Characterization of Instructor and Student Use of Ubiquitous Presenter, a Presentation System Enabling Spontaneity and Digital Archiving

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Abstract. Ubiquitous Presenter (UP)* is a digital presentation system that allows an instructor with a Tablet PC to spontaneously modify prepared slides, while automatically archiving the inked slides on the web. For two introductory physics classes, we examine the types of slides instructors prepare and the ways in which they add ink to the slides. Modes of usage include: using ink to explicitly link multiple representations; making prepared figures dynamic by animating them with ink; and preparing slides with sparse text or figures, then adding extensive annotations during class. In addition, through an analysis of surveys and of web server logs, we examine student reaction to the system, as well as how often and in what ways students' utilize archived material. In general, students find the system valuable and frequently review the presentations online.

*http://up.ucsd.edu/about/

INTRODUCTION

Electronic lecturing possesses strengths and limitations. Computer-based digital projection allows the use of high quality pictures or diagrams, the incorporation of simulations, applications, or web materials, and can facilitate sharing of prepared content by instructors or web-based publication. In contrast, board-based lecturing possesses a naturally controlled pacing and allows extemporaneous presentation of material. Most PER-based curricula de-emphasize lecturing, yet lecturing remains widespread; furthermore, many alternate uses of class time require a shared presentation space. As a result, the features of presentation systems and the ways they are used are important for traditional and PER-based activities. The idea of affordances – those uses to which a tool is naturally suited – is useful for comparing presentation methods.[1] Following Norman, we use 'perceived affordances' to mean "the perceived and actual properties of the thing… that determine just how the thing could possibly be used."[2] While the chalkboard affords impromptu presentations, digital presentation systems such as PowerPoint do not. Table 1 compares the perceived affordances of these presentation modes.

The Tablet PC is an augmented laptop computer with a stylus that can be used to "write" on the screen. Ubiquitous Presenter (UP) is a Tablet PC-based system developed at the University of California, San Diego, based on Classroom Presenter.[3-5] UP allows faculty to write on ("ink") and augment prepared digital material (slides, pictures, etc.) in real time in class. Ink is automatically archived stroke by stroke and can be reviewed synchronously via a web interface. Thus UP uniquely combines affordances of both digital and board-based presentation, as shown in Table 1. The system also supports in-class interaction by students with web-enabled devices – though that aspect of the system is beyond the scope of this paper.[6]

In this paper, we will explore the use of UP's inking and student review features through the study of two introductory physics classes. We characterize ways in which the two instructors capitalized on UP's affordances to use ink in combination with prepared materials during lecture, and analyze specific uses that are enabled by UP's affordances: linking multiple representations, filling in templates or "sparse slides", and adding dynamic elements to prepared material. We do not claim that these techniques could not be

TABLE 1. Perceived affordances of different presentation systems.

Perceived affordance	Board	Digital	UP
Spontaneous changes	Yes	No	Yes
Archiving	No	Yes	Yes
Including prepared material	No	Yes	Yes
Natural pacing	Yes	No	Yes

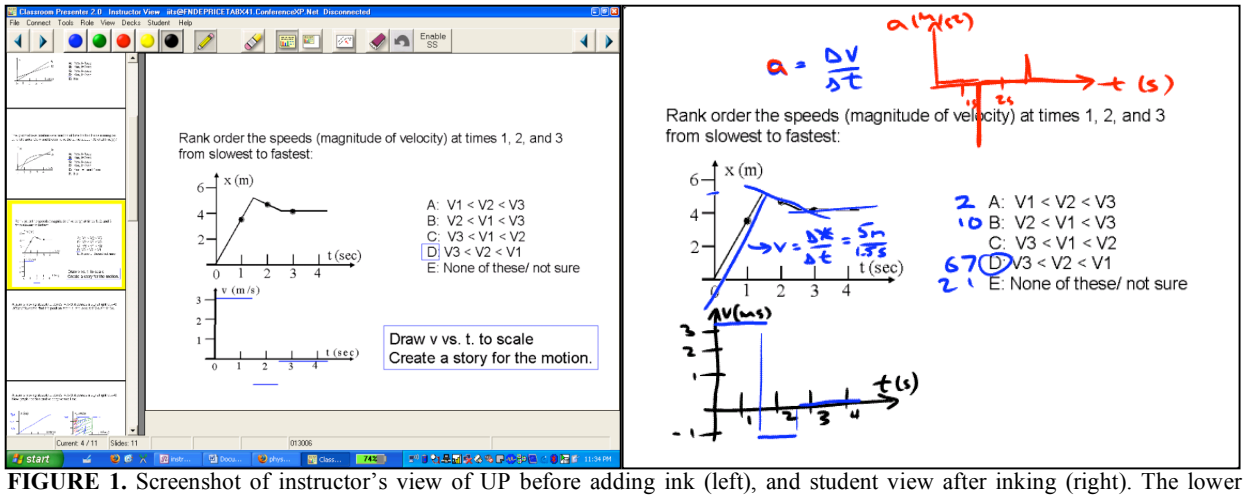

FIGURE 1. Screenshot of instructor's view of UP before adding ink (left), and student view after inking (right). The lower graph and text in the instructor's view are instructor objects, and are not visible to the students.

accomplished using traditional presentation systems; rather, that they are naturally and easily employed given UP's affordances. We also provide preliminary analysis of student use of the system through self-reported student surveys and web statistics on actual system use.

