THE FLIPPED CLASSROOM: TOUCH ENABLED, ACADEMICALLY PROVEN

Technology In Practice Strand

Stacey Roshan
Bullis School
staceyroshan@gmail.com

1. ABSTRACT

In a classroom-based intervention utilizing the flipped classroom model, students showed increased performance and satisfaction. During a two-year experiment in the 11th and 12th grade AP Calculus course, the teacher recorded lectures to be watched at home via the Internet and used class time for problem solving, reversing the standard educational model. Compared with the previous year, average student AP score increased, as did the percentage of students who earned scores eligible for college credit. In a qualitative survey, students unanimously preferred the new format and reported lowered stress and anxiety levels related to homework and learning. Implications for instructional technology, classroom pedagogy, and future technological advances are discussed.

2. PROBLEM STATEMENT AND CONTEXT

Pen and touch technology appear to present exciting applications for educators. This paper explores the potential impact on student learning and satisfaction through the use of tablet PCs and screencasting. In particular, the paper examines the impact of one implementation of the flipped classroom model in AP Calculus AB.[1] High school mathematics classrooms often deserve the commonly held notion of a boring, rigid learning environment where the teacher lectures and the students repetitively practice problems from a textbook until the skill is mastered. The problem is that lecturing to a classroom full of students is not a meaningful discussion; it does not require students to participate in their learning process.

The motivating factor for change in this project was to reduce students' stress levels. Anxiety undermines a student's ability to reach his/her full potential and master challenging AP level mathematics. An unreasonable amount of anxiety and apprehension exists among high stakes courses, such as AP Calculus, particularly at high performing schools. The pressure to achieve at the highest levels to stay competitive in the college admissions process is ever growing. To allow enough time to work problems in the classroom, with the rigorous and fast-paced AP Calculus curriculum, the solution identified was to eliminate and replace the lecture. The flipped classroom provides a means of testing this solution: by pre-recording lessons and sending the teacher-driven lecture home, we hoped to see whether students would regain a voice in the classroom and whether the classroom environment could be transformed into a more calm, excited, inspiring atmosphere where learning can truly thrive.

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[1] The success of the flipped classroom model in the AP Calculus Classroom has garnered attention from a number of media sources including: USA Today, The Washington Post, and CNN.

2.1 What is the flipped classroom?

The flipped classroom changes the traditional classroom dynamic by shifting the method of instruction delivery. In an effort to best support students, class time is spent having students solve problems, where they are surrounded by the help of their peers and teacher, rather than doing this work alone at home without guidance. An effective use of the flipped model in the math classroom is to have students view an instructional video for homework and use class time to work through their questions and engage in authentic, lively discussions.

2.2 The Changing Role of the Teacher and Student

The student-centered classroom requires students to be resourceful and independent in the learning process. By providing customized learning time in the classroom, students take more ownership of their learning and are able to focus on their individual needs, which reduces stress levels. As students work collaboratively through problems in the classroom, stronger students naturally begin teaching their peers instead of the teacher being required to do the majority of instruction. Instead, the teacher's role shifts from driver to facilitator and learning coach. By observing and listening to students' conversations, the teacher is able to direct and guide discussions and immediately catch misconceptions.

2.3 Shift in Classroom Culture and Climate

The successful, prepared student of today is imaginative, creative, and curious. However, in the traditional lecture-based classroom that remains prevalent in the U.S., there is little room for these essentials. The flipped classroom challenges the current format of classrooms by shifting the culture to one of discussion and playing with ideas, providing an inspiring, innovative, and collaborative classroom climate where learning can truly thrive. By alleviating student stress, students have an increased ability to apply and abstract. Additionally, the flipped classroom is a participatory learning environment. When students come into class having previewed material, they are able to engage in an authentic discussion. Pen and touch technology enables the teacher to create video content as a means of moving one-way lecture outside of the classroom and replacing class time with an interactive discussion.

2.4 Technology as a Means of Bringing Compassion Back to the Classroom

There is a common misconception that technology is an ice-cold robotic and automated thing. Instead, technology should be viewed as a way to individualize and customize learning. Flipping the classroom can bring the compassion back into an otherwise overly stressed environment. By giving students the time to feel their questions can be heard and answered and providing class time for one-on-one work, the flipped classroom transforms the relationships that the teacher is able to build with students. As teachers make class time about listening to student discussions instead of feeling the need to do heavy instructing…. allowing the teacher to walk around, observe, support, and get to know students as individuals.

