by 21.87 % over the last five years, and, in the Fall 2000 semester, reached 2,044 registrations distributed over 80 course sections at six different locations. Despite this growth, there was increased demand by well-established companies for state-of-the-art programs (degree or certificate) offered at multiple locations, with a curriculum tailored to the company's needs. The department has a broad course offering and extensive experience in designing and delivering on-site programs for industry, and thus had no difficulty satisfying the curricular requests. However, the typical enrollment at a single location was small (4 to 6 students) and did not warrant a separate course offering. Also, many employees had moderate to heavy travel schedules, and a delivery format allowing for maximal flexibility in time and place for accessing lectures and course materials, or for completing and submitting assigned work, were highly desirable. Obviously, the solution to such a problem is some form of distance education that allows a student to access and work on lectures and course materials at a convenient location and/or time. Let us next describe the two distance learning models that one could pursue.

3. The Model

The distance education scope can be succinctly defined in terms of two dimensions— place and time. Within this framework distance education can be pure or blended. Pure refers to selecting any one of the paradigms listed below. Blended refers to mixing and matching any one of the paradigms listed below with another.

The Work: Place and Time Dimension

Figure 1 illustrates this model. The following paradigms can be studied:

- ❑ Same place and same time
- ❑ Same place but different time
- ❑ Different place but same time, and
- ❑ Different time and different place.

Time / Place	Same	Different
Same	**Face-to-Face Instruction** (Synchronous) E.g.., Traditional	**Non Face-to-Face Instruction** (Asynchronous) E.g.., Pre-recorded Demo in a Lab
Different	**Synchronous Distance Education** E.g.., Video-conferencing	**Asynchronous Distance Education** E.g.., E-Learning

Figure 1: Distance Education Model

Same Place and Same Time: Face-to-Face Traditional Instruction

This is a synchronous traditional teaching strategy. The instructor is present in the classroom with the students. In most cases traditional face-to-face instruction still rules! We have been involved with this aspect of education from the very beginning of time. The plus points with this are that students benefit from the human touch. Many students need this aspect and we quote "The absence of the *father figure* or *mother figure* to take care of them is disconcerting for some students."[3] While this appears to be good at face value research also reveals that having access to the mentor can sometimes prevent the students from working harder. Research reveals such conclusions as "Most students are able to cope with problems, and most students actually enjoy taking responsibility for solving their own problems. This is obviously harder work than letting a teacher do it." [2] Distance learning is not everyone's cup of tea. At least two students in our survey unequivocally longed for *face-to-face* traditional education. They honestly state that their individual learning style does not favor distance learning.

Same Place but Different Time: Non Face-to-Face Instruction

This paradigm is classified as asynchronous because the instructor is not present. Here the participant or student visits the location at different times to listen to some pre-recorded seminar or instructional material (normally constrained by the location's "open

hours" or schedule). The location in this case could be a fixed lab or a classroom with a video recorder. It typically involves some pre-recorded material.

Example 1: The recent kick off of the XP operating system by Microsoft's Bill Gates fits this paradigm. At different times across the world, but at predetermined seminar locations, participants heard a pre-recorded Bill Gates recording describing why the old Windows 95 needs to be dumped in favor of the powerful new Windows XP operating system. How is this paradigm different from *different place different time*? The bottom line is that typically there is a local audience at the same location. From the perspective of the learner this strategy allows for some collaborative, interactive discussion with fellow classmates. But the instructor is not present or available to respond to queries.

Example 2: Another example is pre-recorded video lecture or video lab tutorial (run in a lab room). This model is suitable in a university setting if students need to catch up on pre-requisite knowledge. Let us focus on a course such as Web Programming where students are required to have some pre-requisite HTML knowledge. Before this course begins students are asked to come to the lab and watch the pre-recorded video on HTML, do the labs (without any assistance from the instructor who is absent) and leave at their convenience.

Different Place but Same Time: Synchronous Distance Education

Boston University's has been involved with *Synchronous Distance Education* for more than a decade. The earlier attempts involved video conferencing using PictureTel. Here a "live" professor teaches assembled students in one classroom while other students assembled in a remote campus (with no instructor) participate in the same course using video conferencing.

Example 1: This paper discusses our experience with *Synchronous Distance Education* extensively in Case Study A in the next section. So we will not elaborate this strategy any further here.

Example 2: A variation of this strategy was used by one of the authors (Kanabar) to present instructional material to seminar participants via the Internet using proprietary broadcasting tools from vendors such as *Centra* or *Interwise Inc*. Unlike Example 1 pertaining to PictureTel—there are no live students present in the same classroom where the instructor is broadcasting. This strategy supports highly interactive sessions for up to 25 participants with one instructor and can facilitate deep skills and knowledge transfer. The plus point with this strategy is that the instructor does not have to interface and juggle two unique types of audiences—he/she focuses on the distance audience exclusively. Consequently, both instructor and student experience is likely to be more satisfactory.

