

USING DIGITAL INK AND PODCASTS TO TEACH MATHEMATICS

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Introduction

The idea of incorporating ink and hand-written drawings into a computer based application has become mainstream over the past seven years with the creation of the tablet PC [1]. The term “digital ink” refers to the ability of the user to make drawings and annotations on their computer using a pen device. Two examples of the use of digital ink are shown in Figures 1 and 2. The user draws on the screen with their pen, and the ink appears on the screen as natural looking handwriting and drawings. The digital ink is integrated into the program file and can be saved and viewed by others.

$$\begin{aligned}
 S(x) &= (4x-7)^5 & \text{Inner: } 4x-7 \\
 \text{Find } S'(x) & & \text{Outer: } (\text{inner})^5 \\
 I' &= 4 \\
 O' &= S(\text{inner})^4 \\
 S'(x) &= I' \cdot O' = 4(S(4x-7))^4 \\
 S'(x) &= 20(4x-7)^4
 \end{aligned}$$

Figure 1 Digital Ink Problem

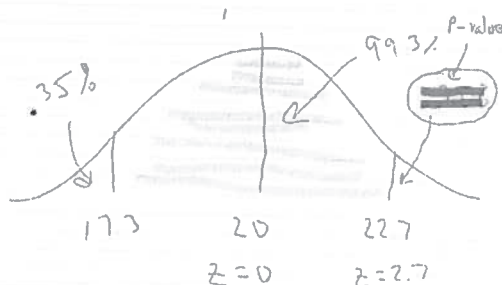


Figure 2 Digital Ink Diagram

The act of screencasting, which is sometimes referred to as podcasting, allows the user to capture the actions being performed on their screen while also recording an audio narration of the movements being conducted [2]. Screencasts are useful for showing demonstrations. These have become a very useful tool in mathematics education, as it allows one to demonstrate key concepts or steps involved in the completion of a problem. Special software is needed to capture the action on the screen, as well as a microphone if you choose to record audio as well. One company that produces this software is TechSmith [3]. They produce both a free version, Jing [4], and a licensed piece of software, Camtasia [5]. Both pieces of software allow the user to complete a screen capture, but the number of available features is what differentiates the price between the two pieces of software.

By pairing together digital ink along with screen capturing software, a mathematics instructor can create digital lessons or podcasts that can be viewed by students outside of class. Lessons are produced in different formats that allow students to watch them on the web, or download them and view them on a portable handheld device such as Apple's

iPod or iPhone. Students then have the option of viewing, reviewing, and pausing the lesson until they feel they have an adequate understanding of the content in the podcast.

Background

Our endeavor into using digital ink and podcasting began while working on a project called the WI PRAXIS Project, which we presented at the 20th Annual ICTCM Conference in San Antonio, TX [6]. At the beginning of the project we were given a tablet PC and the software package Camtasia. The project called for us to work with undergraduate students to make “chalk talks” of work associated with middle school mathematics problems, which would be used by pre-service teachers in an attempt to prepare them to pass the PRAXIS exam. Chalk talk was the name used by the project to mean the creation of a podcast or screencast. Our students worked at developing scripts which they would record in a chalk talk. The chalk talks would then be accessible to novice students with a weak mathematics background. The goal of the project was to provide users instruction that made use of not only voice explanation, but also detailed steps involved in solving the posed problem.

Before we began to work with our student teams, it was our job to become familiar with the hardware so we could train the students to use the equipment to create the chalk talks. As we became familiar with the hardware, it became apparent to us that it would be highly advantageous to incorporate the use of digital ink into our own teaching. We saw the value it would bring to our courses, both during the lesson as well as outside of the classroom.

Getting Started

As a result of our work with the WI PRAXIS Project, we began using this technology for the first time in a Calculus I course during the Fall 2007 semester. The initial use was strictly in-class. As we became more accustomed to using the technology, we continued to use it the following semester in both a PreCalculus course and a Math for Elementary Teachers course. We began to use it more extensively during classroom meetings, but it was also during that semester that we first started creating podcasts for these classes. That semester we created 38 podcasts for those two courses and made them accessible to our students. During the following school year, 2008-2009, we expanded our use of digital ink in our teaching by incorporating it into more of the courses we were teaching. The following courses were all taught that year using digital ink: Business Calculus, Elementary Statistics, College Algebra, Math for Elementary Teachers, and Applied Statistics. During that year we also expanded our production of podcasts as we created 34 in our Business Calculus course, 9 in our Elementary Statistics course, 37 in our College Algebra course, 31 in our Math for Elementary Teachers, and 15 for our Applied Statistics course. The next sections will describe how we made use of the digital ink within the classroom, as well as our uses of podcasts within these courses.

Classroom Use

By teaching our classes with digital ink, it has allowed us to save and archive the interactions that are normally lost at the blackboard with the swipe of an eraser. By integrating notes from power points, with the ability to write digitally, it has allowed us a better mechanism for archiving what it is that happens in our classrooms during each classroom session. At the same time we have the option of using programs such as Windows Journal [7] or Microsoft One Note [8], to write our notes from scratch. Both of these programs allow the user to write up problems, steps, and thinking as it happens in real time. The notes are written on what looks like a piece of notebook paper, so it simulates the idea of note taking for those students wanting to take good notes themselves during class. Both of these programs allow the user the ability to export the notes to a pdf format, which can be later shared with others.