3. METHOD EMPLOYED

The experiment consisted of two groups of students: Control and Treatment. In the 2009-2010 school year, seventeen 11th and 12th grade students (7 female) participated in Calculus AB AP classes taught in the traditional style, with in-class lectures and out-of-class problem sets as homework (Control). In the 2010-2011 and 2011-2012 school years, thirty-one 11th and 12th grade students (13 female) participated in Calculus AB AP classes taught in a flipped classroom, with in-class problem sets and out-of-class video lectures as homework (Treatment).

3.1 Teacher Created Videos

Video lectures, created by the teacher, are used to deliver content for students to watch at home.[2] The Power Point lessons that would traditionally serve as the basis for instruction in the classroom are the basis for the video lessons. The screencast is created using a Fujitsu tablet PC to ink and Camtasia Studio to record.

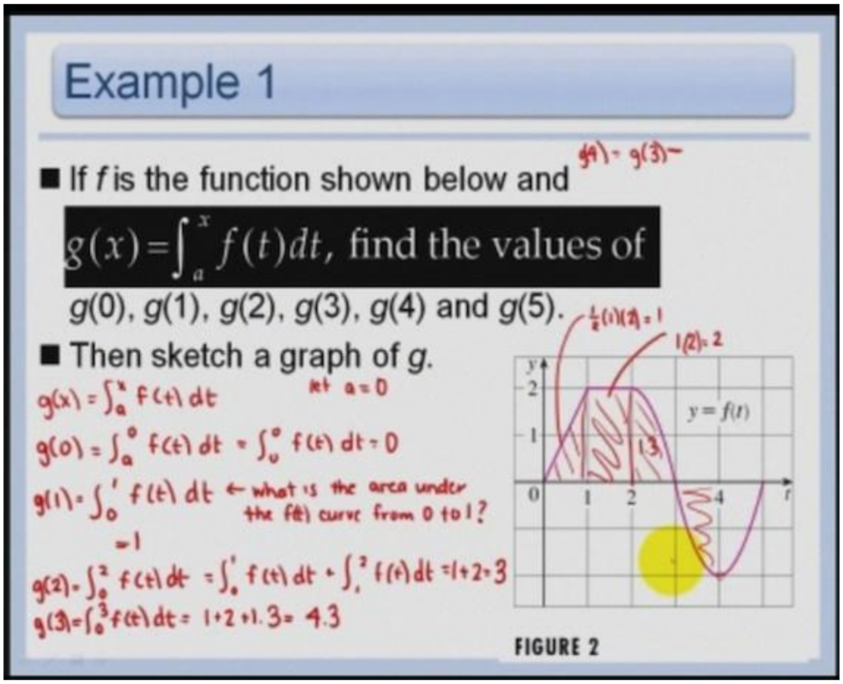

Figure 1: Teacher Created Content Using Tablet PC with Camtasia Studio

Seeing a teacher work through a problem, step-by-step, is a critical piece in making the video lecture easily digestible. Pen technology enables the lecture to flow, as a tool by which teachers can fluidly present their thought process (overlaid with voiceover). Simply speaking over a presentation of static slides would not create a similar interactive, comprehensible experience for students. Students taking notes along with the teacher's inking in the video is a very important component to making the experience less passive.

After recording the lesson, the editing process allows the teacher to not only clean up and consolidate work, but also to add in engaging elements. Current tools available in Camtasia Studio include embedded quizzes and callout boxes.

The quizzing provides a way for students to engage in an interactive activity yielding immediate feedback, for both teacher and student. A variety of question formats can be asked: multiple choice, fill-in-the-blank, and short answer. The benefit of the first two options is automated, instant grading for student feedback while the advantage of the latter option is the ability to assess beyond recognition. In addition to being a tool to help students self-assess, the

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[2] Teacher-created content example: http://www.screencast.com/t/vKNtUTgRH

quiz results provide teachers with a quick snap-shot of areas that need more attention in the classroom. Possible uses for these results include: setting the tone for full-class discussion, grouping students based on need, and as a way of pre-identifying necessary one-on-one work. Finally, teachers can use the feedback to assist in improving video lessons by recognizing which concepts are not being grasped. To track student data, videos with embedded quizzes ask students to enter a name and email address. Videos are viewable on both computers and tablets.

Callout boxes are another way of increasing engagement by zoning students attention and providing a visual clue to important talking points. Much like margin notes or highlighted definitions are used in a textbook, callout boxes can be used to call attention to key concepts.

