Flip Your Classroom to Increase Active Learning and Student Engagement

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Background

Like all technologies, new teaching technologies have changed dramatically over the last 10 years. A set of these technologies allows for lecture capture, the ability to digitally capture what is happening in the classroom. Initially lecture capture was used to help students review difficult course material, compensate for missing class, and in online courses (EDUCAUSE Learning Initiative, 2008). This technology also allowed for another application: the flipped classroom. "Flipping" a class uses lecture capture to record the voice and screen activity of a professor delivering the lecture. The students watch these recordings before coming to class, freeing up time in class for troubleshooting difficult concepts, answering student questions, engaging students in active learning, and creating connections to every-day life.

Bergmann, Overmeyer and Willie (2011) list several advantages for the "Flipped" classroom. Three of the most applicable for college classrooms are:

1. **Development of life-long learners:** Students learn content before coming to class with the aide of technology. This type of knowledge acquisition, and the computer skills associated with it, is a skill that life-long learners in our computer-driven society use, but are not born with. Using this strategy helps develop this skill.
2. **Increased engagement in the material:** During class, students complete active learning exercises that illustrate the applications, implications and/or controversies associated with the material. This illustrates the importance of the material into their everyday lives and helps students relate to the topic.
3. **Increased interactions between students and faculty:** Entire class periods are dedicated to conversations between the students as they complete the in-class activities. Using this strategy shifts the focus from the front of the room. It moves the faculty member from the stage to interacting one-on-one with the students.

Many educators "invented" this application of lecture capture, so it is difficult to give credit to the first. However, flipping the class started most broadly in secondary education, specifically in the classrooms of two high school chemistry teachers, Jonathan Bergmann and Aaron Sams (Bergmann and Sams, 2012). As a relatively new teaching strategy, it is not well researched, especially in college classrooms. Will this technique transfer well into the college environment? And how big can we go – will it work in a large lecture course?

This Study

This study was conducted in two courses at the University of Missouri – Columbia. In Spring, 2010, a Genetic Diseases course was flipped. Genetic Diseases is a 3-credit hour elective biology lecture course offered to non-science majors. It averages 30 students. Students in Genetic Diseases take the course because they are interested in the topic; many of them have or know a family member who has a genetic disorder. Motivation is not a problem in this class.

This study also included a General Biology class that was flipped in Spring, 2012. The General Biology course is an introductory biology course for non-science majors. It is a 3-credit lecture course and

averages 400 students per section per semester. Students enter this class with various degrees of enthusiasm. Many of them have had poor prior experiences and are convinced they "can't do" science. Many others are just looking to fulfill their degree requirements. Class was scheduled for 8 AM. Attendance at 8 AM is consistently 15-20% lower compared to other times and exam scores are also lower (data not shown). The early start may have been a factor in this study.

In both courses, lecture material was recorded into one or more short (7-15 minute) recordings. Students watched these recordings before coming to class. Students were also provided with assigned readings, animations (for example, see http://www.biology.missouri.edu/courses/bio1010/life_organized.swf), and simulations (for example, see http://atl.biology.missouri.edu/projects/stone/btb.html). These activities were designed to cover the scientific concepts and introduce real-world applications of the content. Students demonstrated their completion of these activities via an online quiz or by bringing a news story, a reflection or some other product to class.

Once in class, students used the content they had learned to complete various in-class activities. Activities ranged from jigsaw exercises, concept maps, role-playing exercises, past exam questions, problem solving, case studies, problem-based learning, games and debates. Students generally worked in groups, usually of 2 or 3 students, and each student wrote their answers individually. There was also time to answer student questions and troubleshoot difficult concepts.

This study had three research questions regarding this teaching strategy:

1. Will "flipping" a class impact student learning?
2. Will "flipping" a class impact attendance in class?
3. What are student attitudes toward this teaching strategy?

Student Learning

To measure impact on student learning, exam and assignment scores in the "flipped" classes were compared to scores earned by students in previous non-flipped (control) semesters. The same professor taught all semesters involved in the study and the content and learning objectives were similar. For the General Biology class, the control semester was also taught at 8 AM.

In the smaller Genetic Diseases class, the flipping strategy was used during Units 1 and 2; Unit 3 did not lend itself well to being flipped, but serves well as an internal control. The scores for Exam 1 and Exam 2 increased from 78.5% and 77.5% in the control semester to 86.2% and 90.0% in the flipped semester, respectively. There was no significant difference for Exam 3 (Figure 1).

