# USING PODCASTS & DIGITAL INK TO ENHANCE MATHEMATICAL COMMUNICATION

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## Introduction

Communication is one of the ten standards stressed in the National Council of Teachers of Mathematics (NCTM) "Standards" [1] for K-12 mathematics instruction. It is also emphasized in documents published by both the American Mathematical Association of Two-Year Colleges (AMATYC) [2] and the Mathematical Association of America (MAA) [3] on undergraduate mathematics instruction. So often it is difficult to open the lines of communication between instructor and student, as well as between student and student. When asking the client disciplines what they hope their majors will learn when taking classes in the math department, they often cite the ability of their students to communicate about quantitative situations as one of their most highly prized objectives [3].

Twenty years ago, communication between instructor-student and student-student was relegated to interactions in the classroom, visits to office hours, and outside of class study groups. By 1995 most instructors and students began using email as a new form of communication to correspond outside of class. Today, communication has evolved from email correspondence to: discussion boards, blogs, wikis, social networking, and podcasting.

Of these five forms of communication, we believe podcasting can be most advantageous in terms of teaching and learning mathematics. Not only can ideas be expressed orally, but through using screen-capturing software, mathematical work can also be presented to the viewer of the podcast. Podcasting merges both facets of what some would describe as an effective classroom lecture. It allows the creator to exhibit correct mathematical work, while also presenting the reasoning and thought process presented in the work. The advantage podcasting has over a traditional classroom lecture is the fact that the viewer has control over how many times he or she chooses to listen and view different portions of the presentation as well as when and where they view them.

## Background

Over the past three years we have been producing more and more podcasts to be used in conjunction with the math classes we teach. Currently we have produced over 250

different podcasts that have been used in conjunction with ten different math courses we have taught. We believe through the use of podcasts and digital ink there is the potential for a new effective form of communication between all members of a classroom environment.

We use a tablet PC along with software programs such as MS OneNote and Windows Journal to produce digitally inked documents [4]. We then use specialized software produced by Techsmith such as Jing or Camtasia to make digital recordings which are used as communication tools both inside and outside of our classrooms [4]. We use Jing if the podcast we are producing is less than 5 minutes, typically for answering homework questions for students or showing students how to use an interactive tool on the web. We use Camtasia if the podcast is more than 5 minutes, typically when we present a short lesson on a mathematical topic.

Our journey 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 [5]. During a presentation at the 21st Annual ICTCM Conference in New Orleans, LA [4] we described how we integrated digital ink and podcasting into our classrooms. We also shared some initial data we collected on student use and comments pertaining to their use of the podcasts we produced.

The theme of this paper is to provide specific examples of the different ways we have integrated podcasts into our classes, specifically in a College Algebra course taught from a refocused approach [6]. One of the ideas behind a refocused course is to place an increased emphasis on solving problems set within real-life contexts. The course placed an increased emphasis on not only teaching manipulation skills, but also through assisting students with their formulation of conceptual understanding about the different skills they learned. Manipulation skills were typically taught within the context of working with different mathematical models which were based on some of the most common families of functions (linear, exponential, logarithmic, and polynomial). The role communication played in this course creates a natural link between the goals we set forth in the course, and the advantages podcasts can provide.

## Use of Podcasts

During a presentation at the 21st Annual ICTCM Conference in New Orleans, LA [4] we discussed four different purposes for integrating podcasts into our courses. For this particular course, we used podcasts to meet the fourth purpose we identified in that paper – providing students the thinking behind steps in a problem they have difficulty with. These podcasts were provided to five sections of students enrolled in the College Algebra course described earlier. Typically podcasts were produced ahead of time for homework problems that we thought students might have difficulty with when working on the assignment. Other podcasts were produced based on questions received from students either during class or outside of class.

