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# Flipping a Class: Impact on Performance and Retention

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## ABSTRACT

In recent years, community colleges have received much criticism about the lack of retention among their students, with developmental students experiencing a higher dropout rate than students enrolled in college level courses. Also in the last several years, academia has seen a marked increase in the interest and implementation of an innovative teaching model, which has come to be known as the flipped classroom model. This model employs a teaching and learning paradigm that uses technology to take the traditional lecture outside of the classroom, thereby giving the instructor more time to spend interacting with and engaging students. This study compares two sections of a Basic Mathematics course at a community college and the impact of the flipped classroom model on student learning outcomes and retention. One section was taught using the traditional lecture model, and the other was taught using the flipped model. The students were tested before and after the course to compare the learning outcomes of each class. This study resulted in 85% of the students in the flipped course passing the class, while only 32% of the students in the traditional course passed. Thus, the positive impact of the flipped classroom model was evident in the passing rate of the students and ultimately in the retention of those students.

**Key words:** Flipping class, student performance, retention, developmental class.

## 1. INTRODUCTION

Community colleges, their faculty, and their administrations are receiving a growing onslaught of questions regarding the effectiveness of the education they are providing. One of the most important topics for consideration is student retention. From a budgetary perspective, colleges must retain students from year to year to realize hundreds of thousands of dollars in revenue that would be lost if those students are not retained [15].

One factor that contributes to the problem of student retention is the extent to which community college students require remedial, or developmental, courses upon entering college. The high attrition from the remedial sequence may be one reason developmental education is not effective [6].

With the proliferation and availability of technology, many educators have adopted the use of technology to engage students both inside and outside of the classroom in delivering, receiving, and assessing students' assignments. The ubiquity of technology has also fueled an increase in the number of instructors who have espoused the use of the flipped classroom style [2].

This research highlights various technologies that are useful in implementing a flipped classroom and investigates the impact of a flipped electronic classroom in Basic Mathematics on student learning outcomes, as well as its impact on student retention.

Community colleges experience low rates of retention among students requiring developmental courses [15]. Many developmental students are first-generation college students, and many lack the necessary study, time-management, and goal-setting skills, family and social support systems, and the financial and emotional wherewithal to succeed in college [14]. Also, it has been found that, what appears to be a lack of motivation is often really a lack of self-confidence, lack of study skills, worry over financial distress, and family and work obligations [10]. The Remedial Education Commission [8] recommended that, "Developmental education providers investigate the further use of technology (e.g., MyMathLab; PLATO; etc.) for the delivery of developmental education."

The instructor in this study desired to eliminate as many of the students' encumbrances as possible by using the flipped classroom model and by utilizing the available technological resources of computers and Internet in the electronic classrooms on campus. This study highlights various technologies used to flip a classroom, investigates if and how a flipped electronic classroom can improve student achievement as compared to the student achievement in a traditional classroom, and determines if improvements in retention can result from flipping a developmental math class.

### Definition of Useful Terms

*Developmental course* – a course that is designed to prepare students for college-level coursework. Developmental, or remedial, courses do not count toward degree requirements.

*Flipped Classroom* – a pedagogical approach in which direct instruction moves from the group learning space (the

classroom) to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter (Flipped Learning Network).

*Traditional Classroom* – a pedagogical approach in which direct instruction comes from the teacher in the form of lectures, and students complete homework assignments outside of class.

*MyMathLab* – an interactive, online learning management system (LMS) designed by Pearson Education to accompany its published math textbooks.

*Electronic classroom* – a classroom outfitted with desktop computers, Internet connections, and a screen and projector to which peripheral devices can be connected.

*iPad, 3rd Generation* – a tablet computer, developed and marketed by Apple, Inc. in early 2012.

*iPad Air 2* – the sixth generation iPad tablet computer, originally released in late 2014. Its use in the classroom was desirable because of its capability to be wirelessly connected to the classroom projector.

*Apple TV* – a digital media player that can receive data from various sources and stream the data to a TV or projector.

*Explain Everything* – an interactive screen casting whiteboard application for iPad.

*JotScript Stylus* – a fine point, Bluetooth stylus designed for writing and note taking on iPad tablet computers.

*MacBook Pro* – a notebook computer marketed by Apple.

*Camtasia* – software designed for recording onscreen activity of a notebook or desktop computer, allowing audio, web cam video, and narration.

*Learning Catalytics* – a "bring your own device" student engagement, assessment, and classroom ntelligence system.

*Movo Pm10 Lavalier microphone* – a lapel clip-on omnidirectional microphone for use with the iPad in creating lecture videos.

*YouTube* – a distribution and social media platform for the free sharing of original video content.

*QR code generator website* - A QR (quick response) Code is a mobile phone readable bar code that can store website URLs as well as many other different types of information.

*QR reader app* – any of several free mobile apps that allow smartphones and mobile devices to can barcodes, QR codes, and other content.

*REMIND* – REMIND is a one-way communication tool that allows teachers to send short, group text messages to students.

*Texas Instruments TI-30XIIS* – a basic two-line calculator that is recommended for developmental students at the community college in this study.

*Tell Me What to Write* – an in-class exercise in which students were paired together to solve problems.

*Math Rumors* – an in-class exercise in which rows of students would compete to be the first row o correctly finish a series of steps in simplifying an algebraic expression.

