Ubiquitous Presenter: Increasing Student Access and Control in a Digital Lecturing Environment

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ABSTRACT

The University of Washington's Classroom Presenter lecturing system enables an active lecturing environment by combining a standard electronic slide presentation format with the capability for extemporaneous ink annotations by instructors and students using Tablet PCs. Thus, it can promote more interactive, student-centered learning. While many students may own laptops, few are yet Tablet devices. Also, Presenter uses multicast networking, which has availability and reliability issues. Ubiquitous Presenter (UP) expands Presenter via common web technologies to support non-Tablet audiences and enhance student control. UP enables students, using internet web browsers, to (a) synchronously or asynchronously view the slides and ink that are broadcast by the instructor, as well as (b) provide contextual submissions via text overlaid on the instructor's slides. The only compromises are that non-Tablet students cannot produce ink, and that professor ink is provided after a small time delay.

Categories and Subject Descriptors

K.3.1 [Computers and Education]: Computers Uses in Education – collaborative learning, computer-assisted instruction, distance learning.

General Terms: Human Factors.

Keywords

Educational technology, active learning, collaborative learning, classroom assessment, Presentation tools, Tablet PC.

1. INTRODUCTION

Emerging classroom technologies, while allowing for innovative pedagogical practice, can experience cost barriers to access and adoption. UW Classroom Presenter (or just Presenter) provides instructors the ability to quickly and intuitively annotate digital slide presentations using the Tablet PC, as well as receive student-annotated slide submissions from audience Tablet PCs. In this work we describe the motivation and design of Ubiquitous Presenter (UP), a system which enables users with a variety of non-Tablet, internet-enabled computer devices to access live lecture materials generated by the instructor with Presenter,

including ink annotations. In future work we will evaluate UP's use in CS courses. UP additionally enables (text-based) student submissions without the need for student-accessible Tablet PCs, instead allowing submissions via internet browsers. UP enables widespread deployment of Classroom Presenter without the need for several Tablet PC devices or a multicast network setup, and simplifies the use of Classroom Presenter for student submissions – a powerful pedagogical feature that was previously costly and difficult to utilize.

Ubiquitous Presenter, like Classroom Presenter, enables a more active, student-centered lecture environment without a dramatic shift in established teaching methods. Although instructors still use prepared slides as a guide, the ability for students to have questions addressed quickly and easily during a lecture allows students more control over the learning experience. Additionally, the ability to review archives of annotated slides after a lecture provides students with a lasting resource. Student submissions enable instructors to further address the varying needs of students by allowing anonymous understanding checks and feedback sessions. At its limit, the two-way annotation of the instructor's slides enables a conversation between the instructor and students.

An additional, beneficial side-effect of UP's move from multicast to a client-server architecture is that students can now more readily browse forward and back through slides in a lecture, supporting a wider variety of learning styles. Though technically possible in Presenter, the broadcast communication structure of the system meant this ability was rarely utilized by students. Providing students with such active control over the lecture environment both within and outside of the classroom can promote student involvement in learning [1], and allows student difficulties and concerns to be addressed quickly and effectively.

For these benefits, students using non-Tablet devices sacrifice the ability to submit ink − instead overlaying typed text on slides. Also, slides and ink are provided to non-Tablet students through a polling mechanism, resulting in slight delays. Significantly, Tablet-using instructors and students experience no compromises.

In the following, we begin with some background on UW Classroom Presenter. We then describe UP's design and implementation (based on a download of source code from the Presenter web site), followed by a discussion of its use both inside and outside the classroom. We close with a discussion of related work and closing remarks.

2. CLASSROOM PRESENTER

UW Classroom Presenter (Presenter), first deployed in 2002, allows an instructor to teach in a dynamic, responsive manner using Tablet PCs. The obvious benefits of pen computing – the ability to freely annotate and move about while lecturing – are combined with Presenter's unique features, enabling a spontaneous, student-centered, yet organized lecture. Slide minimization allows the instructor to produce blank space along the margins of a slide for inking examples in real time, answering questions, or making corrections to slides; while the whiteboard feature allows instructors to create entire slides on-the-fly. Presenter enables students to leave personal (private) notes to themselves on slides. The student submission feature enables instructors to conduct structured (or unstructured) spontaneous understanding checks of students who also have a Tablet PC. UW Classroom Presenter has been used in over 75 Computer Science classes, from introductory courses to Masters level and distance learning programs [2,3].