Podcasts were made available to students through multiple methods. Once the podcasts are produced by the instructor, they are loaded to a server located at screencast.com. When loaded at the site, it gives the instructor flexibility to set up classroom folders, so students have a common site to go to each time to watch podcasts about the material. Individual files are either named by specific problems from the text, or by the mathematical concept covered in the podcast. The site also allows the student with the click of a button to setup an RSS feed, so when new content is uploaded to the site, the students are informed of it and it can be viewed. Students can also setup an instant download with their iTunes account.

Another feature of screencast.com is the fact it produces a specific url for each podcast stationed on the site. Thus another method we have used is to provide students with specific links to each individual podcast. The links can be provided through a course management system, via individual emails, or placed in assignment word documents so students know exactly which problem is linked to the podcast they will watch.

## Podcast Examples from College Algebra

The textbook used for this course was *Explorations in College Algebra* by Kime, Clark, and Michael [7]. The following three examples are problems that were emphasized within three different themes: function representation, linear models, and exponential models. Each problem is broken down into four screenshots to provide an example of how the podcast progressed as it was presented to the student. A complete transcript of the podcast will not be presented, but a verbal description of each screenshot will be.

The theme for the first problem (Figure 1) is to get students to be able to correctly interpret information about a function by looking at its graph. The problem asks the student to find appropriate outputs when inputs are given, appropriate inputs when outputs are provided, and discuss other features of the graph such as domain, range, and extreme values on the graph.

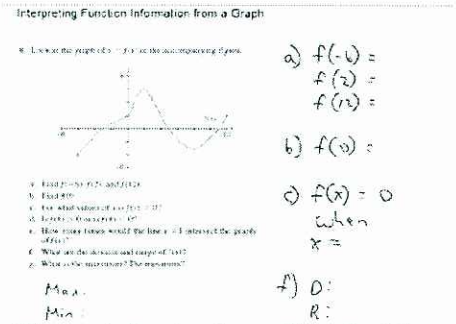

Figure 1 Beginning of the Problem

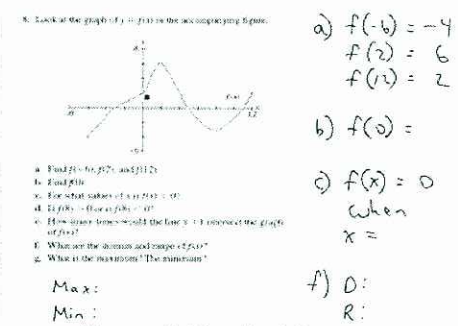

Figure 2 Vertical Intercept

The podcast begins like all of our podcasts do; asking the student to pause the problem until they have had a chance to do it on their own. Once the student has worked the problem, they should come back and listen to it to see if their answers and reasoning match. As the problem progresses (Figure 2), you will notice the student is able to visualize the vertical intercept as a black dot appears on the screen hovering around the point symbolizing the y-intercept. As the students move to examining the horizontal intercepts (Figure 3), black dots are placed on the axis to connect the points to the symbolic meaning in function notation: $f(x) = 0$. The problem concludes (Figure 4) with a discussion of domain and range, while once again connecting the visual of the graph (horizontally and vertically) to their appropriate symbolic representation.

