

Enhancing the Classroom Learning Experience with Web Lectures

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ABSTRACT

In this paper, we present our vision and initial research results on the use of web lectures to enhance the classroom learning experience. By using web lectures to present lecture material in advance of class, more in-class time can be used for authentic and engaging learning activities. A formative evaluation and extensive pilot study have yielded promising results: hence we are further exploring this evolving concept.

Keywords

Web lectures, constructivist learning, educational technology, educational intervention

INTRODUCTION

Learning sciences research tells us that students learn much better “by doing” rather than “by listening.” Thus, passive learning – the traditional lecture – is being replaced in our classrooms by more active learning activities that emphasize student problem solving, discussion, presentation, and other “authentic” learning-by-doing activities. At the same time, students continue to need information – facts, concepts and context – to meaningfully engage in these activities. In the past, students have acquired this information via readings and the traditional lecture. But, with more class time used for active learning as a way for students to convert information into knowledge (i.e., understanding), there is

less time for in-class lectures.

We are exploring the use of web lectures (talking heads audio and video with PowerPoint) as a way to present the information in advance and outside of class, to prepare the students for the more meaningful in-class activities. Our exploration encompasses both pedagogy and technology.

We seek *pedagogical techniques* that motivate students to actually watch the lectures in advance (the same challenge as motivating students to read material before coming to class). One such technique is to have students prepare an in-class presentation based on material covered in a web lecture. Another is to have students complete a homework assignment that depends on the web lecture.

We also seek *technological support* for the pedagogical techniques, to imbed in the web lecture viewing mechanism technological capabilities that will engage students in activities that relate to their classroom participation. For instance, to encourage students to ask questions about a web lecture, a convenient way to ask the question in the context of a particular lecture slide could be provided – such as being able to type or speak the question with the slide, making the question available to the instructor in advance of the class meeting. Some questions can be answered by email; those that would spark class discussion can be held for the next class meeting.

The research is being conducted in the context of an introductory, senior-level course on Human-Computer Interaction (HCI). Presentation materials are created with Microsoft PowerPoint, and are then used in lectures that are captured with Microsoft Producer. The class itself is

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heavily project-based, with four-student teams doing a semester-long requirements analysis / design / implement / evaluate user interface project. The web lectures, PowerPoint presentations, and other material are made available to the students via the Georgia Tech Human-Centered Computing Education Digital Library (<http://hcc.cc.gatech.edu>).

The longer-term implications of this work, which we only mention but do not further discuss, include:

- Use of web lectures created by teachers other than the course instructor, possibly leading to the creation of a marketplace for web lectures that is analogous to the marketplace for text books.
- A decrease in the number of in-class contact hours in a traditional semester-long course (leading in turn to some possible economies in the educational process).
- Use of the web lectures and supporting material in a distance learning setting rather than to enhance traditional learning.

EDUCATIONAL THEORY INSPIRATIONS

Web lectures can be used to augment, not replace, the classroom learning experience. The traditional one-to-many lecture still prevalent in classrooms today all but ignores the accepted contemporary learning theory. Much of this is due to the inherent lack of learner engagement in such lecture settings [1]. Many times, the problem is not that the instructor does not desire to foster learner engagement; rather, the instructor does not have time to do so while covering all the required course material. Our goal, therefore, is to take advantage of the opportunities and technological affordances [2] of pre-recorded web lectures in order to decrease the in-class time spent on information transfer and increase the in-class time available for more active learning.

Although the traditional didactic lecture is quite ubiquitous, learning theory to support the effectiveness of this pedagogical method is not. Granted, this is the way things have been done for centuries, and the historically consistent use of this methodology, and this methodology alone, helps justify its continuing use; students are accustomed to learning in this manner. However, educational theory suggests that there are better ways to promote learning and create effective learning environments.

Edgar Dale's "Cone of Learning" [3] (Figure 1) suggests the least effective learning method involves learning through passive information presented through verbal symbols (i.e., listening to spoken words) which is in fact the style of many lectures, while the most effective learning method involves the student actively participating in "hands-on" learning activities.

Additional research based on Dale's findings, conducted by the National Training Laboratories, produced the Learning Pyramid [4] (Figure 2). The Learning Pyramid illustrates the average retention rates for different teaching methods, where lecture was found to provide the least retention (5%), and more active methods such as practice by doing and teaching others were found to provide the most retention (75-90%).



Figure 1 Dale's Cone of Learning, redrawn from [3].