In the larger General Biology class, the flipping strategy was used for one lecture each week throughout the semester. For Exam 1, the flipped course averaged 72.6% and the control course averaged 74.4% (Figure 1). These differences were not statistically different. For Exam 2, the flipped course averaged 74%, a statistical improvement over the 70.4% recorded in the control semester. Assignments also saw a marked improvement, with the flipped course averaging 82.14% compared to the control course average of 71.2%.

Were exams easier in the flipped semesters? To answer this question, I assessed exams from all semesters. Each question was categorized and scored using Blooms Taxonomy, with basic "knowledge" questions worth fewer points compared to higher-level thinking questions. Using this strategy, the exam questions had an average "toughness" of 2.0, compared to 3.1 in the flipped class. In General biology, the control semester had an average score of 2.34, compared to 3.15 in the flipped semester. Given this, the improved scores seen in Figure 1 and 2 most likely represent a positive impact on learning, as measured by exam performance.

Attendance

One concern voiced about lecture capture is that if all the content is online, students will no longer attend class. In the control semesters the average attendance was 93.3% and 74.6% for Genetic Diseases and General Biology, respectively, compared to the flipped semesters' average attendance of 95.3% and 80%. Flipping the class did not have a negative impact on attendance. If anything, it improved it.

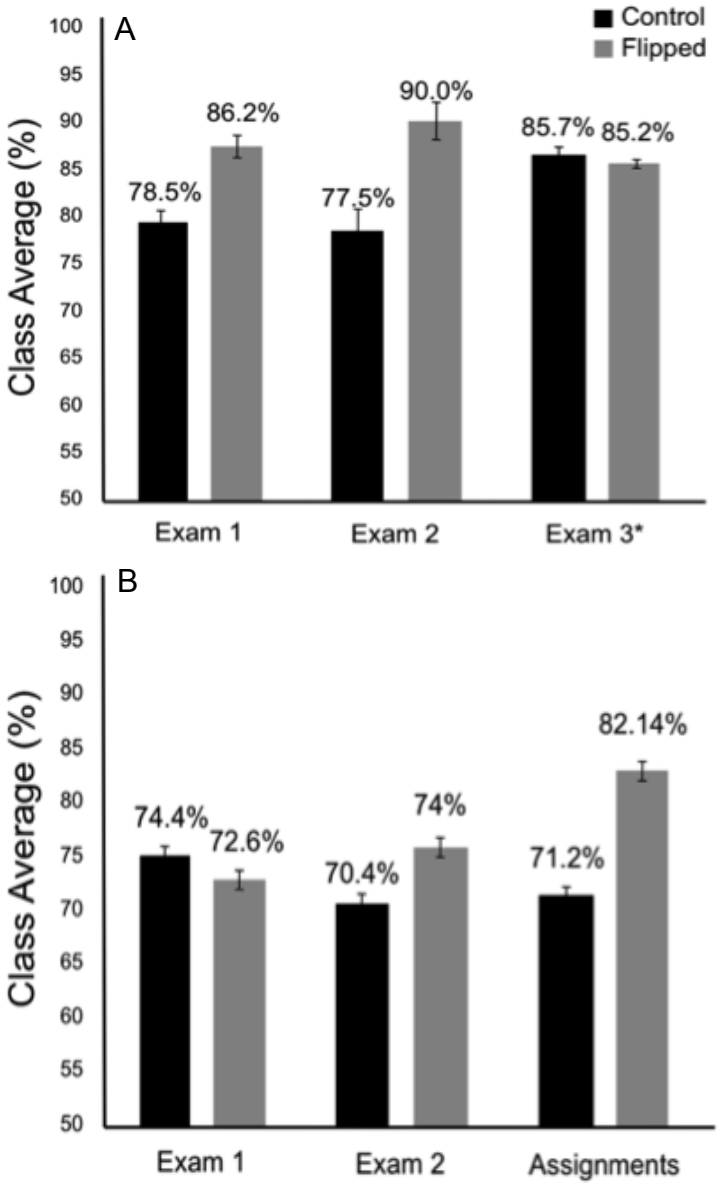

Figure 1 – *Exam and Assignment averages in the flipped and control Genetic Diseases (A) and General Biology (B) courses.* *Exam Unit 3 in Genetic Diseases was not flipped.

Student Attitudes

This strategy does not necessarily require more study time, but instead maximizes their time-on-task by guiding students in activities they can do outside of class. But will students see it that way? One concern is that they may view this strategy as "busy work" or that they were "having to learn" twice the material. Student attitudes were assessed via a multiple choice and free-response questions survey using the University of Missouri's online questionnaire system, MoCAT.