2.1 Limitations of Presenter

As Presenter has grown in popularity, users have voiced the need for a more reliable, accessible form of it. The features and benefits of Presenter are attractive to many, but there are barriers to use. Students wishing to view slides and ink up-close, or wishing to save lectures for later review, must have access to a Tablet PC with Presenter installed.

Presenter uses a broadcast model of communication. At the start of the class session, the instructor broadcasts slides to all of the student devices. During the lecture ink strokes and slide transitions are broadcast. This creates a problem for late joiners, since they will not have access to the slides or the ink that was broadcast before they joined. Requiring the instructor to rebroadcast materials each time a student joined the session could severely impact performance. The broadcast networking is implemented in Presenter using multicast networking [10]. This introduces two further problems. First of all, multicast networking does not guarantee delivery of packets, leading to reliability problems. This is a particular issue for sending slides in a wireless environment. Second, not all networks support multicast. Routers are often configured to block multicast packets, so in many university environments it may not be possible to use multicast across different subnets.

Student submissions, a powerful feature of Presenter, are not fully utilized due to the need for multiple, student-accessible devices. In order to allow student submissions, instructors must obtain a number of Tablet PCs (one per collaborating group, for example), install Presenter on the device, establish a multicast-enabled network for the class to use, and distribute the Tablets to students. This is costly and interruptive – in one instance; an instructor would bring Tablets to class, distribute them for a submission activity, and then collect the devices after the activity was complete.

3. UBIQUITOUS PRESENTER

In response to these limitations, we undertook the development of Ubiquitous Presenter, a web-based extension to Classroom Presenter that allows Presenter materials to be accessed and annotated by a web browser on any internet-enabled computing device. Our desire was to widen the accessibility of such Presenter features as the ability to review slides with ink and enable student submissions, while taking advantage of the availability and reliability of the internet for broadcast.

3.1 Project Goals

These goals were outlined at the beginning of the project:

1) Availability of full-featured Presenter slides (automatically hiding instructor notes) on the web in a browser-neutral representation such as PNG or JPEG.

2) Synchronization of slides and instructor ink between the instructor machine running Presenter and the web-based repository of UP.

3) Enabling of student submissions via the web interface (without disrupting traditional Presenter multicast submissions).

4) Support for Tablet PC users to continue to use traditional Presenter with no degradation of features.

All four of these goals have been met and the system will be available download (free for academic use) in mid 2005 after a period of in-class testing.

3.2 System Design

UP is a client-server application programmed in PHP, a server-side language that generates simple HTML and limited JavaScript that is passed to student browsers. This reduces cross-browser compatibility issues and client-side processing requirements. Devices capable of running current versions of Internet Explorer, Netscape Navigator, and Mozilla can run UP. JavaScript must be enabled on the browser for some features to work.
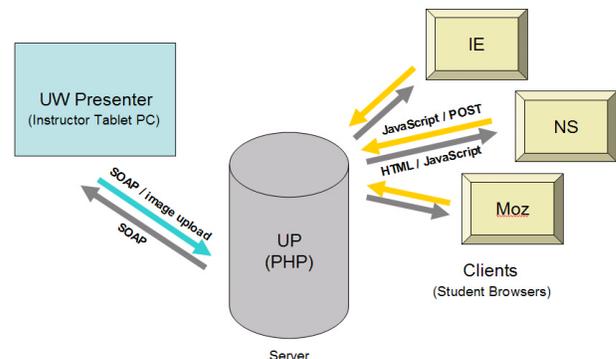

Figure 1. Setup of Ubiquitous Presenter system. A centralized server running UP enables compatibility with a number of browsers.

By isolating most of UP's processing on the server, any failures do not compromise the instructor's Presenter session. Instructors are notified of server errors, but presentations are not interrupted. If students encounter an error or incompatibility in their computers, they are still able to simply unsynchronize from the presentation and manually follow along (synchronization is described in Section 4.1).