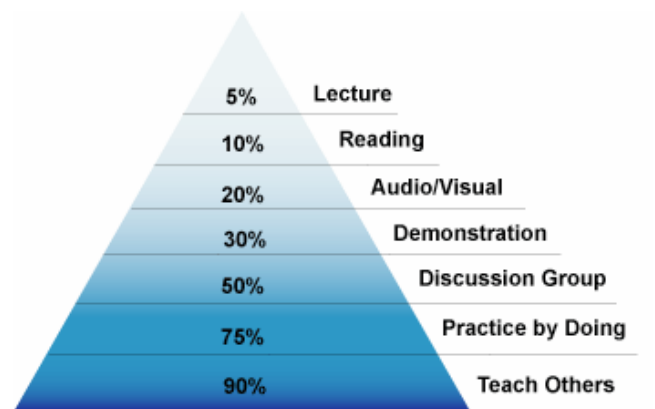


Figure 2 The Learning Pyramid.

Both of these figures suggest that students viewing web lectures should retain *at least* as much as students listening to traditional lectures. Because Microsoft Producer allows the viewer to pause and review a web lecture, one could argue that web lectures fall in a learning effectiveness category significantly better than do traditional classroom lectures. More to the point, when a large portion of the lecture material to be covered precedes attending class, much more in-class time is available to engage learners in more authentic, active learning activities that the above illustrations suggest are the most effective.

Even more contemporary educational theories suggest that active learning environments are the most effective way to increase motivation and learning. Duffy & Cunningham argue that constructivist learning theory and learning theories based on constructivist principles are more effective than traditional methods [5]. Constructivist theory suggests that learning is best achieved by active construction of knowledge in meaningful contexts. Also important in the process of learning and cognition is the critical role of social interaction in such knowledge construction activities [6]. These forms of learning environments often involve learners participating in somewhat open-ended, student-centered activities that include some collaborative problem solving, results sharing, and public/personal articulation and reflection.

As noted previously, with more in-class time made available by having students watch web lectures, many opportunities arise to integrate constructivist-inspired learning activities into a course. Many learning theories and activities based on constructivist principles can be implemented relatively easily: project-based learning [7], problem-based learning [8], inquiry-based learning [9], cognitive apprenticeship (reciprocal teaching) [10], and role-playing activities [11], to name a few.

Previous research suggests that using pre-recorded lectures in the distance learning context produces “no significant difference” [12] in learning effectiveness. Although we do not intend to use web lectures as they have been used for distance learning, this result and the previously noted Cone of Learning and Pyramid of Learning support our use of web lectures as a means of information dissemination.

We believe that the most beneficial way to use web lectures will be when they are used *in addition* to normal classroom time, as a way to *supplement* the classroom experience, not to replace it. This is in marked contrast to the distance learning approach of using web lectures to replace the classroom experience.

When students come to class with a baseline of knowledge, they can truly engage with the material [13], and the extra in-class time made available by students watching pre-recorded web lectures can then be used more effectively to answer questions, discuss difficult subject material, and engage in more active, authentic learning activities.

Of course, using the three levels for modeling educational software [14] 1) rationale and organizational level, 2) content and subject matter level and 3) interaction and engagement level, we should be aware that all three are equally important: e.g. emphasis on interaction and engagement without completeness of content can decrease the overall quality and effectiveness of a course.

RELATED WORK

Research into the use of recorded video material in the classroom dates back to the 1970s. One famous study is the Tutored Video Instruction study conducted by Gibbons at Stanford University. This research found that when remote students watched a recording of a lecture in small groups, typically size 3 to 10, with a facilitator (tutor) present to periodically pause and prompt discussion, they typically outperformed the students who attended the live lectures [15].

Since that time, technological developments, especially the rapid growth of the internet, have brought exciting new opportunities to guide and enhance learning, and new ways to apply Gibbons’ results. Furthermore, advancements in the field of learning sciences and cognitive psychology have increased our understanding on the principles of learning and transfer [16]. Using pre-recorded web lectures streamed over the web, especially in the context we intend to use, is still largely unexplored. This is mainly due to relatively recent technological advances in audio/video compression, web portability, network bandwidth, and presentation software. With these recent advancements, research on the application of internet technologies in education is now accelerating.

Here at Georgia Tech, the eClass project [17] (formerly named Classroom 2000) captures audio and video from live in-class lectures, and then aggregates this with presentation slides, the instructor’s annotations, and visited websites. Subsequent lecture review is the major capability offered by a packaged eClass presentation. Extensive use of the eClass system throughout many courses over the past years has produced encouraging results, and research into its uses continues today.

An experiment with online web lectures similar to ours was conducted at the University of Wisconsin with a large-enrollment computer science course for engineering students [18]. Two scheduled large lectures per week were dropped and replaced by web lectures, which students would watch at their own convenience, either at home or in campus computer labs. The class hours with the professor and teaching assistants (T.A.s) were entirely dedicated to active learning sessions. In the individual lab sessions and group lab sessions, which were not graded (to remove the pressure of completely finishing the material and instead concentrate on learning the material), students solve comprehensive engineering problems. Although requiring more self-discipline, the majority of the students enjoyed and learned as much or more using the new course format.