INSTRUCTOR USE

In this section, we explore the ways in which two physics instructors used UP in their introductory courses. We focus on characterizing patterns of use common to both instructors, and relate those uses to the affordances described above. Course A (57 students, taught by EP) was a semester long course for physical science and mathematics students at a public regional university; course B (180 students) was a quarter long course for life science students at a public research university. Both instructors were using UP for the first or second term, were trained and supported in their use of the system, and described themselves as comfortable with the system.

During class, instructors can add ink of several colors, erase, undo, and create extra blank space. Figure 1 shows a fully inked slide, in this case, an in-class question with solution. An individual "ink stroke" is captured as a placement of the Tablet pen on the screen until the moment of lift from the screen. Writing a single word may account for several strokes. Drawing of diagrams almost always happens in many strokes. In Course A, 40 lectures had inked slides, out of 42 class meetings. On average, lectures had 6.9 inked slides, with 31.7 ink strokes. In course B, 24 lectures had inked slides, out of 29 class meetings. Representing an alternate use, lectures in course B had more slides (12.8 on average) with less ink (19.6 strokes on average), as compared to course A.

Figure 2A shows an example of linking multiple representations. In this slide, the instructor has used lines to link pictorial representations to mathematical representations. Variables are thereby explicitly and

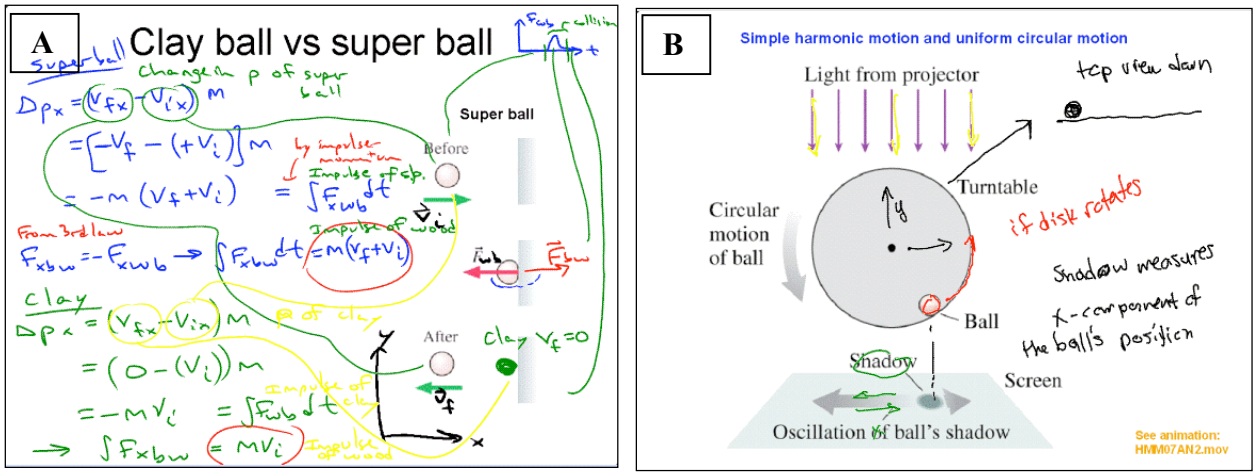

FIGURE 2. Fully inked slides showing use of ink to link representations (A) and make a figure dynamic (B).

graphically connected to the physical situations they represent. Instructors also linked pictorial and graphical representations, written problem statements and mathematical representations, and variables and expressions substituted for them. This pattern of usage rests on the affordance of spontaneous inking: instructors can easily add or erase a line in a different color. While an instructor writing on the board or using PowerPoint might connect representations with a gesture, instructors writing on a TabletPC running UP readily used ink for this purpose, thereby creating a graphical link.

Next, we describe two patterns of use that rely on mixing prepared materials with ink added in class. The instructors often extensively inked sparse slides – slides with little prepared material. The sparse prepared material included outlines (filled out in class); rhetorical, motivational, or transitional statements (leading to related analysis or derivations); problem statements (worked as examples in class); and graph or figure templates (drawn on in class, *e.g.* to show data collected in class). Thus, the prepared material may act as an anchor, a prompt, or a workspace, while the ink is added dynamically, so that the presentation is "created" in front of students. Instructors are frequently frustrated with the "canned" feel of PowerPoint lectures and the limitations of animation that must be prepared in advance. Because UP affords spontaneous inking, instructors can capture the "live" feel of a chalkboard lecture. Indeed, we find that slides are often inked extensively, to an extent that would be overwhelming if presented all at once instead of built up incrementally.