Student browsers remain synchronized through a hidden HTML frame that polls a single image file, referred to as the current display file. This current display file is modified whenever an action (such as a slide change, ink overlay, or minimization)

occurs. The hidden frame then sends a message to the visible frame to update the image by reloading. Students may experience a short delay – no more than 3 seconds – before the image displayed is the current one.

A majority of the synchronization between Classroom Presenter and UP occurs through short file transfers and SOAP (Simple Object Access Protocol) remote procedure calls. When the instructor changes slides, a SOAP call is made to the PHP server containing the position of the new slide, and PHP executes the call, switching its current slide. When ink is exported to UP, a small snapshot image of the ink overlay in Presenter is sent to the server via an ink-overlay SOAP call. PHP composites the ink with the slide, using PHP GD image library commands, and the resulting image is displayed to students and copied for archiving. Other Presenter features, such as slide minimization or slide clearing, are also executed via simple SOAP calls from Presenter to the UP server.

Student submissions are similarly handled through HTTP POST commands and processed via the central PHP server. Upon beginning a submission, students are provided a copy of the slide being broadcast. Students may annotate the slide with text, and the server composites the text's images with PHP GD library function calls as new blocks of text are added. Once the slide is satisfactory, students choose to 'submit' the slide, and a permanent image copy is created and made available in the presentation's submission directory. The Presenter session running on the instructor's Tablet periodically checks for new images in the submission directory, and downloads the submissions as they become available and converts them into native Presenter slides.

4. USING UBIQUITOUS PRESENTER
In accordance with our goal to increase access to the novel learning modalities enabled by Presenter, attention was paid to preserving as many of its features and uses as possible. Attention was also paid to not changing the instructor's use of Presenter.

4.1 Instructor Use
The instructor creates a presentation in Microsoft PowerPoint and saves it to Presenter's native file format (CSD, or Conferencing Slide Deck). Both a PowerPoint add-in (available when Presenter is installed) and a related standalone application, Deckbuilder, can be used to accomplish this – users without Powerpoint can create CSD files, and those who are already familiar with PowerPoint may export directly from the PPT interface[1]. Deckbuilder and the PowerPoint add-in have been modified to allow the presentation to be uploaded by the instructor to a UP web server. Upon upload, the slides are available for review in the UP interface. Students may peruse the slides independently, with synchronization turned off (since there is no active lecture), as soon as slides have been uploaded. Instructors also have the option to password protect their presentation, preventing others from editing preferences or

synchronizing to the presentation, as well as providing a student password, preventing public access to UP slide presentations.

To begin a UP lecture, the instructor selects "Synchronize to Web" from the Presenter menu, and a list of available uploaded presentations are shown. Upon selection of the appropriate presentation (and password, if necessary), it becomes "live" and students using UP with slide synchronization enabled will see the first slide of the instructor's presentation appear in their browsers. The instructor now may change slides, ink on slides, and use whiteboard and slide minimization features, with the results automatically displayed on students' browsers within a few seconds. Ink is automatically exported when a natural pause occurs in inking patterns, indicating the instructor is discussing an annotation, or is encouraging students to pause and consider it.

If desired, instructors may conduct understanding checks or request feedback from students using UP's student submission feature. From the Classroom Presenter menu, instructors select "Enable Web Submissions". Students are then allowed to, via their browsers, position text over the active slide, and save the annotated slide for instructors to load back into the Presenter interface for review. As students submit their annotated slides, they appear automatically as another "Web Submissions" slide deck in the instructor's Presenter interface for review.

4.2 Student Use
Students using UP are not required to install anything – all that is needed is a web browser (recent versions of Internet Explorer, Netscape Navigator or Mozilla) and a URL exported by UP.

A key feature is that students may use UP to view live presentations in class as broadcast by an instructor either synchronously or asynchronously as they choose − likely, a combination of the two in the course of a lecture. In general, we expect students to stay synchronized with the instructor's active slide and ink. However, students may still be reviewing a slide when the instructor moves to the next [4, 5, 11]. In UP a student can temporarily switch to asynchronous mode to review (or preview) slides at their own rate, choosing to resynchronize at any time. Since all ink is captured on the web-server, students who unsynchronize do not lose the ability to access inked slides that occurred while they were unsynchronized. Figure 2 shows a student browser view of a live lecture. Student control over synchronization is set at the top right of the page with a radio button. While synchronized, navigation buttons (top left) are disabled.