Different Place and Different Time: Asynchronous Distance Education

This is commonly referred to as e-learning or on-line learning, as well. What is Online Learning? Basically, it is distance learning using various instructional mediums primarily the Internet. The number of students associated with online learning was 710,000 in

1998, but is expected to exceed 2.23 million in 2002. [2] This paradigm is probably what distance education is all about and where it is heading. This is evident from the formal definition of the term *distance education* by several authorities. IDDA states: "Distance education is a process to create and provide access to learning when the source of information and learners are separated by time and distance." [4] To be classified as true distance education the university should be able to deliver both at a distance and across different time zones.

From the perspective of both the instructor and the student, asynchronous distance education can be a frustrating experience. As indicated earlier, not all students enjoy distance education or e-learning. Their individual learning style simply does not favor solitary distance learning. Many students enjoy interaction with other students and learn deeply only when the instructor is present physically in a classroom setting. From the perspective of the instructor as well asynchronous distance education can be a frustrating experience. Several instructors have complained about juggling technology and tools, in addition to the normal workload of delivering a quality lecture. Also teaching asynchronously and when there is no live audience present can result in an impassive style of teaching. It is not easy to talk to a camera for 3 hours (without going insane). The passion and "story-telling" normally present in live presentations by the instructor can vanish. Interestingly, according to researchers, such "story telling" is a valuable component of quality distance education.

4. Case Study 1: Synchronous Distance Education Strategy

Here is a typical scenario for our pure "different place… same time" distance education strategy. Beginning in the Fall of 1996, a total of twenty-nine Metropolitan College students took part in a unique distance education program at the Foxboro Education center in Foxboro (Boston suburbs). State-of-the-art teleconferencing equipment from PictureTel Corporation allowed one instructor to be in two places simultaneously via video. Every Tuesday and Thursday evening, twenty students gathered in a classroom in the main campus (live setting) and nine settled into a conference room in Foxboro, about 35 miles away. The nine students participated with the instructor and students via a large-screen television monitor. This allowed the students to see the professor and even the fellow classmates at the live campus. The instructor also used a monitor, which allows him to see the distant class. Students can be seen and heard by the instructor, and an ask questions and interact as they would in a typical live class environment. The students were motivated to enroll for several reasons. Several students were employees of the Foxboro Company and worked at the Foxboro classroom location or in the surrounding area. They appreciated the opportunity to take classes in their own backyard and not travel 35 miles away in difficult traffic each way. Other students not working at the Foxboro Company were also allowed to enroll in the courses. They presumably registered in the courses for convenience. In most cases they lived or worked near by.

In the Fall of 1996, three courses were offered, originating from two different locations. After the initial experience the program expanded and several more courses were introduced gradually over the next semesters.

Lectures and Teaching Material

The instructors had to be proactive with such a teaching strategy. For example, students at the distance education campus had to have access to all the teaching material including handouts before the class begins. The following strategies were used.

(1) Posting the lecture material and slides on the departmental web site.
(2) Sending some of the material via email.
(3) Using FedEx to deliver some teaching material, handouts, and graded projects and assignments (as well as term tests) to a liaison at the distance education campus.
(4) The liaison at the remote site would collect tests and assignments and mail it to the instructor.

The above procedure became more streamlined as newer technologies became mainstream. For example, since the initial offerings, instructors have used home-grown departmental systems, WebCT and CourseInfo to receive information. Such systems have "Drop Boxes" which work satisfactorily for receiving tests and assignments from students.

Teacher-Student and Student-Student Interaction

The teacher had to struggle somewhat with the camera while the class was in session to facilitate student-to-student interaction. For example, if a student in the classroom had a question for a student in the remote campus, the instructor would have to turn the PictureTel camera away from him and on to the student. After some initial hiccups this usually worked well. We did not have access to the more modern cameras that are voice activated and which navigate automatically.

E-mail: Apart from occasional phone calls, e-mail was the primary mechanism for communication between the student and the instructor. The amount of emails that the instructor received increased dramatically with distance education. "Email overload" was a common complaint from the distance education instructors.

Communicating Performance Results: The departmental web site was used extensively to post the results of student performance. Students had confidential access to their accounts and they could check grades on an individual basis.

5. Evaluating Distance Education

For each course, and for each location (live and virtual classrooms) traditional instructor evaluations and a customized course evaluation were conducted. The customized evaluation sought information from students on issues such as their experience with distance education technology and experience with the virtual instructor. This information was collected at the end of the semester via questionnaires.

Instructor Evaluations: Table 1 compares the difference in instructor evaluations from two groups of students. One group is the set of students in the "live" class (i.e., where the instructor was physically present) vs. the remote class (where the instructor was absent but teaching virtually via video conferencing). Here, for the same course and for the same

instructor, we have calculated the difference between the two locations. A plus "+" indicates preference for distance education over traditional face-to-face education. A minus "-"indicates that students prefer face-to-face instruction.

