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Successfully Flipping a Mathematics Classroom

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Synopsis

This paper addresses the successful results of a flipped classroom for general education college students most resistant to mathematics. It reviews student performance and satisfaction and explains various pedagogical strategies such as small group work and monitoring student engagement. Challenges of a flipped classroom are examined including formatting the on-line presentations, insuring that students view them, and the limits of classroom interaction.

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Science, technology, engineering, and math (STEM) courses are arguably the most easily adaptable and scalable to a flipped classroom. As a professor at a small, liberal arts college that prides itself on personal connection between faculty and students, I, with some trepidation, decided to pilot my first flipped classrooms last fall. I chose our "Mathematics for the Liberal Arts" course, and as the name might suggest, this course typically fills with students with the greatest math phobia and therefore resistance to learning. My hope, on flipping this particular course, was that it would be great to have a room full of students actually prepared and engaged with the topic of the day for a change. I was, however, uncertain how my students would take to this style of teaching.

Clyde Herreid and Nancy Schiller note in *The Journal of College Science Teaching* that flipping the classroom offers students more active learning and teachers better insight into a student's style of learning [4]. I hoped my pedagogy would maximize the efficacy of the course and minimize the students' 'fear and trembling.' My plan was for the students to view and listen to my lectures for their

homework and then come to class to work on the problems themselves; therefore, I could intervene with individual students struggling with problem solving.

At the first class meeting, I announced to the class that I was going to try a new teaching technique called a flipped classroom. The students were full of questions and uncertainty. None of the students had experienced a flipped classroom. I assured them that if the class seemed to be heading in the wrong direction, then I would resume the old lecture style that they were all accustomed to seeing. They were quite willing to go along with me. The students dutifully viewed and listened to my first lecture. At the start of the next class, I assigned a set of problems for them to complete during class time. Immediately, I began to see benefits of this "flipped" technique. All the students were doing the work that I assigned them. If any of them had a question, I was right there to help and explain the problem at hand. One student commented that if she was at home and got stuck, as she just had seen, she would have given up and failed to complete the homework. Many other students in the class nodded in agreement.

As class ended and students handed in their homework, I knew that for the first time in over 30 years of teaching, *every* student had done *all* of the work that I had assigned. Now, this was the same amount of homework that I assigned before

flipping the classroom. Daphne Koller writes in *The New York Times* that "presenting content in short, bite-size chunks, rather than monolithic hour-long lectures, is better suited to students' attention spans" and "engagement through exercises and assessments is a critical component of learning" [4]. In a flipped classroom, class time in its entirety can be used for the students to work on assigned math problems, all of which should be completed in-class. If a particular assignment needed more time than the allotted 50 or 75 minutes, then I had the students complete the work in the next class period. And indeed, as Koller predicts, active learning held their attention and promoted increased engagement.

Additionally, on the students' homework that I collected, I required them to write out a complete solution, justifying their answers by either showing all the calculations or writing an explanation for their conclusion. My hope was that the students would spend more time thinking about the problem and its solution. Also, when it came time to study for the test or final exam, they would have their own record of how they solved the problem, instead of just a number that answered the problem. In the traditional classroom, I do not collect homework, but spend class time covering solutions to specific problems that students note as problematic. As an added incentive to do the homework well, in the flipped classroom a 10% homework grade was included in the overall course grade.

Throughout the rest of the 2013 fall semester, I kept this basic technique of the out of class homework being a PowerPoint presentation with an accompanying sound file (mp3 format). Each of the presentations was between 15 and 20 minutes long. This allowed the student the options of watching the PowerPoint, listening to the sound file, or synchronizing the pair. The February 2012 issue of *EDUCAUSE*'s "7 Things You Should Know About" focused on flipped classrooms. Some of the mentioned downsides were time and effort in preparing and posting lectures, student's inability to experience lectures in person, decreasing class attendance, and a possible lack of software and hardware necessary for students to view the lectures [2]. Despite these negatives, the improved performances of my students as well as their positive evaluations suggest that this is nevertheless a compelling approach to teaching mathematics.

