A Web-Based Graduate Certificate for IT Professionals – Design Choices and First Evaluation Results

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Abstract

This paper presents the design of a web-based Graduate Certificate program in Databases and Client/Server and discusses first evaluation results. Our goal was to find a format that achieves course quality at low development costs, allows for easy student access, and further development. This led to the following design choices: (i) A blend of face-to-face on-site lectures and web-lectures, synchronizing streaming video and audio, with a slide presentation, graphics and animation; (ii) On-line weekly office hours; (iii) Weekly homework assignments, proctored examinations and/or semester projects; (iv) Communication and course management through a course web site, including downloadable teaching materials, homework submission tools, grade management, threaded discussion, chat, e-mail. The first course taught in this format is evaluated against a control section delivered in parallel, and in the traditional classroom format. Student performance and satisfaction in the distance and on-site sections, based on final grades and course evaluation, were very similar. In addition, responses to questionnaires targeting the technology and the delivery format showed a clear endorsement of the approach. Some evaluation results were counter intuitive: very few students requested additional on-line office hours, there was no strong preference for either "on-line only" or "face-to-face only" instruction. This indicates that the combination of synchronous and asynchronous delivery successfully addresses the tradeoff between flexibility and synchronicity.

1. Introduction

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 [1]. 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, was 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 time and place, independent of other students or the lecturer (*asynchronous* learning). 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 the classroom. 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, and, for the last five years, has been regularly offering PictureTel teleconferencing courses. 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 [2], 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 [3].

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. 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.

In this paper, we discuss the choices made in the design and implementation of the program, and the experiences gained from teaching the first course. The program was launched in Summer 2000 with the program prerequisite – an introduction to computer science with C++. A section of the same course and taught by the same instructor was offered in parallel on-campus, in the traditional classroom format, and served as control. We compare student performance and satisfaction based on final grades, course evaluation questionnaires given to both sections, and two questionnaires evaluating the technology, given to the distance education students six weeks into the course and the last week of classes, respectively.

2. Curriculum

The curriculum of the Graduate Certificate in Databases and Client/Server is fairly typical for the field (see Table 1). The courses build on each other and are offered in sequence.

Table 1: Graduate Certificate in Databases and Client/Server - Curriculum

Course	Course Prerequisites	Description
Program Prerequisite		
MET CS 231: Computer Science with C++	programming experience in a high-level language or consent of instructor	Covers the elements of object-oriented programming and the C++ language. Data types, control structures, functions, library functions, classes, inheritance and multiple inheritance. Use of constructors, destructors, function and operator overloading, reference parameters and default values, friend functions, input and output streams, and templates.
Program Requirements		
MET TC 535 Data Communications & Computer Networks	MET CS 231	Basic concepts of data communications, overview of LAN/WAN, encoding digital and analog signals, transmission media, asynchronous/synchronous protocols. Circuit, packet, message switching, internetworking devices, topologies. LANs, ISDN, ATM, GIGANET, X.25, TCP/IP, wireless/satellite communications, and data communications futures.

MET CS 579 Database Systems	MET CS 231	Introduction to DBMS; relational model, architecture, theory, query language-SQL; issues in database recovery, concurrency, security, and integrity; data modeling and database design; other topics: Client/Server. Provides practice in SQL and simple front-end SQL applications.
MET CS 679 Client/Server Systems	MET CS 535 and MET CS 579	Client/server architecture, open distributed systems; front-end client technologies, presentations layer; server technologies, database access, integrity control, procedures and triggers; middleware; well-enabled database retrieval; client/server configurations; client/server as a tool to meet business processing requirements; practical exposure: client and server design and implementation.
MET TC 771 Internet Application Development	MET TC 535 and CS 679	Distributed application architectures, language systems (e.g. Java, Active X, PERL, JavaScript). Distributed object standards (e.g. CORBA and COM), and net-focused development methodologies. Internet agents. Investigation of current literature and a term project are required.

3. 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.