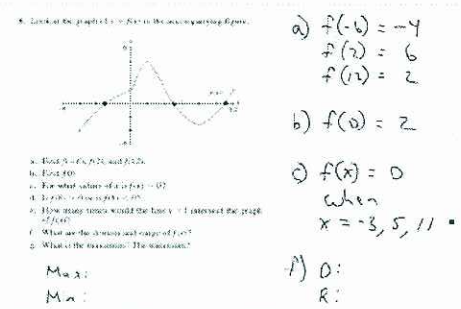

Figure 3 Horizontal Intercepts

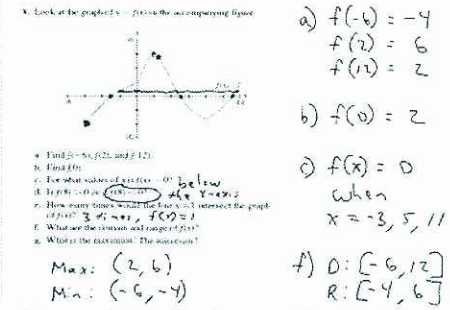

Figure 4 Wrapping up the Problem

In problem 2 (Figure 5), the student is asked to focus on finding an unknown coordinate in a point based on knowing the slope between that point and another given point. By using the podcast, we are able to communicate the idea of consistently relating appropriate components of points together. This is accomplished (Figure 6) by highlighting these common components using different colors. This same highlighting technique could be employed during a classroom session, but it will be lost once the problem is erased from the board. In this case, the student can rewind if needed to better understand why those coordinates are being paired together.

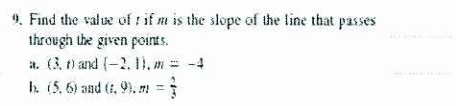

Figure 5 Beginning of the Problem

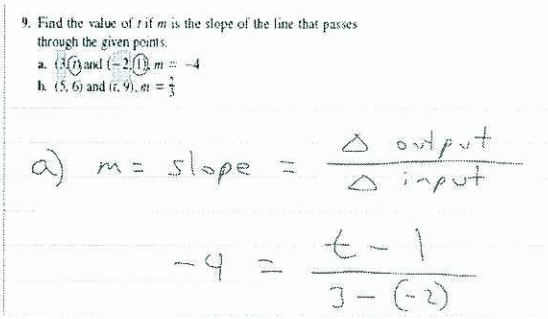

Figure 6 Highlighting Information

As the first part of the problem is being completed (Figure 7), different pen colors are used to highlight different symbolic steps being taken to solve for t. Even though the podcast verbalizes the reasoning behind the steps (Figure 8), explanation of movements are also written on the screen to reinforce what the student is hearing. It is our hope that as the students are following the work they completed themselves, they get in the habit of adding in comments like these (Figure 8) to explain what it is they are doing as they perform the next manipulation. At the same time, we hope that our students start to formulate a justification and reasoning in their minds similar to the think aloud process we are presenting them while they listen and watch the podcast.

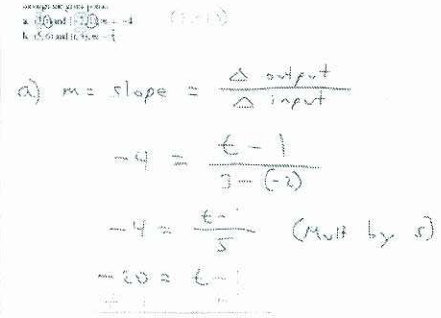


Figure 7 Showing Steps

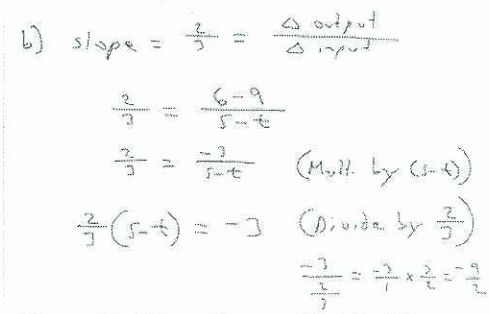


Figure 8 Wrapping up the Problem

In problem 3 (Figure 9), the student is to create quick sketches of graphs that relate to one of four different models (two linear and two exponential) presented to them. The focus in the podcast is to convince students how to create non-exact sketches that are true to the characteristics of the model. This is done by focusing in on the type of model it is, the shape of graph the model will produce, and looking at important points on the graph (such as vertical intercepts). Graphs are created (Figure 10) by inking rather than using a computer program or a calculator in order to convey this message to students. The strategy of creating a table of points is not encouraged in this problem, as it is the form of the model that we want our students to focus on in order to drive the picture they create.