Research at Edith Cowan University by Oliver and others stresses the need for internet-based learning environments to make better use of technological affordances in order to create and facilitate more active learning opportunities [19]. Although their end goal, to create a more active learning environment, is similar to ours, their focus is

exclusively internet learning, whereas we intend to create and facilitate more active learning through the combined use of internet and in-class activities.

Collard *et al* [13], in the School of Chemistry and Biochemistry at Georgia Institute of Technology, have found encouraging results in studying the effect of decreasing the amount of class time spent on information transfer in order to increase the time available to illustrate concepts and approaches to problem solving. To decrease class time spent giving a traditional lecture, they use online pre-lecture assignments (called “HWebs”) that ask questions about material covered in the assigned reading. This ensures that students will have already had exposure and critically thought about the material to be covered in each class or lab session.

PROCESS

In this section we discuss the structure of our research, the technology we are using, and how we have initially evaluated the web lecture intervention.

Design Experiment

We conduct our research as an educational *design experiment*: “an attempt to engineer an innovative educational environment and simultaneously conduct experimental studies of these innovations” [20] or “to study different ways of using technology in classrooms and schools and to begin to construct a systematic science of how to design educational environments so that new technologies can be introduced successfully” [21]. Research in a live educational setting is extremely complex. Aspects of the learning environment are sometimes isolated and treated independently, while they are in fact part of a whole learning ecology. Twelve years after the original articles in 1992 on design experiments in education, design-based research has become an accepted blend of empirical and formal educational research, a methodology for understanding how, when, and why educational innovations work in practice [22]. This implies that we forgo the unrealistic hope of conducting carefully controlled experiments for a more holistic study.

Technology

For the authoring of web lectures we use Microsoft Producer [23], a plug-in for Microsoft PowerPoint 2003. Microsoft Producer facilitates seamless integration of one video feed, two audio feeds, Microsoft Power Point slides, and web pages. All of these components can then make use of many different presentation layouts, which can include a real-time navigable table of contents. For recording, we set up a small studio with appropriate lighting and background.

After the web lectures are recorded, they are published on the web. This is easily done, because a web lecture is simply an HTML web page with an embedded streaming video image. The video is encoded with the Windows

Media Series 8 or 9 codec and stored on a streaming media server; the HTML files reside on a web server.

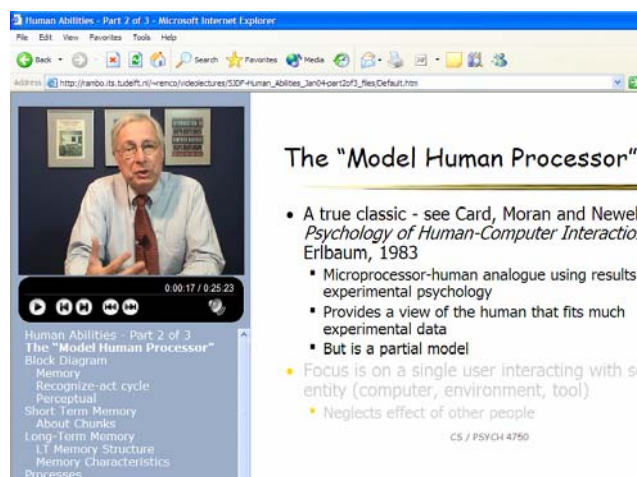


Figure 3 Web lecture playback in Internet Explorer.

Figure 3 shows the playback of a web lecture in a Microsoft Internet Explorer browser window, which is divided into three panes. In the upper left is the streamed video image, displayed by the Windows Media Player. In the lower left is the Table of Contents (TOC), a list of entries that correspond to slides at the right of the screen. They also contain an anchor point in the video stream; users can skip around in the web lecture by clicking on the TOC entries. In the right pane is the current PowerPoint slide. Bullet points on a slide change from light gray to black as they are discussed by the lecturer.

Figure 4 shows the workflow for authoring and streaming web lectures.

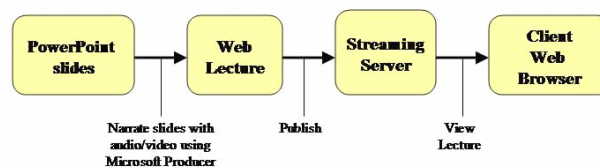


Figure 4 Web lecture production workflow diagram.

The host infrastructure necessary to support web lectures is shown in Figure 5. The client connects to the server over TCP/IP with a web browser. The web browser embeds a media player that communicates with the streaming server through the Microsoft Media Services (MMS) protocol; the slides are displayed in the browser in plain HTML. The server runs the latest version of Windows Server 2003 (Enterprise Edition) and Windows Media Services 9, the streaming server software. The web server is Apache version 1.3.29.

