Enabling student control of a classroom's shared screen

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Abstract
We describe a system that provides students with control over shared displays in a lecture. We discuss both the philosophical motivation for the system, and the design issues we encountered in building the system.

Introduction
Electronic presentations are widely used in higher education today. Most commercial slideware tools that run these presentations embody a teaching philosophy wherein the presentation is a one-way conduit through which an instructor transfers information to students. Yet a competing pedagogical philosophy is gaining approval by educators—one where students play an active role in the learning process [1]. In this paper, we describe a prototype system that uses laptop and handheld computers operated by students to enable a higher degree of student involvement and a stronger student-instructor interaction in classrooms.

Scenario. Larry is sitting in his discrete math class, trying to follow a proof that the instructor is presenting to his class. The material is difficult for him, and there are multiple steps in the proof where he does not understand. He raises his hand tentatively to ask a question, much to the relief of other students who were also struggling to follow. The instructor grants partial control of the screen to Larry to ask his question. Larry, using his own laptop, highlights the lines where he did not understand the step the instructor took, asking his question: “What was the step here and how does it relate to this step? Why didn’t you do X instead?” Other students can see Larry’s actions on the screen, agreeing that they do not understand the step. While the instructor explains the logic behind the proof, another student in the class, Roper, using his TabletPC, quickly scribbles out an alternative proof taking the step X proposed by Larry. Roper then uses his computer to request a spot in the “presenter’s queue”—thereby indicating to the instructor that he wishes control of the screen. Once the instructor is done answering Larry’s question, he allows Roper to take control of the screen. Roper then shares the proof he has quickly scribbled out from his laptop onto a different shared screen. As he explains the proof to the instructor, the instructor nods and says to the class, “This is a brilliant proof, and a great use of the MultiPresenter system.”

The scenario is one that philosophically motivates the present work—that students are active entities that are capable not only of producing novel ideas and work, but that in doing so they can more effectively learn and understand the material. In particular, the description illustrates two pedagogical scenarios supported by our current prototype: the ability for students to take control of the screen to ask a question, gesturing at the screen, and second, the ability for students to contribute content to the shared display.

This new prototype system is build upon the MultiPresenter system [3], a novel presentation system designed to work on multiple and high-resolution displays. It allows presenters to organize and present both pre-made and dynamic presentations that take advantage of the large display surface accessed from a personal laptop. In MultiPresenter, we focused on functionality that enhanced an instructor’s practice (e.g. persisting information, allowing ad-hoc non-linear presentation styles). In designing the current system, we augmented that feature set with new tools to enable audience control of the display.

Systems that have explored “active learning” techniques typically employ students’ handheld or laptop devices to drive back-channel communication, such as polls, question answering, or anonymous voting [2,5]. In contrast, we realize a more direct approach, providing students with the functional affordance of controlling parts of the screen surface, as well as the ability to bring their own content to be viewed by all. Some systems have allowed students to annotate instructors’ slides to be shared in the classroom [4,6], yet the instructor remains under full control of the scarce screen resource. We envision learning environments where screen real-estate is no longer a scarce resource, thereby enabling new types of interactions. For instance, in the described scenario, some screens may be used by the instructor to present learning material, while others are used by students to raise questions, or to share relevant material.

Our system already supports the entirety of the scenario described at the outset. Some of the questions that we might ask when planning such a system include: How should we facilitate such interactions? What kinds of access control should we build in order for such a system to work well in actual classrooms?

What kinds of pedagogical patterns are best to support student involvement?

Requirements

In our design we had several goals in mind: (1) *Enable different pedagogical uses* – We wanted the audience to be able to control specific parts of the screen. Our goal was to design and provide several simple affordances, and then to allow instructors to devise different pedagogical patterns using those affordances. (2) *Provide instructor control* – Although students are given some control of the screen, the instructor still retains authority over who controls the screen, and to decide which information could be under shared control. (3) *Support a student queue* – Only one student may control the screen at one time using turn taking. While this may limit some interactions, it allows for a structured, clear way for students and instructors to understand how to use the system and for students to perceive a fair system of turn taking. (4) *Require only simple infrastructure* –The system should enable simple connection to the instructors' laptop over HTTP or TCP, so any wireless device would be able to connect. A simple client should be implemented so students are able to easily connect to the instructor's computer.

Design

A communication module was added to MultiPresenter to enable incoming connections from students' personal devices. Students' personal devices use a dedicated client that communicates via a dedicated TCP socket connection using a custom protocol. Cursor location and mouse clicks are transferred from the communication module to the Presentation manager module of MultiPresenter.

An instructor can decide when to enable student control and when only instructor control of all screens is preferred. In the current implementation, student control is allowed only on one screen, while the other screen is still used for the instructors' slides. Student control of the secondary screen is determined according to a queue. Only one student can control the screen at a time. The instructor can see the student queue, and at any given time can stop all student control, remove students, or change one or more students' locations in the queue. The analogy we made is to students raising their hands in a classroom in order to ask questions. The instructor handles the turn taking, usually trying to allow the first student who raised a hand to ask the first question (take control). When the student has answered, the instructor can give control to the next student in line.

Using a client application, students can request control of the screen. When the student reaches the top of the queue, she is notified and can then start interacting with the shared display using the client. The student can move her mouse in a set area that is mapped to the shared display and see her cursor on the screen. The student can move and resize clips, annotate, or highlight information using her mouse. The student can also move backward and forward through the slides in order to bring up previous information. In addition, the student can bring images or screen captures from her computer to the shared screen. The student (or instructor) can then interact with these clips by resizing, moving, or annotating them.

Informal Evaluation

In order to evaluate the system, we ran a demo session in our laboratory. The purpose of the session was to test whether our implementation was able to support a large number of users, to examine the utility of our turn taking protocol and to get initial feedback on our design. Fourteen people consisting of faculty members graduate and undergraduate students from our HCI reading group participated in the session with their own laptops. After a brief introduction to the system and explanation on how to use the client, we commenced with a 20 minute lecture on multi-touch screens (a topic of interest to the reading group's participants). Participants were encouraged to request control of the screen and to contribute relevant information. Following the lecture, participants were given five minutes to browse the Internet and find related material to share with the group. We then conducted an open discussion on the lecture's topic, with each contributing member controlling the screen in turn.

Participants provided positive comments as well as constructive suggestions for improvements of the system. Issues of note included the usability of the system, such as the ability to delete one's own clips (but not to delete clips that were posted by others), or to have more feedback on the position of the student in the queue. Others suggested more advanced features such as the ability to allow students to send the content to the instructor's laptop and have the instructor post the content, or to provide a view of the shared screen on the student' laptop. Some participants commented on the security of the system and on the importance of denying different kinds of abuse of the system.

Summary

The main research contribution of this system is an investigation of a platform that gives presentation affordances that were not possible before. The benefits and pedagogical implications of such a system are not obvious. While allowing audience members a form of interaction with the presentation surface not otherwise afforded, the way the instructor will use the system in class, the audience size, and the number of audience members with computational devices all have implications on the benefits of the system and its chances for success.

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