3.2 Student Created Content

Moving lecture outside of the classroom creates valuable time in the classroom. One effective use of class time is giving students the opportunity to teacher their peers. For example, students can be made responsible for creating video responses for test preparation. Instead of the teacher standing at the board, students work individually or in pairs to create video solutions to questions. The videos are then uploaded to the Internet, where they can be tagged and archived to create a library of student-created content for future reference.

Beginning in the 2011-2012 school year, students were asked to create video content. To ensure quality, students were asked to prepare a "script", reviewed by the teacher, before recording was allowed. This was often a collaborative process, involving the teacher and other students. Students were then given an iPad to record, using the ScreenChomp app and a BoxWave sylus. The value in this exercise was found to be multifold: providing large-scale peer-to-peer teaching opportunities, creating a lasting resource of content created by learners, and offering a value opportunity for the teacher to assess thought process and target the source of a misunderstanding. Most powerfully, this activity enhances higher-order thinking and a deep understanding; effectively explaining a topic requires a thoughtful, step-by-step process rather than a more procedural solution.

One of the main problems faced by students when using the iPads to create video solutions was the ability to write legibly on the iPad. The problem became more pronounced over the course of the year as Calculus equations became more complex. One solution was to have students solve the problem on a piece of paper, neatly written, below a copy of the problem itself and then to take a picture of the work using the iPad. The picture was then placed into the ScreenChomp app as a background. In recording, students provided a voiceover to explain the steps in the written work, while using the stylus to circle, shade, and draw quick sketches or equations.[3]