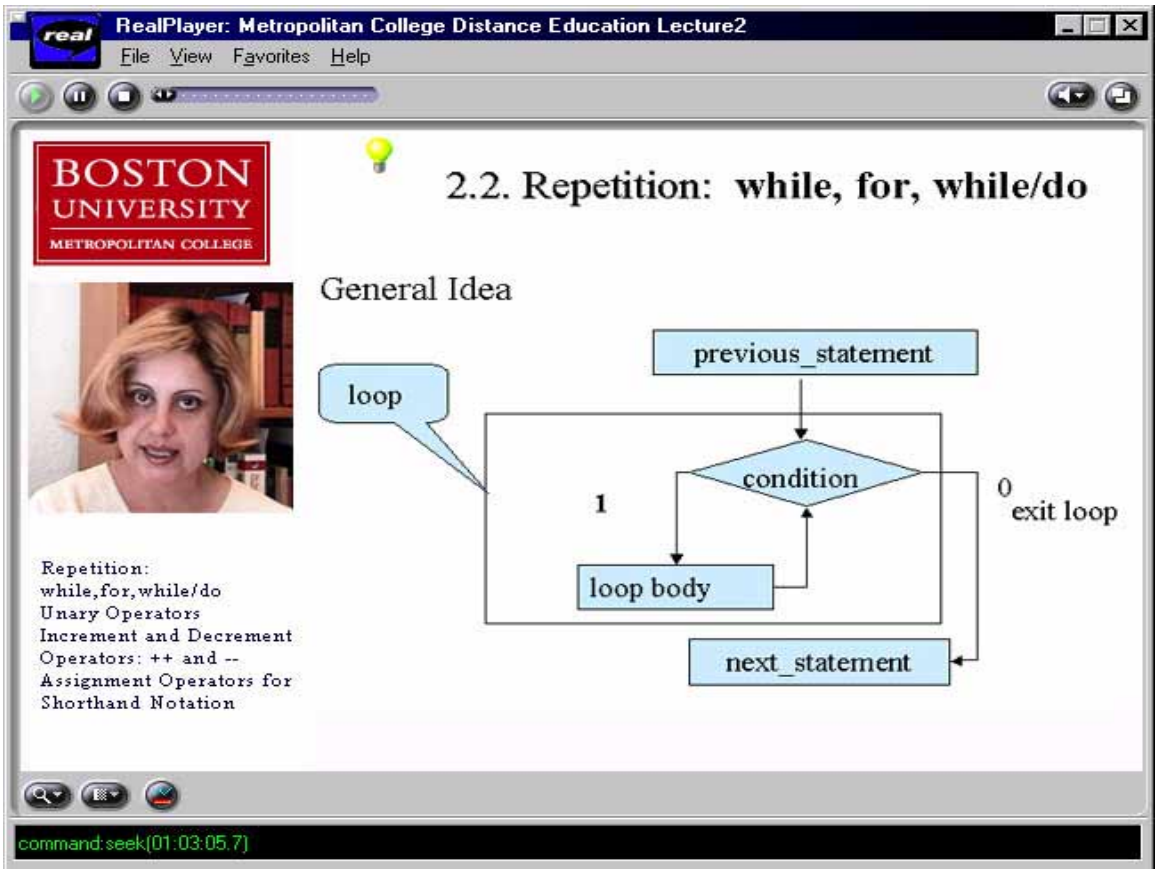

Figure 1: Web-Lecture Layout

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, University of Central Florida) video tape their on-campus classes and make 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. Table 2 shows the syllabus of the prerequisite course, and in the remaining of this paper we will restrict the discussion to this course. 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, e.g. pointers and their relation to arrays (week 4), classes (week 8), virtual functions and polymorphisms (week 11). 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.

Lecture Slides, Reviews, Practice Problems, and Homework Assignment were made available for downloading on a weekly basis and linked to the corresponding topics on the course web site (Table 2).

4. Teacher-Student and Student-Student Interaction

We selected WebCT as a courseware management system based on its rich functionality, and used it initially for all class interactions. However, using the system for managing a distant education course led to a series of problems that we will briefly mention in relation to the specific function in which they arose. The generic causes for these difficulties were the rigidity and limitations of the system in dealing with different types of external files. Some students also experienced problems accessing the system from sites with strong firewall protection.

Evaluating Student Performance: The basis for evaluating student perfromance 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 through WebCT. Unfortunately, almost all students were frustrated with the clumsiness and rigidity of the submission process when submitting multiple files. Towards the end of the course homework submissions were done mostly through regular e-mail.