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[1] While importing of lecture materials from non-PPT images is supported, Presenter's instructor objects are only supported in PPT.
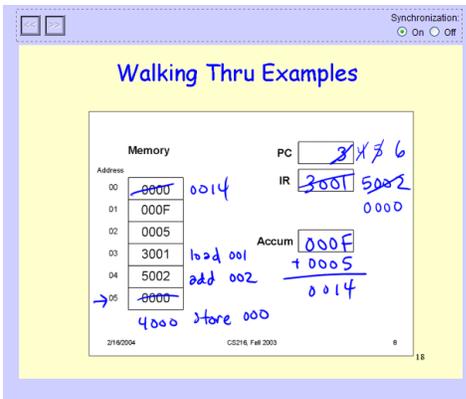
Figure 2. Student view of synchronized presentation. Slides update automatically to include ink or slide transitions.

Outside of class, students may preview slides as soon as they are uploaded and review slides plus ink annotations once a presentation is complete. As an instructor gives a presentation and ink is displayed in UP, archives of the ink are saved chronologically. In Figure 3, the various versions of inked slides occur as [1] [2] etc. at the bottom of each slide as it is displayed. Note that the original un-inked slides are always available for student viewing. This allows students to replay a lecture, viewing any annotations, examples, or corrections as added during a lecture.

4.3 Active Learning with Student Submissions

A powerful feature of Classroom Presenter, extended and made more accessible in UP, is the ability to accept student submissions contextualized in the presentation. These submissions are often comprised of annotations on top of a slide the instructor has designed for the purpose, though an instructor can also create a student activity extemporaneously using the Presenter whiteboard. Currently, UP supports text submissions on top of pre-loaded presentation slides, though plans exist to extend this feature to include 'ink' submissions from student browsers using a Java applet to allow "drawing" using a mouse or other pointer device. Such ink capability is considered an important component of student submissions; both in expanding the types of activities allowed and allowing students greater freedom of expression. Thus activities involving or requiring graphical responses may be limited by the current UP student submission feature.

Once student submissions are enabled by an instructor, students view a "Create a Submission" button below the slide display area. Students may click this button to open a new window, displaying the slide. Students may fill a textbox, then click on the slide to place the text onto the slide. Students may add several blocks of text, and edit previous annotations as shown in Figure 4. Once satisfied, the students click 'submit', at which point the slide plus annotations is sent to the instructor's Presenter interface. Note that students retain complete control over their submissions. Any text box can be edited multiple times before submission. Anecdotal use of Presenter student submissions with Tablets has shown that students frequently rework their answers and do not want initial results transmitted to the instructor.

4.4 Use Outside the Live Lecture

Just as slides and ink may be reviewed after a presentation is complete, instructors may opt to leave the "allow student submissions" feature on after a presentation. This enables students to complete an assignment based on a slide or leave feedback and questions about a presentation. To access these submissions, the instructor need only resynchronize to the presentation, and all submitted slides will reload into the Presenter interface. Additionally, the instructor has the option of making student submissions available for review within the UP interface, allowing both students and the instructor to access submissions without the need for Presenter. These student submission slides appear as an [SSx] link underneath the slide to which the submission text was added, as shown in Figure 3.

When submissions are displayed online, slides remain anonymous, but students are able to compare their results with others, or review their own work. This feature may also be employed within the class, enabling an instructor to have students
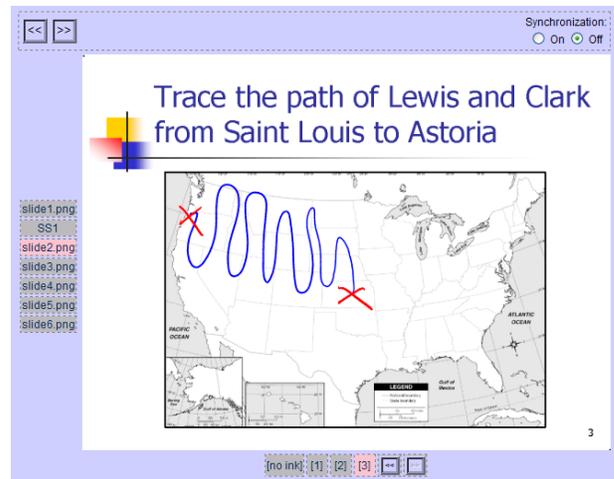