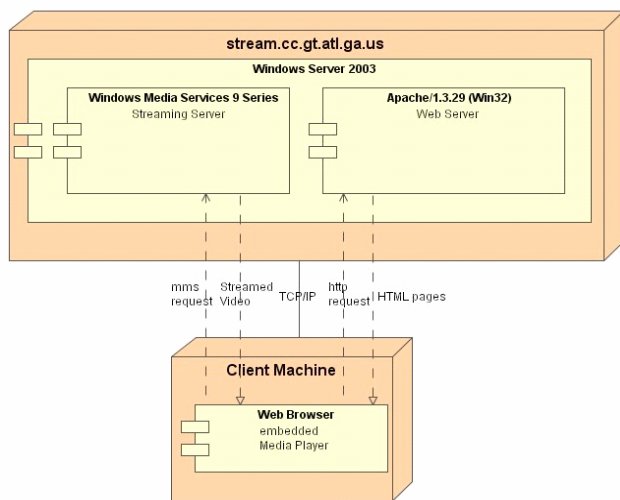


Figure 5 UML Deployment Diagram for the Web lecture host infrastructure.

CS4750 User Interface Design

We have used the online web lectures to redesign the course format of CS4750 User Interface Design, an introductory HCI course for senior undergraduate Computer Science students (http://www.cc.gatech.edu/classes/AY2004/cs4750a_spring/index.html). A typical HCI course teaches theories, principles, and design guidelines. It usually contains a project or lab assignment where students carry out a design path. Ideally, the curriculum of an HCI course should find the right balance between students becoming knowledgeable about HCI theory and obtaining skills for designing effective new user interfaces.

The curriculum consists of 30 classes of 75 minutes, 2 each week, and a semester-long design project. Of the 30 class meetings, 25 are lectures; the other five are for project presentations and discussions and a mid-term exam. Throughout the semester there are scheduled homework assignments to illustrate specific concepts of user interface design. Enrollment is typically 35 to 40 per class. Assessment is based on the homeworks, end-product of the design project, and mid-term and final exams.

Fall 2003 Semester: Formative Evaluation

To obtain some experience with producing and using web lectures, we did some in-class tryouts during the fall 2003 semester. Web lectures were shown in two class periods – one with the professor present, and one with the T.A. present – each followed by a survey. The survey indicated that there is a definite minimum threshold for the production quality of web lectures, but students did not feel professional production quality is necessary. The major concern, audio quality, was readily addressed with better microphone placement and higher-quality classroom speakers.

The initial response of students to the web lectures was mixed. A majority found the in-class web lecture experience worse than a live lecture, expressing that they did not come to class to watch a web lecture, that watching was tedious and boring and without sufficient interaction with the professor. Some suggested they would rather watch the web lecture at their own convenience.

However, there were also a number of positive responses:

- “Professor presented information without going on tangents, so all material was presented in a shorter period of time.”
- “All the material was covered in 20 minutes, within my attention span.”

We also learned that:

- Students perceive the class experience as better when the professor is actually present to give comments and answer questions.
- Audio quality is more important than quality of the video talking head image. This is consistent with other research [24].

Although the sample set was too small to draw any real conclusions, the formative evaluation during the fall semester provided us with excellent guidance on how to improve our production quality. Also, the surveys provided us with an initial image of students’ attitudes towards web lectures.

Spring 2004 Semester: Pilot Study

Having streamlined the process of recording, authoring and publication, we conducted a pilot study of the use of web lectures with CS4750 in the Spring 2004 semester. We modified the course so 17 class meetings were lectures (rather than 25), five were learning by doing classes, and three did not meet – because of the extra student time taken to watch web lectures. The remaining five classes were used the same way as the five non-lecture classes in the fall semester. Students were asked to watch 13 web lectures, lasting a total of 4 hours 37 minutes.

PEDAGOGICAL TECHNIQUES

In this section, we discuss the pedagogical techniques we have used to motivate students to watch the web lectures in advance of class. We also discuss the learning activities used in class. The design of these learning activities was influenced by educational theories such as cognitive apprenticeship, project- and problem-based learning, and other constructivist approaches.

Motivating Students to Watch Web Lectures

An important question is how we can encourage students to watch the web lectures before class. Many of the in-class activities require some basic knowledge to be effective. Although students indicated that they regard watching a web lecture as similar to ‘doing your reading’, multiple focus groups and surveys made it apparent that

students need and want some form of explicit motivation. We have tried several mechanisms to provide this explicit motivation:

- Quiz given in class about the web lecture.
- Students individually or in teams prepare a class presentation on the subject of the web lecture.
- A homework assignment that depends upon web lecture material.
- Explicitly stating that classroom discussions will require knowledge of web lecture material.