Table 1: Instructor Evaluation: Teleconferencing - Live vs. Remote.
(Scale: 1 – poor, to 5 – superior)

	Difference in the Evaluations: (DistanceEducation – OnsiteEducation)
Instructor 1	+ 0.08
Instructor 2	+ 0.55
Instructor 3	- 0.9
Instructor 4	0
Instructor 5	-1
Net Range	-0.254 = 6.35% of scale range
Key	"+" indicates preference for the distance education. "-" indicates preference for traditional face-to-face instruction

It can be sent that students enrolled in the "live" classroom expressed a slightly higher degree of satisfaction with the instructor. This is not surprising, as research has proven that it is possible to learn much more in a given period of time when there are no restrictions on the availability of visual aides. According to research the highest amount of learning takes place through sight--a staggering 83% with hearing following this at 11%. Taste, touch, and smell account for the remaining 6%.[5] Students participating in the live classroom got a full dose of visual effect. They saw a full sized "3-D instructor" in person, as opposed to a small TV screen. An interesting conclusion is that the size of the TV screen that the distance education students learn from should be large for greater impact. The difference of 6.35% in favor of live classes is not inconsequential but small enough to suggest that it can be reduced with better visual aids such as large screen, improved voice quality and more varied presentation techniques.

Course Evaluation

The results of the course and technology evaluation are presented in Table 2. The data pertains to students who were participating in the course remotely. It is organized into three categories of questions: Technology, Speaker and Session. A rating of "1" implies that students were not satisfied and "5" implies that students were completely satisfied.

Table 2: Course and Technology Evaluation: Teleconferencing – Remote Setting

Number of students in sample: 24

	Poor / Strongly Disagree	Frequency of responses					Superior/ Strongly Agree	
I. Summary		**1**	**2**	**3**	**4**	**5**		**AVERAGE**
1. Aggressively develop this model of distance education		1	5	3	6	9		3.71
2. Technology is of acceptable quality.		0	4	2	14	4		3.75
3. Learned the material expected.	r	1	2	2	12	7		3.92
4. Would recommend this platform as an acceptable compromise to being there.		1	5	5	8	5		3.46
5. Technology is interesting but not acceptable as a training platform.		4	14	2	3	1		2.29
II. Speaker								
6. Speaker clearly defined session objectives.		1	1	3	8	9		3.93
7. Speaker made session interesting.		0	0	4	9	8		4.04
8. Speaker communicated concepts in a clear manner.		0	1	4	8	9		4.02
9. Speaker was comfortable with this platform and interacted with the class effectively.		0	1	5	7	9		3.98
III Session								
10. The materials were well organized, accurate and complete.		1	2	2	9	8		3.85
11. The materials extensively illustrated the concepts presented.		0	1	5	9	7		3.89

The responses to questions 4 ("Would recommend this platform as an acceptable compromise to being there") and 5 ("Technology is interesting but not acceptable as a training platform") endorse the technology with some reservations. This is discussed further in section 6. Similarly the rating of 3.98 for question 9 ("Speaker was comfortable with this platform and interacted with the class effectively"), although positive, indicates

that from the student's perspective, the instructor had some problems working with the video-conferencing equipment. This is not surprising as the previous generation of teleconferencing systems used for the course did not feature voice activated camera and the instructor had to constantly juggle the camera angle so that the students at the remote site could correctly see the students, and also switch between blackboard, tablet and slides. This takes a great deal of co-ordination on the part of the instructor.

Comparison with Students at the Live Setting

Table 3 provides a summary of the results from the live setting. This table also displays results organized into the three categories of questions: Technology, Speaker and Session and is comparable to Table 2. The only difference is the response from students as it pertains to question 4 "Would recommend this platform as an acceptable compromise to being there?" This question is not relevant in the live setting, as the students listening to the lectures live from the instructor.

Table 4: Course and Technology Evaluation: Teleconferencing — Live Setting

Number of students responding: 8								
		Frequency of responses						
I. Summary	*Poor / Strongly Disagree*	**1**	**2**	**3**	**4**	**5**	*Superior / Strongly Agree*	**AVERAGE**
1. Aggressively develop this model of distance education		0	1	3	4	0		3.38
2. Technology is of acceptable quality.		0	1	1	6	0		3.63
3. Learned the material expected.	r	0	1	0	7	0		3.75
4. Would recommend this platform as an acceptable compromise to being there.		0	0	0	0	0		(not relevant)
5. Technology is interesting but not acceptable as a training platform.		1	4	0	2	0		2.43
II. Speaker								
6. Speaker clearly defined session objectives.		0	0	0	6	1		4.13
7. Speaker made session interesting.		0	0	1	5	1		4.00
8. Speaker communicated concepts in a clear manner.		0	0	0	6	1		4.13
9. Speaker was comfortable with this platform and interacted with the class effectively.		0	0	1	5	1		4.00