Figure 3. Student view of unsynchronized presentation. Students may peruse original slides, inked slides and student submissions that occurred during the live presentation.
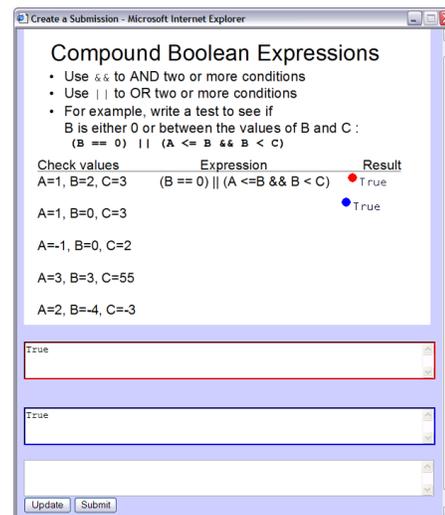

Figure 4. The student submission screen allows students to add an unlimited number of text blocks to the slide.

review their peers' submissions anonymously, or have the class collectively review a specific, particularly interesting submission.

5. OTHER USES OF UBIQUITOUS PRESENTER

5.1 Distance Learning
Perhaps the most flexibility is afforded by Ubiquitous Presenter in distance learning. In order to utilize traditional Presenter in such instances, a multicast network must be established between the instructor and the remote location. Students using UP, however, need only to log onto the URL representing the presentation they know will occur at class time. Thus students unable to attend class, distance classes conducted at remote locations, etc. may all attend a Presenter lecture without any special setup, and may utilize all of the features of Presenter – including student submissions, which like submissions done on-site, are immediately available for review by the instructor.

6. RELATED WORK
A number of projects have addressed the issue of using technology to support lecturing and learning environments.

Early work focused on integrating slides and writing includes Lecturer's Assistant [6] and ZenPad [7], the presentation component of the Classroom 2000 system. Golub [8] has independently developed a system for presenting material from a Tablet PC known as Tablet Mylar Slides.

The DyKnow system [5] has goals similar to our own. In DyKnow, students sit at PCs, optionally equipped with pen enabled technology, while the instructor lectures from an electronic whiteboard, video tablet or PC. DyKnow encourages students to annotate instructor material synchronously, with the option to review class work asynchronously. DyKnow Vision utilizes progressive disclosure to help keep students on task. Students can go back at any point within a class session to review material, but they are not able to get ahead of the instructor. DyKnow is focused on an effective classroom experience that fosters collaboration as well as the development of a good set of notes. UP differs in that we target a minimal classroom infrastructure where only the instructor must have a Tablet PC and students may interact using any internet-enabled device.

In the Virtual MultiBoard System [4], they address the lack of context enabled by a single digitally projected slide in comparison to multiple sliding blackboards. They develop software to support the use of multiple video-projector based presentations in order to address students' need to see more than the current slide – though the entire class will be shown this same view.

Engaging the class is a major goal of Active Class [1] which has currently targeted the PDA-platform to bring interaction to the classroom. Also, commercial systems exist allowing students to respond to multiple choice polls using remote controllers [9].

7. CONCLUSIONS
Ubiquitous Presenter not only expands accessibility of the popular Tablet PC Presenter system, but helps to address a wide variety of learning styles. Students are able to review slides and instructor ink annotations at their own pace either during or after a presentation. Instructors may choose to review student comprehension during or after a lecture through student submissions, and may make these submissions anonymously available for peer review. In one step, instructors provide students with reviewable lecture materials, an interactive lecture including spontaneous annotations addressing student questions or additional information, and a means for assessing student comprehension or extracting student concerns. Through Ubiquitous Presenter, student access comes not only through expanded access to the live lecture itself, but through extended accessibility of lecture slides, instructor ink, and peer submissions even after a lecture has concluded.

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