
FUTURE COMPUTING ENVIRONMENTS

Can Electronic Notebooks Enhance the Classroom?

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ABSTRACT

We are interested in prototyping future computing environments that will enhance the classroom experience and empower both teacher and student. In this paper, we describe the Classroom 2000 project at Georgia Tech which is integrating personal and group pen-based technology, audio services and the World-Wide Web to record in-class interactions for later review.

Keywords

Ubiquitous computing, educational applications, pen-based input, using the WWW, audio indexing.

Introduction

Our vision for educational technology is to empower both teacher and student to enhance existing modes of classroom interaction as well as form new modes of group and individual activity and break the physical and temporal boundaries of the traditional classroom to provide ubiquitous electronic access over time and space. Imagine that while studying for an exam, the student could query a repository of all information collected throughout the course. This would include intelligent content-based searches through the teacher's prepared lecture notes, the student's own notes taken during class, and the audio and video records of the classes. In reviewing this information, the student could also make associations between issues discussed in separate lectures. Then imagine that this retrieval and association could be done across all classes that an individual student had attended or all classes taught at an institution. Providing automated support for the capture and exploration of such a rich information source is our ultimate goal in this research. It is for these reasons that we began a project to introduce and examine the effects of electronic notebooks within the traditional lecture-based classroom. We call the project Classroom 2000 to suggest a futuristic approach that is not very far off in time. Our prototype classroom, which has been built over the last 3 months and tested in an undergraduate computer science course, will be fully functional for a graduate level HCI course in the Winter Quarter of 1996 at Georgia Tech.

Background

Shneiderman *et al* [2] discuss the effects of introducing technology into the classroom in terms of the paradigm shifts that result. All of the existing systems discussed in this article, and all of the attempts we are familiar with have some commonalities that we are trying to avoid. Technology in the hands of the student usually translates into a workstation at each desk. This approach is fine, and even necessary, for classes which involve computer-based activities (such as programming). We want to investigate the usefulness of alternative interfaces which are less intrusive and allow natural handwritten notetaking, such as a pen-based laptops, PDAs or tablets.

Our work in Classroom 2000 has been greatly influenced by the work in ubiquitous computing and electronic notetaking done at Xerox PARC. We want to capture information provided by the teacher during a lecture, so electronic whiteboard capabilities provided by the Xerox LiveWorks LiveBoard [1] naturally suggest themselves. The teacher in Classroom 2000 uses the Liveboard and our software to present and annotate prepared lecture presentations.

We also wanted to provide the students with an electronic notebook with the capability to take notes during the class that could be the basis for review after class. The Marquee note-taking prototype developed at Xerox PARC [3] came the closest to what we wanted to have in the hands of the students. Marquee provided a simple mechanism for producing notes with a pen-based interface that also created automatic indexing into a video stream. We currently have the capability to handle digital audio recordings of classroom lectures and will eventually be able to support digital video. Using the students's electronic note-taking as a simple and automatic way to index into those rich information streams provides a value added capability beyond paper-based notes.

Framework for Classroom 2000

In designing the prototype for Classroom 2000, we found it useful to divide the activities into three distinct phases---pre-production, in-class use and post-production.

Pre-production

In the lecture-based model of the classroom, we assume that the teacher does some preparation for each lecture. This pre-production phase can range from the preparation of a complete slide-based presentation that will be shown in class to a less formal preparation of notes that the teacher alone will use during the lecture. Any prepared materials that the teacher wishes to make available to students during the lecture must be transformed into a format that can reside on the student's electronic notepad and be presented on the Liveboard during class. We developed a single software system, ClassPad, that runs on both the Liveboard and the student notepads (see Figure 1 for a screenshot of the ClassPad prototype). We have automated the pre-production phase so that all the teacher must provide is a Postscript file of the prepared presentation, which is then run through a UNIX filter to create the files for ClassPad. After simple adjustment of initialization parameters for ClassPad, all material is set for the live lecture.