Of course, students are responsible for class preparation. Motivation and study discipline are often a result of the ability of an instructor to encourage and engage students' implicit motivation. The instructor's enthusiasm and the ability to inspire students is a subjective, difficult to measure factor that can have a large influence on study discipline and eventually, students' performance.

Alternate Settings for Web Lecture Viewing

We studied two ways to watch a web lecture – individually and in project team groups. Our hypothesis was that students would prefer watching in groups because of the opportunity to discuss the material and to study in a social setting. Based on the Fall 2003 formative evaluation, we did not further investigate in-class viewing.

Observational studies of three project teams suggested that students are more focused when watching a web lecture in a small group setting. Students felt this was due to the more “formal” feeling of watching a web lecture in a group, saying that they would be less likely to be distracted or to distract others. For example, multiple students commented that in a group setting they would turn their cell phones off, but in an individual setting they would not. Along with this positive effect of viewing web lectures in groups, however, we also found that because of the social context students were less likely to make use of the ability to navigate within the web lecture, such as to review selected material. Students said they did not go back in the lecture if they did not understand something because they did not want to interrupt the other viewers. When watching web lectures individually, students said they were more likely to skip around in the playback, more likely to be distracted, less likely to watch the entire lecture, and indicated that including more interactive elements would help them stay focused.

In-Class Activities

The in-class activities were designed to stimulate the social process idea generation and reflection on others' ideas. The activities were grounded in real-world examples or anchored to the group project activities.

Critiquing Existing User Interfaces

Critiquing is not only a required skill for professionals working in the area of user interface design, it is also a good mechanism for students to learn and develop good

user interface design. We used this learning activity in three settings:

- **Instructor Guided:** An in-class critiquing session guided by the professor.
- **Group Activity:** An in-class critiquing session carried out by groups of 4 students scaffolded by professor and T.A. with groups presenting their results at the end of class.
- **Homework Assignment:** Critiquing done individually as a homework assignment before class with a Hall of Fame/Shame nomination and voting activity during class.

As preparation for the critiquing classes, students were requested to watch the web lectures on design guidelines. In these cases, watching the web lecture was motivated by the need to be able to adequately justify one's design compliments/criticisms.

Evaluating the classes with surveys and focus groups, we found that students especially appreciated the group critiquing and Hall of Fame/Shame activities. Some students indicated that they found the Hall of Fame / Shame class the most enjoyable class of the whole semester. The class in which the professor led the critiques was not perceived as useful.

Project Group Presentations

Within the constructivist paradigm, reflecting on experiences constructs, reinforces, and updates in the mental models we use everyday. By presenting project experiences during class, students effectively articulate and reflect on the principles and processes that are important in the everyday practice of HCI. We used this mechanism several times throughout the pilot study.

Two weeks after the project teams had started working on the project they selected, teams were expected to present the results of their requirements gathering in class. In preparation for the process of requirements gathering, students were encouraged to watch two parts of a web lecture on the subject. Each in-class presentation lasted around 5 minutes, with another 5 minutes for questions and comments by the class. This activity proved to be very valuable for the process of generating ideas for the projects, and lively discussion provided constructive feedback for each presentation.

At the midway point in the semester, a poster session was organized. This in-class activity was used in previous semesters as well. Each project team has a poster that conveys their overall project idea, intended end users, and design alternatives. Professor, T.A., and several graduate HCI students visit each project group, listen to their poster explanations, and provide feedback on the design alternatives. Project teams were also graded for their poster and presentation.

Near the end of the semester, when project teams were evaluating their prototype, the teams were asked to

present a cognitive walkthrough of their prototype. As with the in-class requirements gathering presentation, students were asked to watch a web lecture to become familiar with the cognitive walkthrough. The web lecture was created by capturing a live lecture by another professor. The resulting web lecture was very similar to ours, except the video feed for the lecture was a view of the whole class and live lecture as opposed to just a production quality talking head. Project teams were able to produce and present effective cognitive walkthroughs, and many students commented that the activity was both educational and enjoyable. One surprising finding, however, was that almost all students stated that they prefer studio produced web lecture to the live recorded web lecture.

RESULTS

In this section we discuss the results of the first iteration of our educational design experiment.

Structuring Research Questions

To help organize our research questions, we applied the Flashlight Triad Model [25].

The Triad refers to the combination of a technology, a learning activity, and an educational outcome. Research questions can be raised concerning any one element of the triad, or concerning two elements together.

Figure 6 shows two applications of the triad model.

Technology	Activity	Outcomes
HWebs: Short online homework assignments over material covered in readings.	Students do assigned readings and complete an HWeb before class.	The instructor can assume students' baseline knowledge and move on to applications and problem solving.
Web lectures	Students watch the web lectures before class; time in class is used for learning activities.	Students develop better UI design, critique, and evaluation skills.