At the end of each semester, I have my students do a student evaluation of my course. For every student that gave a negative review of the flipped classroom, like "I need stuff taught to me by a teacher," there were two others that affirmed its benefits. Some of their insightful comments were as follows: "liked doing homework in class to ask questions;" "learning at home and doing homework in class is good for helping more people understand material more quickly;" and "homework in class is helpful, online lectures are great." There was never an issue of access to my lectures, perhaps because I offered PowerPoint presentations with

accompanying mp3 format sound files. With wireless classrooms, some of my students even accessed the lectures while doing the in class assignments.

Cynthia Brame, a professor at the Center for Teaching at Vanderbilt University, argues that "the higher cognitive functions associated with class activities, accompanied by the ongoing peer/instructor interaction that typically accompanies them, can readily lead to the metacognition associated with deep learning" [1]. My students were also encouraged to work in groups for peer interaction within class activities. The self-selected group sizes ranged from 2 to 6. I often found weaker and stronger students together, with the stronger student "teaching" the weaker students. As I monitored the students' progress, I checked to make sure that they were not making mistakes and encouraged the students to avail themselves of the opportunity ask me questions about the assigned problems. Instead of showing them how I would solve the problem, I asked them leading questions. Everyone, myself and the students, were more engaged in the learning process than before.

In one of Brame's key elements of a flipped classroom, she encourages the professor to "provide an incentive for students to prepare for class" [1]. This past year in the flipped classroom, I did not provide such an incentive. Presbyterian College uses Moodle as its course management system. I was able to keep track if a student at least accessed the PowerPoints and sound files. For example, during

the time frame, in my Fall classes, when the material of the second test was covered, only 68.8% of the time the students previewed the material for class. The students were clearly unable to "wing" the in-class work, thus slowing their progress, and there was a 10% drop in the grades verses the first and third tests. To increase the viewing (and listening) percentages, in the future I plan on assigning an online quiz that engages the student with each of the presentations. With this refinement in pedagogy, my hope is to improve each test average.

All in all, I had three classes of near equal sizes, with a total of 73 students that completed the flipped course. Prior to flipping the classroom, I had taught three classes of near equal sizes, with a total of 65 students that completed the course during the academic year of 2012-2013. All classes were given three tests and a cumulative final exam. I decided to compare the influence of flipping the classroom on each of the three test average, the final examination average, and the overall course grade average for the three classes.

Prior to flipping the classroom, the test score average was 81.24%, the final examination average was 71.17%, and the overall course grade average was 78.72%. The flipped classroom produced an average test score of 83.90%, a final examination average of 82.88%, and an overall course grade average of 83.47%. It should be noted that overall grade percentages were arrived at after negating the effect of the homework grade; however, when included, overall averages in the

flipped classroom were even higher. Using the null hypothesis, that there is no difference in the populations, and a 98% confidence interval, I could not reject the null hypothesis for test score averages, but could reject the null hypothesis for the final examination averages and overall course grade averages. This result suggests that the new methodology did not necessarily affect the students' performance on individual tests, but had a significant impact on their long term understanding and retention of the material in the course. As a result of the flipped classroom, the course grade average was boosted dramatically from a 'C' to a 'B.'

References:

[1] Brame, Cynthia J. "Flipping the Classroom." Retrieved from http://cft.vanderbilt.edu/guides-sub-pages/flipping-the-classroom/.

[2] *EDUCAUSE*. "7 Things You Should Know About…™", (February 2012).

[3] Herreid, Clyde Freeman and Schiller, Nancy A. “Case Studies and the Flipped Classroom.” *Journal of College Science Teaching*. Vol. 42, No. 5. 62 – 66 (2013).

[4] Koller, Daphne. “Death Knell for the Lecture: Technology as a Passport to Personalized Education.” *The New York Times*, (December 5, 2011).