[3] Student-created content exemplar: http://youtu.be/Y48s16qRCP0

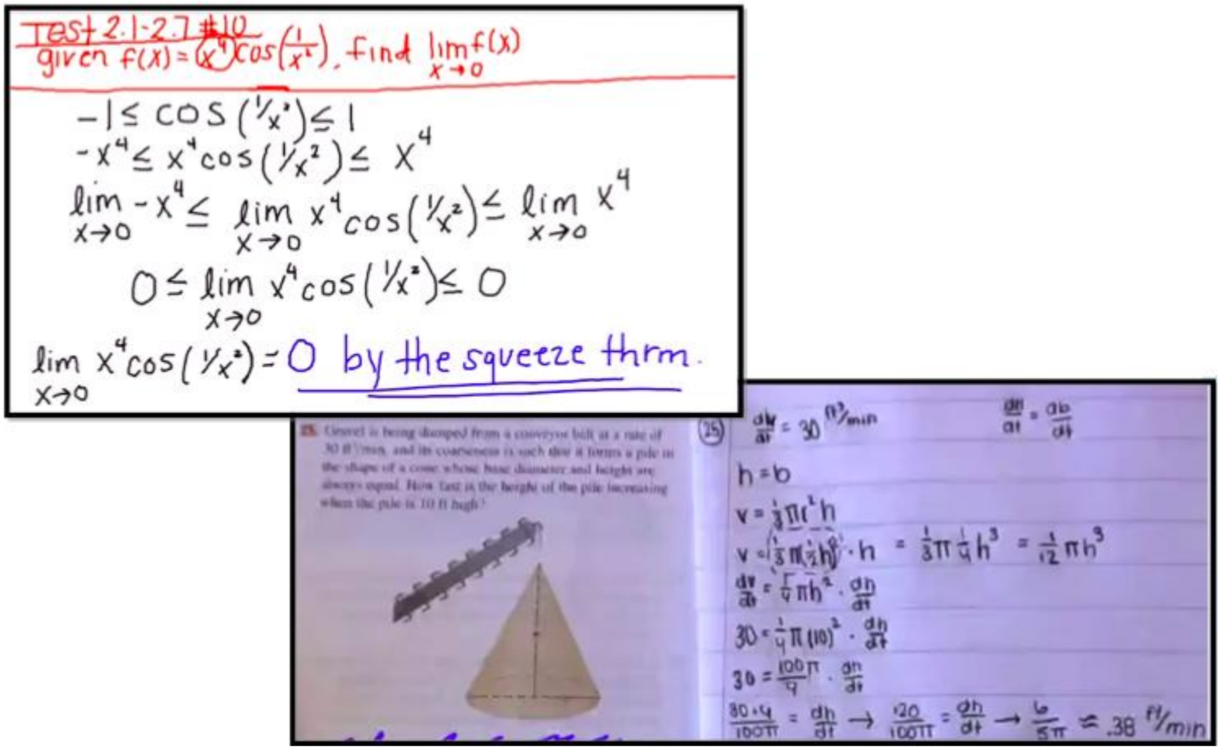

Figure 2: Two Student-Created Content Using the iPads

4. RESULTS AND EVALUATION

Before exploring the results of the flipped classroom experiment, it is important to recognize the limitations of the study. First, classes are not only non-randomized but carefully selected: only students with strong prior performance in mathematics can enroll in the Calculus AB class. While there was no explicit change in the selection criteria used between the class years, the potential nonetheless exists that implicit differences exist. Second, because the Control and Treatment groups come from different class years, there are potential cohort effects. Some attempt is made to address this point in my analysis, but it remains an important drawback of the study. Limitations aside, there are two key components to understanding the impact of a flipped classroom on students: quantitative academic performance and qualitative reviews of the learning experience.

To address quantitative performance, the study benefits from the standardized, third-party review process of the Advanced Placement tests operated by the College Board. At the conclusion of all classes, all students were administered the Advanced Placement Calculus AB test. Scored between 1 (no recommendation) and 5 (extremely well-qualified), the exam is independently evaluated by the College Board.[4]

As predicted, participants in the Treatment condition had higher AP scores (M = 3.588, SD = 1.176) than did participants in the Traditional condition (M = 4.065, SD = 0.892), $t(46) = -1.58$, $p = .121$, indicating a rise in quantitative academic performance in the flipped

[4] Unfortunately, the exact scoring method used by the College Board changed somewhat between the Control and Treatment administrations, removing penalties for wrong answers and creating stricter guidelines for higher scores. However, the national distribution of scores was nearly identical for both tests, suggesting that the score comparison remains robust.

classroom. While this increase did not reach conventional levels of significance, the restricted range of the AP exam and large ordinal differences would necessitate a sample size beyond that available in this limited case study for anything but the most large effect size.

As noted earlier, the subjective experience of the students is also an important part of the flipped classroom model. To test for differences in student experience, 16 students (7 female) in the 2011-2012 class completed anonymous questionnaires indicating their agreement on a 1-5 scale for a series of statements.

One important pattern that emerges from the responses is an emphasis on individual pacing and instruction. Students strongly endorsed statements like "I felt that instruction was more individualized because the lectures were watched at home." (M = 4.13) and when asked their favorite part of the class, 12 out of the 16 students identified the ability to rewind and review video lectures at their own pace and, importantly, on their own schedule.

A reasonable hypothesis might be that academic performance increased because students spent more time at home watching lectures in a flipped class than a traditional one. Students, however, showed strong endorsement for opposing statements ("I felt that the format of class helped reduce my homework load.", M = 4.19; "The format of class helped reduce my anxiety about homework.", M = 4.13), which suggests that lowered stress, not increasing workload, is a more salient instructional characteristic of flipped classrooms.

Finally, students overwhelmingly preferred the flipped class structure ("I would prefer to go back to the "normal" format that other classes use.", M = 1.63; "Overall, I preferred the format of this class.", M = 4.75) but were also conscious that it may only be appropriate in certain environments; when asked what type of class the format would work for, the majority of the students (9) responded "Only AP and Honors Classes".

5. DISCUSSION

In the flipped classroom model, the problem solving activity is brought inside the classroom, inciting authentic thinking questions and allowing teachers to monitor understanding, performance, and to immediately pick up on misconceptions. Time spent actively interacting and engaging with students provides evidence of student comprehension before assessments – one of the key reasons underlying increased student achievement. Other factors include in-class time for one-on-one instruction to target individual gaps and collaborative problem solving. Finally, access to online lectures for students to re-watch (in part or in full) after in-class discussion and problem solving allows students to tailor homework to their needs.

Pen and touch technology provides fluidity and natural flow to videos, significantly increasing students' ability to independently follow the thought-process being conveyed. Asking students to take notes in the viewing process increases engagement and provides students with a reference to bring to the classroom. This framework has been an essential component to successful implementation of the flipped model.

In conclusion, changing the type of work performed at home has been a means of reducing student stress and re-energizing the classroom experience. Alleviating student anxiety has been an important component in stimulating higher-order, critical thinking in class. The results have yielded increased student satisfaction and higher AP scores. In flipping the dynamic, the teacher's role in the classroom transitions to guide and learning coach, emboldening students with a stronger voice. By shifting the classroom culture to a collaborative, student-centric space and providing students with a resource bank of teacher and student-created instructional content, students become empowered learners.