

The Efficacy of Flipped Pedagogy in STEM Learning at a Minority Institution

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ABSTRACT

Flipped classroom is a learning intervention that reverses the traditional learning environment and is gaining momentum in secondary and higher education institutions. It may consist of videos of lectures watching at home, and completing homework-based practice problems during class. Majority of studies focuses on student's perceptions and single group study designs. The results from the student's perception are mixed, but overall positive. There are few studies done at Historically Black Colleges or Universities (HBCUs). This study examined the efficacy and impact of flipped classrooms at Fayetteville State University (FSU). Two flipped classrooms were given pre and post surveys that tested the student's perception. We collected midterm and final grades to compare the academic performance of students in the flipped learning (experiment) and traditional (control) classroom. A quantitative method was utilized to examine mean differences in the flipped vs. traditional teaching approaches. For an in-depth analysis, we examined gender and ethnicity mean differences. Students rated flipped learning positively, but still preferred the traditional format. Students in the flipped learning course performed better academically than students in the traditional course.

Introduction

The quality of STEM education is important for strengthening the capacity of the U.S. workforce, increasing the economic growth, and keeping the U.S. competitive in the world (Casey, 2012). Because of this, the U.S. must keep the STEM education as high quality as possible (NSF, 2011-2016). This has been done by doing intensive research to test for the best pedagogical strategies. Within these studies, research has shown that students learn better when working together with peers, interacting with the faculty, and actively engaging with the material, is incorporated into the classroom (McDermott and Redish, 1999). Instructional strategies such as collaborative learning (Johnson, Johnson, and Smith, 1991), problem solving (Savery and Duffy, 1996) and team-based learning (Michaelsen, Sweet, and Parmelee, 2008), can improve knowledge acquisition, communication skills and self-directed learning (Krathwohl, 2002; Vygotsky, 1978; Redish, 2003).

For this type of instructional method to work, student interaction has to be successful, but the traditional classroom does not provide this type of environment. The traditional classroom and its pedagogy and curriculum would have to be remodeled to break down the barriers that diminishes "active learning" to take place. "Active learning" is a method in which students are more engaged in the learning process by being more involved in discussion, writing, readings, brainstorming, exploring etc. active learning requires a higher level of thinking such as evaluation and analysis (Bonwell, 1995). One pedagogical method has incorporated these elements is flipped learning.

Flipped learning is a pedagogical intervention that has recently gained attention in secondary and higher education institutions. Flipped learning is a teaching/learning approach in which lectures are typically converted to videos that students watch at home before class and homework activities are done in class (Bishop and Verleger 2013). This is the reverse of the traditional classroom where lectures are done in class and homework activities are done at home. It is a new initiative that several instructors are adopting into delivery of instructions. To ensure that class activities are engaging students in active learning, a variety of classroom restructuring is employed. One such classroom restructuring is the Hi-Tech Studio consisting of about 4 or more round tables each accommodating 3 groups of 3 students each. This Studio combined with flipped pedagogy is called Student-Centered Active Learning Environment Upside-down Pedagogies (SCALE-UP).

Traditional vs Flipped

In the traditional classroom setting, 90% of class time is spent on delivery and review of the material, and only 10% of class time is spent on problem-solving and hands-on activities. This method of teaching does not benefit every student. The high achieving students are not challenged, thus do not benefit from lectures, and the students having trouble do not receive the remediation they need. Only student who fall in the middle fine lectures beneficial. Due to only 10% of class time dedicated to application, there is only a limited amount of time to use different methods to meet the needs of the students, making this old-style lecturing format inefficient and non-engaging. Unlike traditional lecture style, The Studio Classroom offered by the SCALE-UP program, meet the needs of diverse learners. Because videos are available, student can learn in their own unique way. They can pause, rewind, and re-watch the videos as many times as they need. After they receive the video content, they go the Hi-Tech Studio Classroom to apply what they learned. Student can ask questions because 5% to 10% of class is dedicated to the instructor answering them. The remaining 90% of class is for problem-solving, and hands-on activities. Because of this, students are engaged and challenged. The instructors and LA's have the time to work with every group thus giving them the individualized time they need. Through the student-student and student-instructor's interactions and technology driven atmosphere, high level students excel by teaching their peers, and failure rates go down (Kramer, Brewe, and O'Brien, 2008). The high level of interaction in the flipped learning classroom has a significant effect on knowledge retention, academic achievement, attitudes towards STEM fields, and psychological change (Wolfe, 2008).