III Session								
10. The materials were well organized, accurate and complete.		0	0	0	5	1		4.14
11. The materials extensively illustrated the concepts presented.		0	0	0	5	1		4.14

Table 4: Comparison of Student Ratings: Teleconferencing — Distance Vs. Live

Question Number	AVERAGE Distance Site	AVERAGE Live Site	Difference (Distance - Live)
1	3.71	3.38	0.33
2	3.75	3.63	0.12
3	3.92	3.75	0.17
4	3.46	not relevant	not relevant
5	2.29	2.43	-0.14
6	3.93	4.13	-0.2
7	4.04	4	0.04
8	4.02	4.13	-0.11
9	3.98	4	-0.02
10	3.85	4.14	-0.29
11	3.89	4.14	-0.25

Table 4 compares the averages of the remote (Table 2) vs. live (Table 3) setting. It can be seen that students at the distance site provided a notable favorable rating for the answers to the following three questions.

1. Aggressively develop this model of distance education (0.33)
2. Technology is of acceptable quality. (0.12)
3. Learned the material expected. (0.17)

To a certain degree this difference expresses the bias of the distance education students towards the distance education paradigm. Recall that the university initially created the distance education program at the Foxboro location on request from some of the students (employees) who wanted to complete the degree remotely (and avoid the tedious commute to Boston). It seems that the students at the remote location were more motivated and made a serious attempt to work with the technology available to them. The students at the live setting possibly learnt more from the instructor and found the use of "tablets", "TV" and "camera" a nuisance that did not necessarily aid their learning. (This is evident in the next section.)

Analysis of remaining questions reveals that the students at the live setting evaluated the course more favorably than the students at the remote location (with the exception of question 7). However, these students were frustrated with the intrusion of distance education technology into their seminars. They did not like the fact that the instructor's attention was being divided between two audiences. Also, they did not like the idea of having the instructor divide his attention between both the remote class via the TV screen and the local class.

6. Discussion of Student-Instructor Feedback

In addition to the questions presented in Table 2 and Table 3, students were asked for their comments on two open-ended questions:
    (1) What features of the technology are most problematic for the learning process?
    (2)   What features of the technology are most conducive to the learning process?
In this section we provide a narrative of the comments from the students. Their comments can be classified into several categories such as technology, telecommunication failure, and student satisfaction.

The following comments all pertain to problems experienced with the PictureTel system and the telecommunication link failures:

   "Disconnections during a lecture (causing class to be postponed on a few occasions.)"

   "Lost connection with remote site."

   "Downtime and frequent problems."

   "Teacher had to divide attention to two different classes."

   "Cuts into instructional time while (instructor was) playing with blackouts."

   "The problems (telecommunication failure) we're beyond the control of the instructor."

While the PictureTel technology setup was troublesome, this situation was compounded by the fact that the technical personnel completed the technical set up long before the class began and were not available when the instructor experienced problems late at night.

Within the same context the student also commented the following:

   "Room and set up were less than desirable."

   "Whiteboard usage was not done well."

   "It was hard to read off the television monitor."

"Small viewing area. But instructor compensated this limitation by publishing his notes" (in advance).

"All data was on a television screen, the blackboard becomes useless, the features that the instructor can use in the classroom is limiting."

"We have to view the class on a TV screen, which is not acceptable."

Note that some instructors used an *electronic tablet* for writing instead of whiteboard. These tablets projected the contents of the tablet onto the TV screen at the distance education site more clearly than the whiteboard. The contents of the whiteboard (or blackboard) did not present very well via video at the remote site. Critical comments similar to the above came from students at the live site. As mentioned earlier on, such students found it annoying to have the lecture material presented on a TV screen. This is one more issue where there had to be trade-offs. Writing on a tablet would provide better display of contents to the remote site but the students at the live site did not find this a satisfactory mechanism and would have preferred to see the instructor use the whiteboard. Some instructors used PowerPoint slides with better results.

The following comments pertain to perception, technology and student satisfaction. Note: In addition to the instructor, students at the remote site also had to juggle the camera angle during presentations so that the students and the instructor at the live site could see the students or their work clearly.

"Getting used to the technology."

"Not as easy to communicate with instructor."
" Feedback delays ---asking questions and getting responses two to three seconds later."

The above problems are not extraordinary—it is normal to experience some lag when communicating via video conferencing. Students still need to get used to such problems.

The following comments from some students provide further insight into the limitations of distance education:

"No human touch."

"Difficult to interact with instructor."

"Easy to lose focus get bored and not pay attention (due to the distance from instructor)."