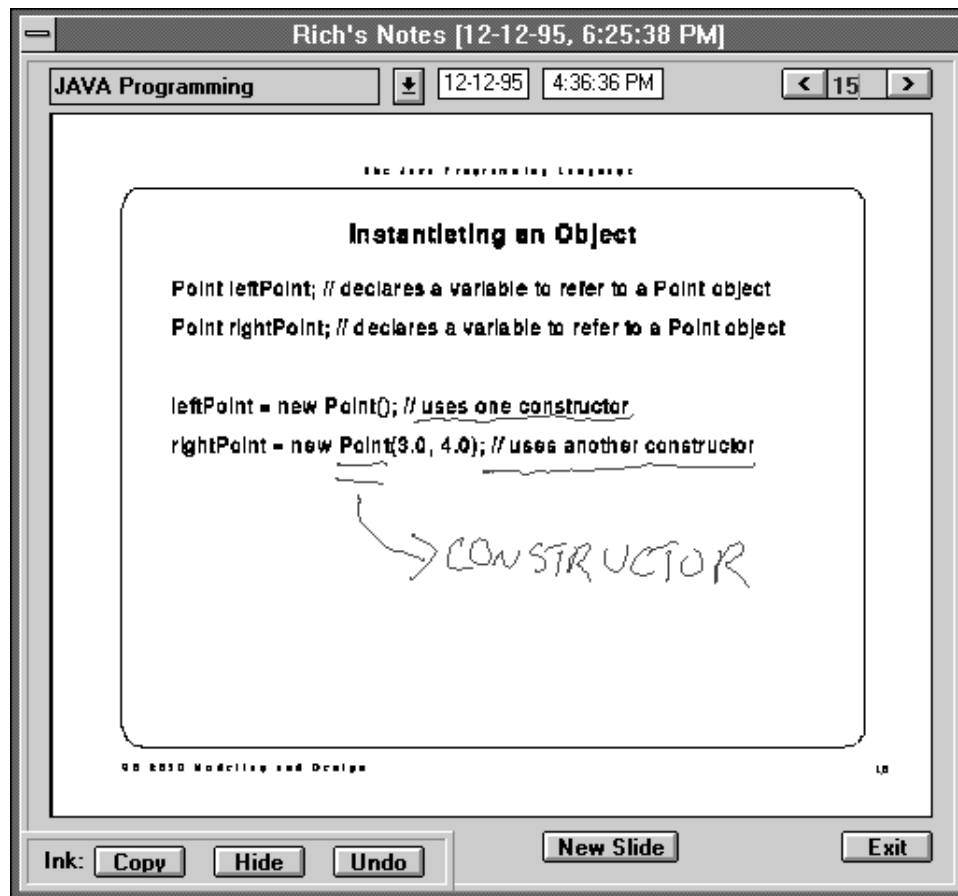


Figure 1: Screenshot of ClassPad prototype

In-class use

A prototype, ClassPad, was written in Visual Basic. This application runs on both the Liveboard and pen-based Windows machines in the hands of the student. As the teacher is presenting the lecture, she can mark the slides with additional annotations. The students can do the same thing. Blank slides can also be created on the fly in order to insert additional notes that might not fit on the prepared slides. The entire lecture is currently digitally recorded; we will soon be able to support digital video recording as well. Every pen annotation is recorded with a timestamp to facilitate audio indexing. It is important to

stress that in designing the ClassPad application, we tried to introduce as little extra work for the note-taking student.

Post-production

Once the lecture is complete, we enter the post-production phase of Classroom 2000. We have tried to treat the whole data collection and reviewing task as a Worldwide Web authoring and browsing task. A class home page holds a syllabus containing all information accumulated for each lecture, including the prepared lecture notes, the teacher's and student's annotations on those notes and the audio track. The ClassPad application accumulates annotations and timestamps and produces an HTML document that can immediately be hung off the class Web page for browsing from any Web browser. The browsable form of the notes contains links attached to each slide that accesses a customized audio service tool to deliver the portion of the lecture pertaining to that slide.

We will in the future be able to do some further post-processing of the collected lecture information (notes plus audio). For example, we could use a voice recognition system trained on the teacher's voice to provide keyword-based search within and across lectures. We could use handwriting recognition to convert the notes into a more searchable form. We could create automatic links within and between lectures linking up parts of the course that discussed a common topic. These augmented capabilities would support both the student and the teacher in reviewing lecture and course material. Ultimately, the entire course would result in an on-line multimedia book authoring session.

Evaluating Effectiveness

We have developed all of the Classroom 2000 infrastructure during the Fall Quarter of 1995 at Georgia Tech. Throughout the quarter, different aspects of the prototype classroom were subjected to live evaluation in an undergraduate programming course with 40 students. We received constant feedback on various aspects of the prototype system (use of Liveboard, the ClassPad application, the Web-based syllabus and audio service). At the end of the quarter, we issued a questionnaire asking for specific feedback on Classroom 2000.

Almost all the initial reactions to the new technology were positive, but that is to be expected amongst technically-oriented undergraduates. Students appreciated the increased class participation that the Liveboard encouraged and the increased availability and richness of lecture material after class (especially when they missed class). The organization of material on the Web greatly facilitated review. Several students chose to design and implement (in Smalltalk) a tool to help in the construction of the Web syllabus, making the task of maintaining the class page much easier for the teacher. Although the audio service was only completely functional for one lecture, students did find it useful to hear class discussions connected with static notes.

During development, we only had one electronic notepad for student use, and some students complained that this caused a distraction. Despite having cross-platform Web-based electronic versions of class materials, some students still preferred paper copies of materials for review. The Web implementation was not well-suited to printing out the in-class material. The increased technology in the classroom tended to make students lazy about writing their own notes and they were sometimes disappointed by the quality of notes provided by the class scribe. The general feeling was that the scribe notes were only well-suited for the individual who took the notes.

Classroom 2000 will go "live" during the Winter Quarter of 1996 to support a graduate introductory course in HCI. We hope to overcome many of the problems cited in our initial evaluation by providing electronic notepads to a larger percentage of students on a rotating basis. We will also use the course to provide a longitudinal study to determine the effectiveness of this technology in the classroom. We expect new forms of pedagogy to emerge through continual use of Classroom 2000, but rather than try to predict what those forms will be, we have chosen to implement a system and observe it in use.

Conclusions

During the three months of active design, development and use of Classroom 2000 we have learned several things. We have found it very useful to separate the activities into the pre-production, in-class and post-production phases. We have come to appreciate the need to make entry into Classroom 2000 easy for both the teacher and the student so we have put in extra effort to streamline any activity that is above and beyond what would normally be done in a lecture-based course. We have seen that the novelty of the electronic classroom soon wears off, so Classroom 2000 needs to have clear advantages over the traditional recording mechanisms of paper and memory in order to maintain student and teacher interest.

In response to the question raised in the title of this paper, the electronic notebook can enhance the classroom, but only when it is considered as one part of a larger integrated system uniting activities both before, during and after the actual in-class interaction. The electronic notebook offers capabilities to augment student memory, but many improvements remain before it could replace paper.

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