Research Questions

1. What are the student's perception towards SCALE-UP flipped learning?
2. What was the academic performance of students in the SCALE-UP flipped learning compared to the traditional learning pedagogy?
3. Are there gender differences in the way flipped learning is perceived and/or in academic performance?
4. Are there ethnicity differences in the way flipped learning is perceived and/or in academic performance?
5. Are there differences in students' academic performances in the implementations of flipped learning in the disciplines (Computer Science and Mathematics)?

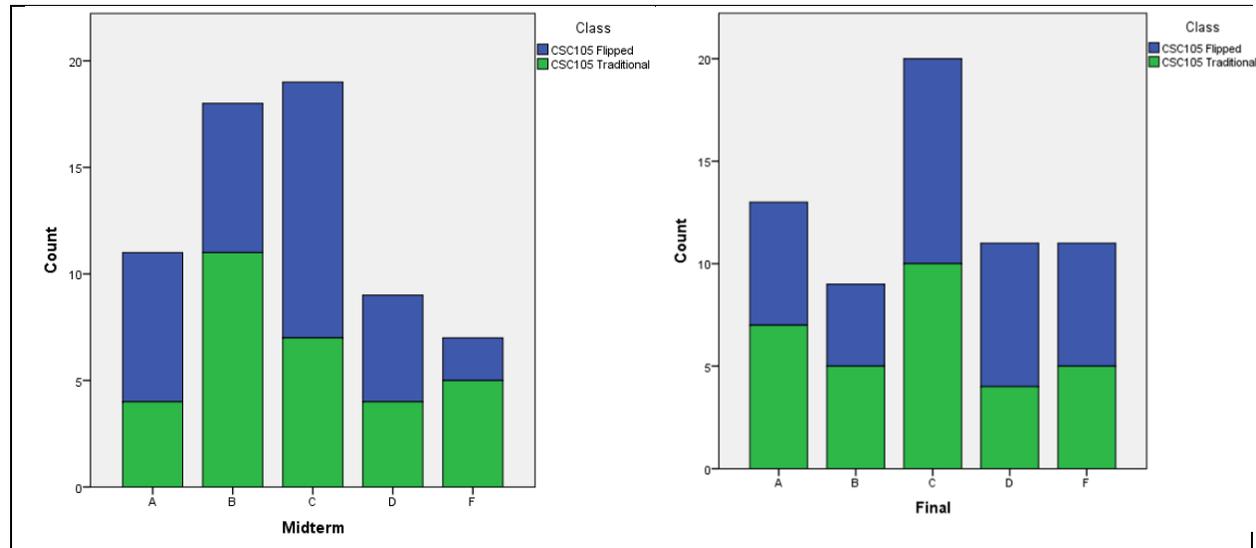
Experimental Design and Methods of Data Gathering

The first part of the study consisted of the collection and analysis of surveys given to students. The surveys tested student's perceptions of the flipped learning class room. A pre-survey was given during the middle of the spring 2018 academic semester. A post-survey consisting of the same question was given at the end of the spring 2018 academic semester. The second part of the study included the comparison of the student's academic performance between those in traditional and flipped learning classrooms. To determine the academic performance of the students, midterm and final grades were collected for the classes given the surveys. Midterm and final grades were also collection form traditional styles courses of the same subject. They were obtained from the course instructors.