"Three hour lecture format without a break came across as flat and tiresome - need commercial breaks."

Several researchers conclude that students do become unfocussed or overwhelmed by the freedom of distance education. It is difficult to follow an instructor even in a live setting for more than 30 minutes before drifting away. At a distance, the students can get lost more frequently. Course design and instructor training could make a big difference here. Substantial effort might need to be placed in training distance education instructors to present new teaching skills and leverage the tools correctly.

What features of the technology are most conducive to the learning process?
The overwhelming response from students here pertains to convenience. Many students echoed similar comments:

> *"The ability to attend classes that would be otherwise unavailable."*

> *"Eliminated need to drive to Boston."*

> *"No commuting!"*

> *"The technology is of advantage to working professionals with limited travel time*."

Our students at Metropolitan College are non-traditional students. Such students are typically campus-commuters, jobholders, and caretakers. Reduced commuting becomes a key priority when pursuing educational opportunities. The above comments validate what several researchers have found in their study of distance education--accessibility and convenience is "conducive to the learning process".

All the lecture presentations were recorded at both the live site and the remote site. Students can use such recorded content to review a seminar. Distance education therefore lends itself to higher interactivity with content. The following comments support such assertion:

> *"The ability to review taped classes."*

> *"If we miss a class or are confused about the lecture we can review the tape."*

The following two comments provide an insight as to how students enjoy the thrill of communicating and interacting remotely*:*

> *"Talking informally with fellow students at the remote site."*

> *"The ability to participate remotely and interact with instructor."*

There were very few students who clearly disappointed with distance education. Such students obviously have a learning style that is at conflict with what video conferencing technology offers:

"Distance education is not compatible with my style of learning. I will not take a remote course again."

"Video conferencing is unwarranted unless the student had disabilities.… (And is unable to commute to campus.)"

.
In conclusion, almost all students enjoyed the opportunity to take courses without having to travel great distances. Several students were taking courses within walking distance of their office location.

7. Case Study 2--Distance Education Strategy: Blended Approach

Quality assurance is the driving force behind such a strategy. Boston University is strongly committed to a close student-faculty and student-student collaboration that evolves long term working relationships, and the majority of the faculty believes this is still best achieved in a classroom setting where there is face to face contact and interaction with students. The latter is not an objection *per se* to distance education or the use of the Internet and web technologies in the classroom. In fact, most courses, the arts and humanities not excluded, have course web sites, complete with course management functions, multimedia teaching materials, and links to on-line libraries and resources. The MET CS Department developed its own web-based course management system as early as 1995, in addition to offering PictureTel teleconferencing courses (presented in the previous section). However, there is one central, immutable feature that these forms of technology-enhanced teaching continue to share with Socrates' conversations in the market place and gymnasia: It is the coming together of lecturer and students to simultaneously engage in educational activities. This style, referred to as *synchronous* or *real time* teaching and learning, remains dominant in higher education. Its essence is the unobstructed give and take of live lecturing and discussing with its unmatched efficiency for immediate clarification and elaboration. Thus, the challenge was finding a design and delivery format that retains the flexibility of asynchronous education, but also provides for a variety of efficient and natural ways of communication, and creates a context conducive to teaching and learning. There is no agreement on what the best characteristics of a distance education environment are, the initial development costs can be staggering[6], and some academics have strong objections. However, there is no denying that technology offers new possibilities for the educational experience and the irresistible promise of the new needed to be explored. [7]

In a first attempt to address this problem, the MET CS Department developed a Graduate Certificate program in Databases and Client/Server for the employees of Keane, Inc. – a well-established consulting company in the field of information technology (IT), with offices in Massachusetts, New Hampshire, Maine and Vermont. [8] The certificate consists of four graduate courses and a prerequisite introductory course in computer science with C++. Our main goal was to balance course quality and development costs, and allow for easy student access, and further development. This led to the following design choices:
  (i)   A lecture format that is a blend of face to face, on-site lectures and web lectures featuring streaming audio and video, synchronized with a slide

presentation, graphics, and animation. Courses follow a 12-week format, with weekly web lectures and one face-to-face lecture each month to provide for synchronicity.

(ii)   Weekly homework assignments, with either examinations or course projects.
(iii)   Weekly on-line office hours through a chat facility.
(iv)   Course web site, providing
- additional forms of communication: chat, threaded discussion, class e-mail,
- teaching materials: syllabus, web-lectures, slides, exercise problems and solutions, links to on-line resources, etc.
- homework submission and grade management.

Lectures and Teaching Materials

While we were early in agreement that a blend of web based and live lectures would best suit our goal, there were a number of important design questions to be answered: What is the best proportion of synchronous to asynchronous delivery? Lecture slides are obviously a must but should lectures include voice and video, or voice only? Should one simply record a live class or create a special recording, based on a lecture script? How much graphics and animation are appropriate and practical? How much interactivity should be built into the lectures and other teaching materials?