Table 2: MET CS 231 Calendar

Week	Topics	Readings /Video Lecture
1: T 05/16	Administrative. Basic Computing Concepts. Programming languages: machine vs. high-level, imperative vs. object oriented. Anatomy of a program: comments, include directives, **main()**, i/o, statements. Data object (variable), data types, arithmetic and Boolea expressions, statements, C++ streams.	Readings: Ch.1 ***ON SITE !*** Video Lecture I
2: T 05/23	Control Structures. Selection : **if**, **if/else** Repetition: **while**, **for**	*Readings: Ch. 2* ***Video Lecture II***
3: T 05/30	More on Selection and Repetition. **switch, break, continue, ?:, do/while,** the type **char** Functions: user-defined and library functions, definitions, prototypes.	*Readings: Ch.3.1-3.9* ***Video Lecture III***
4: T 06/06	More on functions. Storage classes; Scope rules; Inline functions; Recursion vs. Iteration. Arrays: declaration, initialization, passing arrays to functions. Pointers. Arrays and Pointers.	***ON SITE !*** *Readings: Ch.3.15--3.18* *Readings: Ch.4.1-4.4* *Readings: Ch.5.1-5.3, 5.7-5.8*
5: T 06/13	Call by Value vs. Call by Reference. References and reference parameters. Constructing objects with **struct** and **class**.	*Readings: Ch.5.4-5.6* *Video Lecture IV*
6: T 06/20	Classes: members, public and private access; constructors. Review for Midterm. Problems for Studying for the Midterm.	*Readings: Ch. 6.1-6.10* *Video Lecture V*
7: T 06/27	**Midterm.** *Holiday Inn and Portland Office*	
8: R 07/06	Classes (continued) : more on constructors and destructors; **const** objects and functions; **static.** Example: a List class.	***ON SITE !*** *Readings: Ch. 6.10-6.18, Ch.7*
9: T 07/1	Overloading functions and operators; friends; the **this** pointer; **new** and **delete;** Examples: classes Rational (header, member functions, driver) and String (header, member functions, driver).	*Readings: Ch. 8* *Video Lecture VI*
10: T 7/18	Inheritance: base and derived classes; protected members. Examples: classe BCString (header, member functions, driver) and String (header, member functions)	*Readings: Ch. 9* *Video Lecture VII*
11: T 07/25	Virtual functions and Polymorphism. FunctionTemplates Review for Final. Problems for Studying for the Final	***ON SITE !*** *Readings: Ch. 10, Ch.3.21*
12: T 08/01	**Final.** *Holiday Inn and Portland Office*	

On-line Office Hours and Chat: The WebCT's chat facility was used for weekly on-line office hours. While designing the course, we believed that this to be a key feature 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 3).

e-mail: All students were on e-mail and WebCT provided an additional e-mail account. One could imagine that using a course specific e-mail would have the advantage of keeping all course correspondence in one place and together with the course materials. However, our experience showed that students found working with their regular accounts more convenient and efficient.

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

6. Evaluating the Distance Experience

Evaluating the Technology and Course Format. 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 3 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 was 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 3 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 3: Midterm distance education questionnaire 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 4 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 4: Final distance education questionnaire - 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

Comparing Student Performance and Evaluations of Web vs. Traditional 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 sending and receiving site have exactly the same contact hours through a two-way audio-video, show the same trend. Students on the site where the instructor is present give consistently (and sometimes substantially) higher grades than students at the remote site. This has been confirmed by our experience of delivering teleconferencing courses over more than eight semesters and with different instructors. 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 5: Comparison of student evaluations from the distance and traditional course section (Scale: 1 – poor, to 5 – superior)

	distance	traditional	|distance-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

7. Conclusion and Future Work

This paper presented a web-based distance education format developed for delivering credit baring courses, that is currently used in a Graduate Certificate in Databases and Client/Server offered to the employees of Keane, Inc. The design was guided by the

overriding goal of preserving academic integrity and achieving course quality at reasonable development cost. The resulting choices included a combination of web and live, on-site classes, and various forms of student-teacher and student-student interaction. The latter were managed through a widely available courseware system (WebCT) and included weekly on-line office hours, chat, e-mail, electronic homework submission, etc. The web lectures integrate streaming audio and video with a slide show, and a limited amount of graphics and animation. We found that students unequivocally endorsed the proposed approach: this was demonstrated not only by the positive answers on direct questions on course format and technology, but also by some counterintuitive findings, such as no strong preference for either "on-line only" or "face-to-face only" instruction.

Student performance and satisfaction in the distance education course were compared to those in a control section (same material, instructor, web site, homework and examinations), offered in parallel, and in the traditional classroom. The grade point averages in the two sections differed by 0.06/4. The differences in the ratings for the quality of the course and the instructor by students in the distance and the traditional format were within a range of 0.014 to 0.154 over a scale of 1 to 5. This is certainly a success. However, the consistently lower ratings given by students in the distance course indicate that we have not yet attained an environment for distance teaching and learning that makes students feel as comfortable and immersed in the educational experience as on-campus. What exactly the new features will be is subject for future research. As a next step we consider developing asynchronous collaborative environments [4] and strengthening the interactivity and flexibility of the delivery to better respond to differences in learning styles and patterns.

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