Students in the Genetic Diseases course were asked to complete the statement: "Compared to traditional teaching methods, I think the 'hybrid' format (lectures online and activities during class)..." Nine percent completed the statement with "has neither helped nor hurt my learning." The remaining 91% responded that this strategy "has improved my learning". Other free-responses Genetic Diseases students provided include:

- "I love the fact that it creates a teaching environment that is suited for multiple learning habits."
- "I loved that we could come to class with questions and really get to understand the information thoroughly on our own and with the professor's help."
- "I like it because it gets me ready for class and what we are going to be discussing."
- "I felt the material stuck in my brain the more time I had to go over it and think of it practically."
- "It's different and I like how it shows me the educational system is evolving."
- "I like that we don't have to sit through lectures like all my other classes. We can discuss the information with the professor and/or other classmates."
- "It allows us to apply the concepts we learned outside of class to material in the classroom."

Students in General Biology were given a similar survey. Students were asked how much they agree with various statements regarding the flipped class teaching strategy. The results of that survey are summarized in Table 1. The majority of students either agreed or strongly agreed with statements that indicate a positive outcome to the flipped teaching strategy. Those that "strongly disagreed" with the statements were in the minority. All of the individuals who selected "strongly disagree" for one or more of the statements indicated in the survey they had never done the assigned class preparation before class. They were generally resistant either to the work or the structure of a flipped class.

In addition to the surveys, the withdrawal rates were compared between the "flipped" and control semesters. In Genetic Diseases, none of the students withdrew from the course in either semester. In General Biology, however, 8.1% of the students withdrew in the control semester compared to 3.6% in the "flipped" semester. This decrease in withdrawals is another possible indication of the positive influence of the flipped teaching strategy, although more replicates are needed to truly determine if flipping a course reduces withdrawal rates.

Table 1 – Student attitudes towards statements on the flipped class teaching strategy

Statement	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
"The flipped class style helps me to study more throughout the unit."	24.3%	43.2%	16.2%	10.8%	5.4%*
"The flipped approach to this class has helped me learn more than I would have if we had done straight lecture."	36.8%	28.9	13.2%	15.8%	5.3%*
"The In-Class Practice assignments have helped me identify concepts I need to study more."	42.1%	31.6%	13.2%	10.5%	2.6%*
"It is helpful to do an activity when other students and the professor are available to answer questions."	45.9%	37.8%	10.8%	5.4%	0%
"The In-Class Practice assignments have helped me do better on exams."	42.1%	18.4%	18.4%	13.2%	7.9%*
*All of the students selecting "Strongly Disagree" indicated on the survey they had never completed the assigned work before attending class.					

Conclusions

Evidence from this study suggests that in the small college classroom, such as Genetic Diseases, flipping the class can result in large learning gains and positive student attitudes towards the learning process. These gains were likely enhanced by the students' attitudes coming into the course.

In the large lecture/general education course, the results were not as dramatic, however some improvement was measured. Students performed over 10% better on assignments and as well or slightly better on harder, higher-level thinking exams. Many students agreed with statements that indicated the positive influence flipping the classroom had on their learning or performance in the class.

Partially based on the results of this study, faculty in the Division of Biological Sciences at the University of Missouri – Columbia are redesigning multiple sections of the General Biology course. They were selected to be part of the statewide Missouri Course Redesign Initiative. The proposal submitted by the Division of Biological Sciences uses the "flipped" classroom design to create online learning modules for

the students to complete before class. Future semesters of this course – offered at various time slots – will provide more information on the effectiveness of flipping a large-lecture course.

Flipping the classroom does not come without its challenges. Flipping a class requires more work and careful planning (EDUCAUSE, 2012). It not only requires that the professor prepares for lecture, but that he or she also structures some of the students' out-of-class study time as well. Another challenge is the resistance from some students. Even with evidence of its effectiveness, students will resist what they perceive as extra work. The best strategy I have found to address this problem is to be open with the students. Inform the class the first day of the semester about the flipped structure to the course. Show the students the outcome of their efforts compared to a previous non-flipped class. Exude excitement in the potential of this teaching strategy.

In conclusion, the most exciting aspect of the flipped class cannot be measured. What makes it worth the extra time and effort is the energy it brings to the classroom. Flipping the class gives instructors the opportunity to walk around and listen to student opinions and concerns. In the flipped classroom, the professor no longer stands at the front of the room – he or she is out in the seats, interacting with the students.

References

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About the Presenter

Bethany Stone is an Associate Teaching Professor at the University of Missouri – Columbia. She teaches face-to-face, online, and now flipped courses for the Division of Biological Sciences, including General Biology, Botany, Genetic Diseases and Infectious Diseases. Her research interests are in undergraduate student learning and misconceptions. She has presented her work at national and international conferences and was the 2012 recipient of the Ernest L. Boyer International Award for Excellence in Teaching, Learning and Technology based on her work on the flipped classroom.

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