At the end of each class we use our course managements system, Desire 2 Learn, to archive our everyday notes, so they are available to students that both attended and were not able to attend. It allows students the opportunity not to feel so rushed in the classroom session. They do not have to feel that everything must be written down from the class discussion. They are free to go back and look at what was written at their leisure. It also gives students a greater opportunity to examine and appreciate the mathematical form used by the instructor to express solutions to mathematical situations explored in class. It allows students an opportunity to self-reflect on present organizational skills that may be lacking due to poor note taking skills during class. Using digital ink allows the instructor the ability to seamlessly integrate their writing of comments into dynamic activities that may be presented in class. These are activities that might be accomplished through the use of java applets or specialized software.

One of the advantages of teaching from a tablet PC is the fact your back is never turned to the students. You are also never in the way of the students' view of what you are writing on the board. A downfall to using the tablet PC is that it requires the instructor to present the material from a locked position in the classroom, which for us is at the front of the room near our tech cabinet. In order to allow ourselves additional flexibility in our teaching, we have also integrated an AIRLINER wireless tablet, produced by SMART Technologies [9], into our classes. The wireless slate allows the instructor to move around the classroom, while still having the option of writing on the board in digital ink. It allows us to interact with the students at their desk, while still being able to write and project the material on the screen, while standing next to them. By using the wireless slate, it also affords the students an opportunity to more easily present materials in class rather than coming up to the blackboard to do so. This is especially important for those students that may have a limitation that would not allow them to participate otherwise.

Podcasting

As we have begun to integrate podcasting into our courses, we have found four different ways to use them. One purpose we have used them for is to discuss classroom

documents, such as syllabi and semester schedules. We have created them and sent them out to our students before the first day of class, thus minimizing the amount of time spent going over these documents on the first day. A second purpose is to provide additional content, when time becomes short in the regular classroom. Short lessons can be prepared and made available to students so they may gain a better understanding of the material that was presented in class. A third purpose has been to create answer keys for homework questions and quizzes. A fourth purpose of the podcasts has been to use them as a way to answer student questions outside of office hours. When students email questions, it is not always easy to give a full response to the question in a typed form. Instead, by returning them a podcast it will give them an understanding of your thinking behind the steps in the problem, as well as a viewing of form when writing up the solution.

Based on tracking results of usage, we found that different student populations differed in how much they made use of the podcasts. The College Algebra course and Business Calculus course are both examples of first year math courses which are taken by students with varying class standings. Within the Business Calculus course we found that on average each podcasts was viewed by approximately 50 percent of the class. This differed with the College Algebra course, where the average podcast was viewed by approximately 25 percent of the course. Students in the algebra course seemed to be a little more unfamiliar with the technology at the beginning of the semester, and did not seem to understand the value it could provide them until much later in the semester. Those students in the Business Calculus course seemed more tech savvy, and began using them right away at the beginning of the semester.

The Math for Elementary Teachers and Applied Statistics are similar courses in the sense they are sophomore/junior level courses, and there are no freshman enrolled in either of these courses. The students in the Math for Elementary Teachers course seemed to make the greatest use of the podcasts, as many of them were viewed by 85 percent or more of the class. Part of this could be attributed to the fact some extension lessons were completed outside of class as podcasts. It was highly recommended that they watch them so they gained the full understanding of the lessons from class. This was the only class where podcasts were used in this manner. There seemed to be less viewing of the podcasts in the Applied Statistics course, where on average approximately 40 percent of the students viewed each podcast.

The feeling in the Applied Statistics course was this was a group of students majoring in math and physics, and most have had great success with mathematics in the past. A percentage of the students did not see the podcasts as serious tool that was needed to become successful in the course. This is in contrast to the Math for Elementary students, where many of the students have struggled with mathematics in the past. These students saw the podcasts as an additional tool they could use to help with their understanding of mathematical topics they struggled with.

Conclusion

As we conclude our second full year of incorporating digital ink and podcasting into our teaching, we reflect on the effects it has had on us and our students. Based on end of the semester evaluations, our students have spoken quite highly of our use of digital ink and podcasting in their classes.

Students have commented that they appreciate having the classroom notes and interactions readily accessible to them on the web, so they may look back and review what occurred in a previous class session. They also liked the fact that the material is accessible to them if they were absent a day in class. It eliminates trying to decipher notes taken by someone else, and it gives them a basic sense of what was covered that day in class. We feel that even though the notes are accessible to them, it does not replace the experience students have by actually being in class. We have not heard from students that this new form of technology limits or inhibits them from coming to class on a regular basis. Even though students see what was written on the screen during the solving of a problem, they miss the vital aspect of communication that is conducted between professor and students, as well as between student and student.

As far as podcasting goes, we are relatively pleased with our initial endeavors. Many of the students expressed great value in the ability to have access to electronic access to us in a manner where they could pause, stop, rewind, and listen to what we are saying and writing multiple times until they understood the concept being taught. Many students expressed feelings that by having podcasts available to them throughout the semester, it opened up a new area of learning for them. It provided an additional avenue for gaining assistance when they had trouble with the material. Many stated that they hoped podcasting would be available to them in future courses.

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