Figure 6 The first row applies the Triad Model to the use of HWebs [13] before an organic chemistry class; the second row applies it to web lectures viewed before class.

After framing the pilot study using the Flashlight Triad Model, we defined research questions of four different types: questions about each of the triad elements individually, and questions concerning the interaction between the technology and activity. We sought to answer these questions via:

- Four surveys:
 - Survey 1, referred to as “the first survey,” given during the second week of class;
 - Survey 2 referred to as “the mid-semester survey;”
 - Survey 3, referred to as the “group vs. individual watching survey,” given after project groups were asked to watch a web lecture as a group;
 - Survey 4 referred to as “the final survey;”
- Three focus groups:
 - Focus Group 1, held during the second week of the semester with five students;
 - Focus Group 2, held during the sixth week of the semester with five students;
 - Focus Group 3, held the week before finals with four students;
- Three observations/debriefings of project groups that viewed a web lecture as a group

Research Questions and Findings

Type 1 Questions: Technology

The technology for authoring, publishing, and viewing web lectures is mature enough to be used in education and training. Surveys and focus groups showed that server availability, broadband connectivity, and browser support for the streaming video were all satisfactory.

Q 1.1 Do students have broadband internet connection from their dormitory or apartment?

All students had a broadband internet connection.

Q 1.2. Are the web lectures viewable from different computer platforms/operating systems/internet browsers?

Web lecture playback works best on Internet Explorer 5.0 or higher on Windows XP; adequate playback can also be achieved on MacOS X using Internet Explorer or Safari. Our current technology is not compatible with the Linux.

Q 1.3. Do the web lectures have sufficient production quality?

On the mid-semester survey, the majority of the students rated the production quality (defined as the image and sound quality) as ‘sufficient’ (15 out of 27). The Likert scale was defined as ‘1. Very Bad’ – ‘2. Insufficient’ – ‘3. Neutral’ – ‘4. Sufficient’ – ‘5. Very Good’. The average response was 3.89 with a standard deviation of 0.89 (AVG: 3.89, SD: 0.89). The final survey yielded AVG: 4.03, SD: 0.71. Focus groups confirmed that students were increasingly satisfied with the production quality of the web lectures.

Q 1.4. Are there any technological affordances that could improve learning?

Students suggested some features that could improve the educational value of web lectures:

- Integrate interactive questions throughout the web lecture to increase focus and comprehension
- Emphasize the most important parts of a lecture

The survey asked students to rate potential technological affordances from 1 (Totally Useless) to 5 (Very Useful):

- Web forum embedded in the web lecture (AVG: 3.48, SD: 1.26)
- FAQs for each slide (AVG 3.56, SD: 1.12)
- Links to other resources relevant to a slide (AVG: 3.17, SD: 1.05)
- An easy way to ask a question about a slide (AVG: 3.77, SD: 1.56)

Type 2 Questions: Interaction Between Technology and Activity

Q 2.1. How useful do students consider the web lectures for use in education in general? What are the students' attitudes towards web lectures?

As the semester progressed, students' attitudes towards the use of web lectures became more positive, both with the attitudinal surveys and even more so in focus group discussions. This may be due to the students becoming accustomed to web lectures and forming a better understanding of our goals with the web lectures.

Q 2.2. How useful is viewing web lectures in advance of class as a way to use class time more effectively?

On Survey 1, before students had watched any web lectures before class, students estimated the usefulness as AVG: 3.46, SD: 1.04. The mid-semester survey, when students had actually watched the web lectures a few times before class, showed a perceived usefulness of AVG: 3.33, SD: 0.68, while the final survey yielded AVG: 3.26, SD: 1.06. This slight decrease was not statistically significant.

Q 2.3. Do students actually watch assigned web lectures in advance or in lieu of class?

On the mid-semester survey, with a scale of 'none', 'some', and 'all', 4 of 26 respondents had watched 'all' web lectures in advance of class and 21 watched 'some.' The final survey yielded similar results: 3 of 31 respondents watched 'all', and 26 watched 'some' of the web lectures.

Q 2.4. Is watching web lectures alone or in groups more effective?

Our observation and debriefing of three project groups viewing a web lecture as a group yielded

some unexpected findings, as previously discussed. The subsequent group vs. individual watching survey, although not statistically significant because of a small sample size (12), confirmed our observations that suggested individual watching is preferred to group watching. Responses to questions were on a 1 (Strongly Disagree) to 5 (Strongly Agree) scale:

- When watching a web lecture in a group (as compared to watching individually) I am more likely to pause the playback, or go back in the web lecture to review or reflect: AVG: 1.33, SD: 0.49.
- When watching a web lecture in individually (as compared to watching in a group) I am more likely to pause the playback, or go back in the web lecture to review or reflect: AVG: 4.42, SD: 0.67.
- I prefer watching web lectures in a group over watching a web lecture individually: AVG: 2.58, SD: 1.24.