The answers to these questions are constrained by the technology available to the students (most importantly, bandwidth, and personal computer type), and by the development costs (most importantly, the costs for recording the video and developing graphics and animation). Naturally, these answers also directly relate to the quality of the course materials. Our approach was a pragmatic one. We wanted to strike a balance between quality and cost, and impose a minimal financial burden on the student for web related tools. This excluded recordings in specialized studios, and dictated the choice of free software for viewing the lectures, a modest Internet connection speed, and a commonly used hardware/software configuration. In short, we opted for web lectures that can be produced with a reasonable effort in the Department, and accessed and viewed by a large audience.

Scripted Lectures with Video, Voice and Slide Show. The lecture format we chose features streaming audio and video, synchronized with a slide presentation. A content side bar provides for easy navigation. In order to keep bandwidth requirements low, we included only a limited amount of graphics and animation, e.g. flowcharts, and animation of loop traversals. Figure 1 shows a typical snapshot. A digital camcorder (Sony DCR-TRV6) was used for recording and the lecture components were assembled into a smile script. This script was published on the Real Server and viewed by the students with the widely and freely available Real Player. The minimum system requirements for the students were a Pentium II–based personal computer and a 56K modem connection.

Figure 2: Layout of Scripted Lecture Supporting Video, Voice and Slideshow

A scripted prerecorded presentation was chosen over recording a live class. This is a departure from the prevalent practice in academia today, where most schools (e.g. Harvard Extension, Colorado State, and University of Central Florida) videotape their on-campus classes and makes them available for distance viewing. Capturing the ambiance of a live class holds the promise of enabling the isolated distance learner to share in the on-campus experience. However, our review of live class recordings showed that practically all of them spent some time on class logistics, (e.g. when/where are course material posted), and answering questions not directly related to the subject (e.g. the quality of the on campus computer labs). Some questions on the material that were asked in the live class were not really worth recording and broadcasting, especially when they took time away from the lecture, thus shortening explanations on other topics. While necessary and appropriate in the traditional classroom, such activities are a non-trivial waste of time and disk space in the recorded class. Our scripted web-lecture was ca. 25% to 30% shorter than the equivalent live lecture.

Another important issue we considered was the extent of the interactivity built into the lectures and other teaching materials. It has become a mantra in the distance education community that interactivity is highly desirable. And so it is, except when it becomes a purpose in itself and suppresses the logical flow of the presentation. Our review of some highly interactive courses, (e.g. Element K at www.elementk.com), revealed that too many built-in quizzes and exercises tend to fragment the learning process, piling on details and skills, but detracting from the concepts. While the relative merits of skills vs. concepts in a training course may be debatable, there is no question that it is the latter that are central to college education. Thus, we made a conscious decision, in the lectures, to only point to the interactive quizzes and problems, but to provide them separately.

Blending Synchronous and Asynchronous Delivery. Each distance education course was scheduled over a 12-week period, with one live meeting per month or a ratio of 2:5 of live vs. asynchronous lectures. The distribution of the topics between synchronous and asynchronous delivery was not done rigidly at equidistant intervals. Instead, a concerted effort was made to schedule live classes for topics that are more complex, and/or known to cause difficulties for the student. The first class was also conducted face-to-face in order to present the approach, demonstrate the web lecture format through a course preview, and discuss course management and logistics such as how to access teaching materials, submit homework assignments, take exams, office hours (on and off line), etc.

Teacher-Student and Student-Student Interaction
Several courseware management systems (WebCT, CourseInfo, and an in-house developed system) were used. We did not find substantial functional difference between them – the choice was dictated by the personal preference of the instructor. The difficulties working with the courseware typically stemmed from the limitations of the system in dealing with different types of external files an access from sites with strong firewall protection.

Evaluating Student Performance: The basis for evaluating student performance in the class was provided by weekly homework assignments, a midterm and a final examination. The final letter grade was assigned based on a weighted average. Examinations were held on site and proctored. The assignments were posted and submitted electronically.

On-line Office Hours and Chat: Weekly on-line office hours were conducted through a chat facility. While designing the course, we believed that on-line office hours will be key for providing as close a contact as possible. However, students found this feature useful, but not very important (see the rating to question 7 in the student evaluations shown in Table 5).

E-mail, e-groups: All students were on e-mail and preferred using their regular e-mail account as opposed to a course specific account. In some classes students built their own e-group.

Communicating Performance Results: Throughout the semester grades were posted in the courseware system where student could check them on an individual basis.