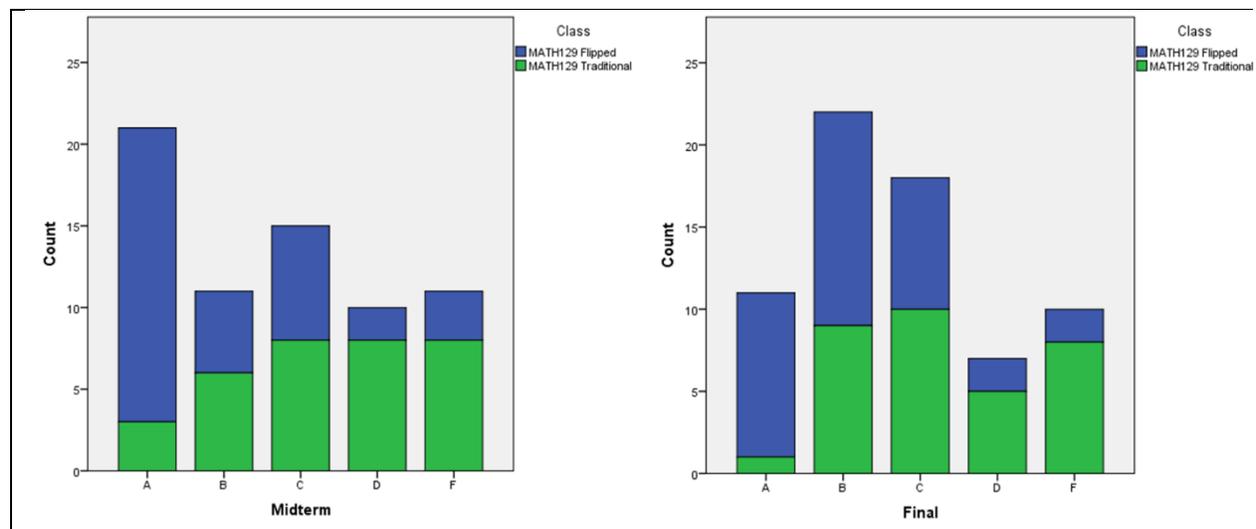
Results and Findings

Based on the analysis of variance test, there was no significant differences in students' perception from both the pre- and post-surveys. The p-value was greater than .096, but less than .822. For about half of the questions, there was a significant difference in the two flipped courses (CSC105 and MATH129) as to how students perceived their experience with flipped pedagogy. When looking at the different ethnicities there was no significant differences between them. For about half of the questions there was a significant difference in the perception of flipped learning amongst genders.

The second part of the study consisted of comparing the academic performance between students in the flipped versus the traditional course. It consisted of a total of 132 participants. 51.5% of participants were from the flipped learning class and 48.5 were from the traditional learning course. 56.1% of the students were male and 43.9% were female. 78% were Black, 14.4% were White and 7.6% were other races/ethnicities.



In the CSC105 flipped learning course, 21.2% of students made an “A”, 21.2% made a “B”, 36.4% made a “C”, 15.2% made a “D”, and 6% made a “F”. Overall, 78.8% of students made a passing grade of A,B, or C. 21.2% of students made a D or F. In the CSC105 traditional learning course, 12.9% of students made an “A”, 35.5% made a “B”, 22.6% made a “C”, 12.9% made a “D”, and 16.1% made a “F”. Over all 71% of students made a passing grade of A,B, or C. 29% made a D or F. The ANOVA test showed there was no significant difference in the academic performance of the flipped and traditional course ($p > .05$, $F = .432$). There was no significant difference in the academic performance between genders ($p > .05$, $F = 1.075$). There was a significant difference in performances based on ethnicities ($p < .05$, $F = 3.733$).



In the MATH129 flipped learning course, 51.4% made an “A”, 14.3% made a “B”, 20% made a “C”, 5.7% made a “D”, and 8.6% made a “F”. Overall, 85.7% of made a passing grade of A, B, or C. 14.3% of students

made a grade of D or F. In the MATH129 traditional learning course, 9.1% made a “A”, 18.2% made a “B”, 24.2% made a “C”, 24.2% made a “D”, and 24.2% made “F”. Overall 51.5% of students made a passing grade of A, B, or C. 48.4% of students made a D or F. The ANOVA test showed there was a strong significant difference in the academic performance of the flipped and traditional course ($p < .0001$, $F = 16.856$). There was a significant difference in the academic performance between genders ($p < .05$, $F = 4.635$). There was no significant difference in the way the different ethnicity groups performed ($p > .05$, $F = 1.385$).

Conclusion

Overall, Students rated elements of flipped learning more positive. They found the worksheets and videos helpful and felt comfortable asking their instructors question. There was no significant difference in how student perceived flipped learning between the middle of the semester and the end. When asked which learning style they preferred, students stated they preferred the traditional format over the flipped format. This could be due to having a difficulty with the change in format. Most student first time experiencing flipped learning was through this study. Having no internet connection could be a reason for this decision and videos can be time consuming for some students. There was a significant difference in gender's perception of flipped learning, with females rating more positively and males rating flipped learning more negatively. Also, there was no significant difference in how different ethnicities perceived flipped learning.

Student in the flipped learning course performed better academically than the student in the traditional course. There was a strong significant difference in academic performance of MATH129 flipped and traditional course, with the flipped course performing better with higher rates of passing grades and lower rates of failing grades. There was no significant difference in how the different gender or ethnicities performed the courses.

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