Q 2.5. How can we motivate students to watch the web lectures in advance of class?

Interestingly, students requested more mechanisms to "force" them to watch the web lectures. In a senior undergraduate course, we want to avoid mechanisms like pop quizzes. We found that handing out a short homework assignment – one that illustrates the subject of the scheduled class and requires the contents of the web lecture for completion – encouraged many students to watch the web lecture. The final survey showed that students perceive these short homework assignments as quite useful (AVG: 3.6, SD: 1.0) on a scale of 1 (Totally Useless) to 5 (Very Useful). For these homeworks students did not receive a grade, but extra credit instead; an overwhelming majority of the students desired these homework assignments to be graded.

Q 2.6. To what extent is attending class useful for students who have not watched the web lecture before class?

During a focus group, students noted that the in-class activities are more enjoyable and constructive if everybody is at the same level of understanding.

Q 2.7. How useful do students consider viewing the web lectures as a way to study for exams?

On Survey 1, before students had seen any web lectures before class, students estimated the usefulness with AVG: 3.83, SD: 0.82. The mid-semester survey showed an expected usefulness of AVG: 3.89, SD: 0.89, while the final survey yielded AVG: 3.29, SD: 1.37. The change from the first two surveys to the last one is a significantly significant

decrease. As the semester progressed, students drifted away from their initial notions that web lectures are only a distance learning tool or another lecture capture tool like eClass [17], and started to understand our true intent in using web lectures. On the final survey, some students commented that web lectures as a means to review for exams are not that useful because they are too long and geared toward introducing new material instead of reviewing it.

Type 3 Questions: Activity

Q 3.1. How useful do students consider the in-class learning activities?

The mid-semester survey showed that a majority of students (19 of 27) found the in-class activities 'quite useful', 2 of 27 found them 'quite useless', 5 of 27 indicated 'neutral', and 2 of 27 indicated 'very useful', for a result of AVG 3.75, SD: 0.70. On the final survey, we asked students to rate each specific in-class activity. The most popular activity was small group UI critiquing, followed by the Hall of Fame/Shame nominations/voting. All activities were rated positively.

Q 3.2. How useful do students consider this course format in comparison to the traditional lecture format?

In comparison with a traditional in-class lecturing format, students slightly preferred the new course setup of web lectures and in-class activities in the mid-semester survey with AVG: 3.21, SD: 0.88. At the final survey, students were slightly more positive: AVG 3.26, SD: 0.96. This slight increase is not statistically significant.

Q 3.3. How willing are students to come to class for the in-class activities?

Attendance levels were quite high for each of the classes. However, it is impossible to determine whether this is a result of in-class activities or some other unknown factor.

Type 4 Questions: Outcomes

Many questions can be asked about educational outcomes. A few of them are listed here, although we have no answers to the questions. This is of course part of our future work.

Q 4.1. If the web lectures in combination with in-class activities allows students to develop better UI design skills, this should be visible in the end-products of the project. How do the end products compare with previous semesters?

Q 4.2. If the web lectures in combination with in-class activities allows students to develop better analysis and critiquing skills, this should be evident in tests where students have to critique a particular UI. How can we design a good test for this purpose?

Q 4.3. How do the mid-term and final examination grades compare to previous semesters?

Fitting our pilot study into the Triad Model helped us form and structure our initial research questions regarding the use of web lectures to augment the traditional lecture. The pilot study provided much useful information and directions for future research. However, recognizing that it was only a pilot, some of the results are not conclusive and many of our questions could not be adequately addressed. In many ways, the pilot study produced more questions than answers.

Instructor and T.A. Roles and Workload

What impact does this approach have on instructor and T.A. roles and workloads? The design phase of the course is about the same effort. Recording the lectures is a new activity that for the teacher takes perhaps two to three times the duration of each lecture, per lecture. So the overall start-up effort is higher. On the other hand, the effort per course offering is less for the teacher, as some classes do not meet (because students watch web lectures instead) and many of the learning by doing classes are student-driven.

The T.A. does have more work because more materials are submitted by students or project teams. These include short assignments completed after watching a web lecture and in-class presentation material submitted by individuals or project teams. Also, given the more active style of learning, students may call on the T.A. for more assistance than with the traditional lecture approach.