Evaluating the Blended Strategy Distance Education Experience
Evaluating the Technology and Course Format: In the first course of the certificate student feedback on the technology and course format was requested twice in the semester through questionnaires, to be filled out anonymously and with the instructor absent from the room. The first evaluation was given six weeks into the course and its results used for some adjustments, and the second evaluation at the end of the last lecture. Table 5 shows the answers to the first seven questions of the first evaluation. It shows

that students reacted well to the technology (graded of 3.33/5 to 3.44/5) and the combination of live and web classes were viewed quite positively (3.75/5 for question 4). However, most interesting and encouraging are their answers to questions 5 and 6, asking whether they prefer having live classes only or web classes only. Both questions were answered negatively (only 2.63/5 for live classes only, and a mere 2.13/5 for web classes only). It is remarkable that no student "strongly supported" a purely asynchronous or a purely traditional format. Another counterintuitive result was the lack of interest in additional office hours (2.38 for question 7). Contrasted with the good reception of the lectures, live as well as on-site, this suggest that the on-line office hours will be more effective and useful if there is a structured, instructor led discussion.

In addition to the questions shown in Table 5 the midterm evaluation asked students to comment on "what [they] like best", "what [they] dislike most" and "what [they] recommend". Best liked was the blended format ("The combo is good. The web classes allow for flexibility and I feel the live classes essential for clarification."), and the convenience ("able to go at my own pace", "ability to take classes on-line"). The dislikes revealed a problem with the bandwidth – the video was difficult to watch with a 56K modem, that we had defined as a minimal requirement. Although we had tested the video-lectures in Boston over the phone lines with a 56K modem, and found it worked well, we had not taken into account that this speed is not guaranteed and may easily drop below 30K when the network is overloaded. Not surprisingly, students recommended providing a voice only version, although they liked the video lectures better. Our solution to this problem was to distribute CDs with the courses, and, starting with the second course of the program, to add a voice only version.

Table 5: Course and Technology Evaluation: Blended Delivery - Midterm
(MET CS 231 K1 Summer 2000)

Number of students responding: 9								
Number of students in the class: 16								
		Frequency of responses						
I.Technology		1	2	3	4	5		AVERAGE
1. I found the video quality	poor	1		3	5		superior	3.33
2. I found the voice quality	poor		1	3	5		superior	3.44
3. I recommend the technology	poor		1	4	4		superior	3.33
II. Format								
4. I found the combination of face-to-face and web classes	poor			3	4	1	superior	3.75
5. I prefer face-to-face classes only	not at all	2	1	3	2		strongly	2.63
6. I prefer web classes only	not at all	2	3	3			strongly	2.13
7. I would like more on-line office hours	not at all	1	3	4			strongly	2.38

Table 6 shows the questions and results of the final evaluation of the distance education format. The questions are more general than in the midterm evaluation, but confirm the midterm findings.   Students recommended this training platform (4.0/5.0 for question 1), found the technology an acceptable compromise to live classes (3.77/5 for question 5) and disagreed with the statement that is not acceptable (2.31/5 for question 5). The effectiveness of the instructor in the new medium was also rated positively (3.77-3.85 on questions 6-9). Given that this was this instructor's first experience with video lectures, the last rating indicates that the technology is not very difficult to master.

Table 6: Course and Technology Evaluation: Blended Delivery – Final
(MET CS 231 K1 Summer 2000)
Scale: 1 – Strongly Disagree (question/statement is absolutely false), 2- Disagree (question/statement is absolutely false), 3 – Uncertain (question/statement is correct, but I have no particular opinion on it), 4 – Agree (question/statement accurately reflect how I feel), 5 – Strongly Agree (question/statement understates my opinion, please comment).

Number of students responding: 13 Number of students in the class: 16						
	Frequency of responses					
I. Summary	1	2	3	4	5	AVERAGE
1. The MET CS Department of BU should aggressively develop this training offering:			2	9	2	4.00
2. I found the technology to be of acceptable quality.		4	3	6		3.15
3. I learned the material I expected to learn.	1	1	3	8		3.38
4. I would recommend this platform to others as an acceptable compromise to "being" there.			1	2	9	1	3.77
5. This technology is interesting, but not acceptable as a training platform.	2	7	3		1	2.31
II. Speaker						
6. Our speaker clearly defined session objectives				2	11	3.85
7. Our speaker made the session interesting				2	11	3.85
8. Our speaker communicated concepts in a clear manner				2	11	3.85
9. Our speaker was comfortable with this platform and interacted with the class effectively.				3	10	3.77