In contrast to extensively inking sparse slides, both instructors also used prepared figures extensively, often drawn from materials provided by the textbook publisher. Prepared figures often served as a focal point for inking, and instructors often used ink to make features of the figure dynamic, as shown in Figure 2. In this example, the instructor has traced over the light rays, drawn a line showing the motion of the ball, and indicated the path of the moving shadow. The figure is thus transformed from a static picture to a dynamic animation, a technique that is particularly suited to describing physical systems.

STUDENT USE

Students experienced the system during class and were also able to view slides online after class. They could view slides without the ink added during class (uninked), fully inked (the default), or at any intermediate stage. Students could therefore "replay" the lecture. We assessed student use of the system in two ways: surveying students and analyzing web server logs of actual user access. We consider both data sources in forming a comparative picture of courses A and B.

Survey results

A self-report style survey reveals students' perceived benefits from use of the system. Response rates were 74% (course A) and 54% (course B) of enrolled students. Not all students responded to all questions. Table 2 indicates the number of students who reported that the system had a very positive or slightly positive impact. The first two rows report on the overall impact; the last four report on the impact on student learning experience based on specific instructor usage modes.

Though differences in reported positive impact exist between the courses, a majority of students felt the system had a positive impact. For both courses, students respond more positively to questions about specific pedagogical impacts (such as drawing a diagram) than to general questions on the impact of the system on attention and understanding. Differences between the courses may reflect differences in instructors' use of the system and student populations.

Students were also asked to characterize their use of the web to review instructor ink after class: given five options, select all that apply. The options were "review of class within a few days", "solve homework problems", "review for a test or a quiz", "because I was not present for class physically", and "other". The most common reply in both courses (43% for A, 74% for B) was to review for a test or a quiz. In both courses, server hits increased just before tests and quizzes. The next most common response in course A was to solve homework problems; in course B, to review a class within a few days. In both courses, approximately 1/4 of the students reported at least one use of the inked slides because they were not present for class physically. These usage patterns reflect the course requirements: homework was graded for credit

TABLE 2. Students reporting positive impacts.

Topic	Course A	Course B
Attention to lecture	81% (34/42)	53% (52/98)
Understanding of lecture materials	71% (30/42)	62% (60/97)
Gave answers to student questions	86% (36/42)	54% (51/95)
Explained a concept	83% (35/42)	73% (71/97)
Drew a diagram, or picture	93% (39/42)	77% (74/96)
Used pen colors	81% (34/42)	80% (77/96)

in course A but not course B, and tests were biweekly in course B but approximately monthly in course A.

Web results

The UP web server records detailed information about when students access the online notes, including which lectures, which slides, which version of ink on a slide, etc. Furthermore, the instructor's actions of inking in class and changing slides are also recorded.

In course A, 93% of students created a user account and at least viewed one lecture slide, while 83% of course B students did the same. The number of slides in course A is 631, and 3 of the 53 (5.7%) students had at least that many hits – meaning they potentially looked every slide in the course, assuming they just looked at the "final inked" versions of each slide. The number of slides in course B is 473, and 62 of the 149 (41.6%) students had at least that many hits. There are many possible explanations for the dramatic differences in student access rates in the two courses, including student motivation, time for studying, study habits, and perceived value of reviewing the slides.

Students are overwhelming more likely to only look at the final inked version of a given slide, rather than to employ the ink replay feature that would allow them to review any process revealed by the incremental inking on the slide. In course A, 8 out of 53 (15.1%) of users had 10% or more of their server hits on "progressive" inked slides (not a completely uninked or "final" inked slide). In course B, the students viewed relatively more progressive inked slides: 41 out of 149 students (27.5%) exceeded the 10% threshold. This is an unexpected finding; the developers and instructors anticipated that the ability to view the lectures notes in progress would be valuable to and utilized by students.

Given that most students primarily viewed fully inked versions of the slides, the number of hits (or traffic) that the students generated can be analyzed in comparison to the total number of slides available in their course. Table 3 shows the number of students who viewed less than 50%, between 50-100%, between 100-200%, and more than 200% of the total number of slides available. Compared to students in course A, more students in course B accessed a greater percentage of available slides, a difference that may be related to differences between the students' goals, motivation levels, extra-curricular commitments, and perceived value of this kind of review.

TABLE 3. Student review of slides on the web. Number who viewed certain % of available slides

% Slides viewed	Course A	Course B
< 50%	77% (41/53)	44% (66/149)
50% – 100%	17% (9/53)	14% (21/149)
100% - 200%	6% (3/53)	20% (30/149)
> 200%	0% (0/53)	21% (32/149)

CONCLUSIONS

Tablet PCs can support novel instructor uses due to a combination of affordances not found in other presentation methods, specifically the ability to include prepared electronic materials and add spontaneous ink. In a review of two instructors' inked lectures from introductory physics classes, we note common uses of ink to link multiple representations, fill in a template or sparse slide, and animate prepared diagrams or pictures. Additionally, the Ubiquitous Presenter system's automated archiving of lecture materials provides an interesting new resource for students by making all instructor content available after class. In general, students report a positive perceived impact on their learning and understanding. Students' reported reasons for reviewing lecture material online are consistent with course structure. Though many students reviewed material online, surprisingly few students replayed the "process" of any given slide from lecture.

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