Lessons Learned

The most important lessons learned are:

- Satisfactory web lectures can be created with modest faculty time and simple, inexpensive equipment.
- Web lectures in advance of class can be used to allow more use of class time for constructivist activities.
- Students have generally positive attitudes towards watching web lectures in advance of class, in exchange for spending more class time on constructivist activities.
- Students desire some form of explicit motivation to watch web lectures.
- Web lectures are better suited to individual watching as opposed to group watching.
- There is some potential for economies in using web lectures, as the number of class meetings per semester can be reduced

FUTURE WORK

Our pilot study frames many interesting research questions and motivates our efforts to explore ways to improve the web lecture intervention. In particular, we

plan to focus on improving the course format in several ways, one of which is to provide a strong technology-based linkage between viewing web lectures and subsequent in-class discussions; exploring the integration of more technological affordances for web lecture delivery; and conducting more sophisticated and controlled studies.

Course Format

Feedback elicited from students throughout the pilot study strongly suggested that some form of explicit motivation is needed to ensure web lectures are viewed *before* class. Rather than relying on pop quizzes, we plan to continue development of short homeworks, similar to Collard's HWebs [13], that will serve multiple purposes:

- The small homeworks will be a source of explicit motivation for students because they will be graded. Each homework will not “count” much, but completing of all such homeworks will be worth enough to encourage students to complete them all.
- The small homeworks will serve to frame the web lecture watching experience. Providing students with a “goal” in advance, in this case completion of a small homework will focus students’ attention on the web lecture.
- We hope this will promote more active web lecture viewing and encourage viewers to take advantage of the technological affordances provided by the web lecture delivery medium (stopping the web lecture during playback, “rewinding” back to an unclear point, etc.).
- The small homeworks will act as a link between the web lecture watching experience and the subsequent in-class discussion. It is important that the material presented in the web lectures be viewed as a foundation and segues into the in-class activities that are designed to solidify and extend the web lecture material.

In addition to developing small homeworks for the web lectures, we plan to develop new and improve the current in-class activities. Students in our pilot study really enjoyed and felt they learned from the in-class activities that were based on their course projects or involved informed and/or guided user interface critiquing. We plan to develop more activities with anchors to project work, integrate more structured critiquing activities, and try to create other engaging activities with pedagogical mechanisms as yet unexplored. This area of future work is extremely important; the educational value of web lectures cannot be fully realized if in-class time is not spent engaging students with educationally meaningful and enjoyable activities.

Web Lecture Delivery

The ability to stop, fast forward, or rewind playback and to navigate to any point in a web lecture using the table of contents navigation bar are simple examples of technological affordances already provided by our web lecture delivery software, Microsoft Producer. Other similar research projects, online communities, and web forums make use of a variety of technological affordances to support collaboration, engagement, or understanding. Examples include discussion forums, links to external resources, integrated interactive activities, and presence indication. We plan to explore which, if any, of these technological affordances may be beneficial additions to web lecture delivery.

Initially, additions that we think will be particularly beneficial include integrating the small homeworks discussed above into the actual web lecture (as opposed to simply handing out paper homeworks), and adding a facility that supports submitting a question during a web lecture. For the latter enhancement, we envision a facility that allows students to simply click a “Submit Question” button at any point during web lecture playback. When the button is clicked, playback will be automatically stopped, and a question submission window will appear with a timestamp automatically recorded. The student could then write their question, and when submitted – either by email or posted to a webpage – the question would have all the information needed for the professor or T.A. to address it adequately. With this functionality, the Professor could view questions before holding class and be prepared to spend the first part of class addressing them.

Quasi-Controlled Study

The study that gave us most of our experience and feedback regarding web lectures was only a pilot. Although it did provide us with enough subjective results to justify and motivate further research, it was not controlled enough to produce any significant quantitative findings. We will conduct a more controlled and focused study during the Spring 2005 semester.

The quasi-controlled study will involve two sections of CS4750 User Interface Design. Both sections will have the same professor and T.A. One section will be taught using the traditional lecture format, while the other will be taught making use of web lectures and constructivist in-class activities. With this study, we hope to increase our understanding of small scale aspects such as engagement with web lectures and in-class activities, as well as gain some insight into large scale aspects such as increased project quality, improved course grades, and more students selecting HCI as their computer science specialization or career.

CONCLUSION

In this paper, we have presented our vision and initial research into the use of web lectures to enhance the

classroom learning experience. Advanced audio/video and networking technology is ubiquitous enough to facilitate production and distribution of web lectures that are inexpensive, easily and quickly created and distributed, and integrated with technological affordances to support asynchronous learning. We are interested in making use of web lectures so that more time can be spent participating in constructivist learning activities during class. Formative evaluation in Fall 2003 helped us achieve a good level of web lecture production quality and provided valuable student feedback. The extensive pilot study in Spring 2004 provided insight into when, where, and how web lectures should be viewed; the kinds of in-class activities that work well in conjunction with previously viewed web lectures; and the promising possibilities of future work.

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