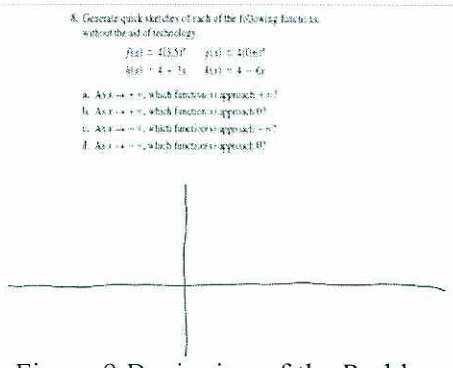

Figure 9 Beginning of the Problem

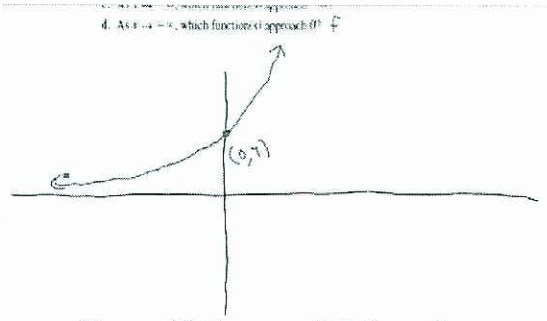


Figure 10 Exponential Growth

As the students discriminate between growth and decay, faint pen movements like that of the red dot on the far end of the decay graph (Figure 11) allow for a discussion about what is happening at the extreme ends of the graph while linking this representation back to the form of the algebraic representation. As the problem concludes, students see a difference in graphical types (Figure 12) linked back to the different types of models that are presented at the outset. In the case of all four of the graphs, students see how all of them had the point (0, 4) in common and link it back to common features within the two different function types.

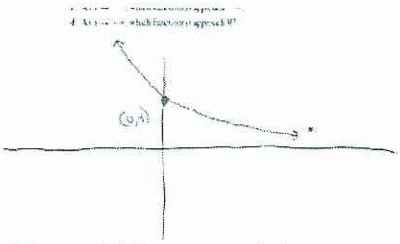

Figure 11 Exponential Decay

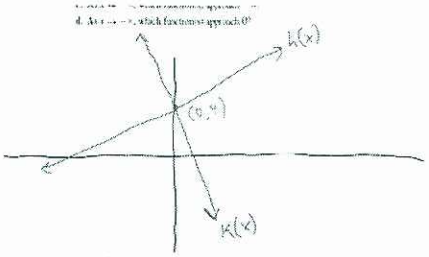


Figure 12 Linear Graphs

## Conclusion

As we conclude our third full year of incorporating 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. Of the podcasts we produced for these five sections of College Algebra, approximately 15 to 20 percent of the students watched a given podcast. Although we would like that number to be higher, we have found in the past [4] that fewer students in this course seem to take advantage of using these resources than say students taking a Business Calculus course or a Math for Elementary Teachers course.

Based on comments at the end of the year, those students that made use of the podcast saw value in them. Some asked why this is not common in all of the math classes they have taken. Our plan moving forward is to continue to integrate these into our classes, and continue to develop a large library of problems that students can access. As we look ahead to the future, we see the possibility of expanding our collection of mini-lessons.

Although it is a hope of many instructors that students come to class having read the book beforehand, that normally is not the case. Much of that has to do with the fact that books are static images that do not interact with students or carry on a conversation with them. Podcasts on the other hand do. Although it is somewhat of a one-sided conversation, from our feedback from students, they often try to decide what will be said next, which means they are engaging with the podcast and not simply looking at it as a one-sided conversation. We could see a point in time, where most of our in-class lecture time moves out of the traditional classroom meeting and instead is accomplished through

students coming to class having viewed the podcast. By doing this, it would provide us even more opportunity to focus on problem solving and in-person conversation between students, while the virtual conversation takes place outside of the classroom.

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