8. Comparing Student Performance and Evaluations of Blended vs. Traditional Delivery Courses

In order to compare overall performance and satisfaction of distance education students to the ones of traditional students we conducted a control section of the same course on campus. The control section followed the same schedule as the web-section and was delivered over the same time period. It was managed through an identical web site with access to the same teaching materials, and taught by the same instructor. Homework assignments and examinations were identical and graded by the same teaching assistant. Although every effort was made to reduce the difference between the distance and the traditional course section to the number of face-to-face meetings, some other differences

remained: it was not always possible to cover the exact same material in the two sections, and, probably more significantly, the students in the distance course were all IT professionals working for the same company, while students in the on-campus section came from a wider range of backgrounds and occupations. Students in the web-based section achieved a slightly better grade point average (3.757/4.) as compared to the on campus students (3.695/4.). Both course sections were given the standard college course evaluation questionnaire that consists of a series of statements to be rated at a scale from 1 (poor) to 5 (superior). The evaluations were completed by 13 students in the distance and 23 students in the on-campus section, which is 81.23% and 79.31% of the students enrolled in the respective sections. Table 5 shows some of the evaluation results. The absolute difference in the average ratings between the distance education and the traditional course were consistently small: 0.081 for the overall course rating and 0.154 for the overall instructor rating. The averages for the instructor's ability to clearly present the material differed by 0.164, for her enthusiasm in teaching the course by 0.014, and her mastery of the material by 0.137.

This is a clear endorsement for our distance education approach. However, there is a caveat: Although the differences in the ratings are small, it is always the distance education section that gives the lower grade. One might be tempted to conclude that the reason for this is the reduced face-to-face time with the lecturer. However, the evaluations in our teleconferencing courses, where the live and remote site have exactly the same contact hours through a two-way audio-video, show a similar trend Given this fact it seems more likely that the lower satisfaction of the distance education students is due to the overall less stable delivery of the distance education class, e.g. failed connection, inability to access the teaching materials or homework assignments at a given time, "hesitation" in the video due to slower throughput, etc. All these factors increase the stress on the distance education student, and naturally lead to a less satisfying learning experience.

Table 7: Course and Technology Evaluation: Blended Delivery – Blended vs. Traditional (MET CS 231 K1 Summer 2000)

(Scale: 1 – poor, to 5 – superior)

	blended	traditional	|blended-traditional|
Number of students responding	13	23	
Number of students enrolled in the class:	16	29	
Percent of enrolled students responding:	81.25	79.31	
COURSE EVALUATION			
The extent to which you found the course intellectually challenging	3.846	4	0.154
I would rate this course overall as	3.692	3.773	0.081
INSTRUCTOR EVALUATION			
The instructor's ability to present the material is	3.923	4.087	0.164
I would rate the instructor's enthusiasm as	3.769	3.783	0.014

The instructor's mastery of the course material is	4.167	4.304	0.137
The instructor's overall rating is	3.846	4	0.154

Conclusion

Our research results reveal the following:

- It is important for organizations engaged in distance learning to provide students an opportunity to determine if distance learning is indeed compatible with their learning style. Many students who are confident and curious lose interest in learning at a distance because it seems boring. Within this context students should be given an opportunity to test out the technology and tools. Providing a sample distance-learning lecture online would be useful here. Also students should be encouraged to explore the different paradigms of distance learning such as:

    - Same place but different time

    - Different place but same time, and

    - Different time and different place.

    It is quite possible that one of the paradigms is more suitable to an individual learner.

- Our research has revealed that preference for *face-to-face* instruction is significant. On a scale of 1 to 5, a slight difference of 0.254 in rating in favor of traditional delivery was detected when the same course was taught at a distance and in a live face-to-face setting. As such we recommend that opportunities for student-instructor face-to-face contact should be created. Such opportunities could range from visits to the main campus (especially the laboratory) by students, to visiting a convenient off campus location (such as a hotel conference room) closer to the students. From our experience, even the most zealous distance education student enjoyed face-to-face discussion and seminars with their instructor.

- The overwhelming response from students in favor of distance education is convenience. Many of our students echoed similar comments:

    "The ability to attend classes that would be otherwise unavailable."

    "Eliminated need to drive to Boston."

    "No commuting!"

    "The technology is of advantage to working professionals with limited travel time."

To balance quality issues such as student learning and student convenience, one should pursue a mix of face-to-face and asynchronous learning.

- While distance education itself is rarely boring, technology limits and constrains distance education. It is very important to have a fail-proof strategy and a back up plan when it comes to distance delivery media. We might have lost a few "possible converts" to distance education with our video-conferencing experience, as the technology was unreliable.
- Since a staggering 83% of learning takes place through "sight" followed by "hearing" at 11%, a larger screen and good quality audio should be used for greater impact during distance education.
- Distance education provides student an opportunity for *multitracking*. Multitracking is an opportunity to leverage multiple learning modes. For example students can review taped lecture videos to understand the lecture material better after a synchronous distance-based seminar. A few students loved this aspect in the courses they took and leveraged it extensively.
- The methods to which instructors and students limit themselves are a concern. Instructors should explore different teaching styles. Institutions should provide funding and train instructors to use distance education tools and techniques effectively.
- Students need to adapt their learning style as well if they want to leverage the advantages of distance education such as convenience and ability to reuse content (multitracking).

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