## 2. LITERATURE REVIEW

### 2.1 Retention among Developmental Students

Although questions persist about retention in community colleges, there are challenges in defining retention. One definition of retention in community colleges considers students' goals other than graduation rates, and is described as a persistence rate [7]. According to [16], retention is "the percent of entering students graduating or persisting in their studies at an institution." Leonard Crawford, in his 1999 report [5], defined persistence as "maintenance of continued enrollment for two or more semesters, specifically from fall term to spring term and/or completion of a degree/certificate or transfer to a four-year college."

No matter how retention is defined, however, most students begin a college course with the full intention of completing it, but yet many drop out before the end of the term [10]. Research suggests the way students perceive their college experiences in general, and their learning environment in particular will influence their willingness to persist [10]. According to Vincent Tinto [12], a foremost student retention theorist, students possess certain attributes that influence their choices of goals and commitments. These attributes include, but are not limited to, skills, abilities, prior education, and family background. The students' goals and commitments must interact with their college experiences in ways that facilitate the students becoming academically and socially connected; otherwise, they are not likely to persist. I order for students to make those connections, faculty must create appropriate learning opportunities [10].

In another study, Tinto [13], found that of the students who prematurely leave college nationally, roughly 70%-80%, do not leave for academic reasons, but for the following reasons: problems adjusting, lack of goals, lack of commitment,

financial strain, difficulty integrating within the college community, incongruence between what students desire and what the college offers, and isolation.

Closely related to the discussion of retention are the subjects of developmental courses and their effectiveness in community colleges. According to researchers at the National Center for Education Statistics [14], 42% of all entering community college students are underprepared for college-level work and require developmental courses. Some studies report 80% participation in developmental courses [11]. According to Jaggars and Stacey [6] of the Community College Research Center (CCRC), "Recent federal data indicate that 68% of community college students and 40% of students at four-year colleges take at least one remedial course. Research suggests that many more students are referred to developmental courses but never enroll in them." In addition, certain student demographics, such as African Americans and Latinos, are overrepresented in developmental courses. In 2013 Complete College America reported that in Texas 72% of African American students and 57% of Latino students require developmental education [11].

Students who are placed into developmental courses, whether correctly or not, often become discouraged and quit before they ever make it to college-level courses [9]. Only 28% of community college students will earn a degree within eight years if they have to take even one developmental course [6]. One analysis by the CCRC found that students who needed to complete several developmental courses before enrolling in college-level courses had too many stages at which they could quit the sequence. For instance, only 11% of 63,650 students in the study successfully completed college-level introductory algebra if they had been assigned to three levels of developmental math [6].

In 2011, the Louisiana Board of Regents (BOR) and Louisiana Department of Education (LDOE) reported, "In Louisiana's 2-year colleges, 63% of the students entering in 2006 enrolled in developmental courses, and only 14% of them had completed a college-level course in the same subject within 2 years of entry." The Remedial Education Commission [8] of the Louisiana BOR and LDOE found that "access to higher education in the United States is widespread, but access to success in higher education has proven to be less common and more frequently limited by a student's degree of proficiency in the core academic skills: reading, writing, and mathematics." The Commission found that recent studies of remediation "have concluded that the system of remediation in this country is framed in an academic sequence, construct and time frame that is problematic." Complete College America (CCA) notes that, "In spite of best intentions, remediation most often becomes the place where students fall down and drop out instead of catch up. It's time to make major changes in remediation so that students have a real chance for the ultimate success; college completion" [4]). Two recommendations made by The Remedial Education Commission [8] were that colleges:

- Examine the role of distance learning and other alternative delivery methods, and
- Analyze the success of remedial students in terms of retention and graduation

Some common distance learning models are online and hybrid courses. One alternative delivery method that is gaining popularity is the flipped classroom model.

### 2.2 The Flipped Classroom Model

With the available technologies in the 21st century, a paradigm shift has occurred in education in the form of the classroom model known as the flipped classroom. Jonathan Bergmann and Aaron Sams, two science teachers in Colorado, are credited with coining and popularizing the flipped classroom model. According to Bergmann and Sams [1], the flipped classroom model comprises any use of Internet technology to deliver lectures to students outside of class in an effort to maximize the time the instructor spends interacting with and engaging students in class instead of lecturing.

The flipped classroom model does not change what is taught, but it changes the way it is taught. It does not replace the teacher; it allows the teacher to be in the trenches with the students and teach them in a more individualized manner, taking advantage of a world that is different from the world of scarce information that existed before the 1990s. "We see flipped learning as a pedagogical solution with an underlying technological component" [2].

Bishop and Verleger [3] state that the flipped classroom model affords the implementation of various student-centered learning theories and methods such as: learning styles, peer-assisted and collaborative learning, cooperative learning, problem-based learning, and active learning.

## 3. METHODOLOGY

In the fall semester of 2014, the instructor taught two sections of Basic Mathematics, which is the first of a three-course sequence of developmental mathematics courses, with Basic Algebra and Intermediate Algebra being the second and third in the sequence. Both sections were held in electronic classrooms, and both sections used the classroom computers and Internet to access MyMathLab to take chapter tests in class during the designated class periods. One section was taught using the traditional classroom model, and the other section was taught using the flipped classroom model. Both sections were graded on a ten-point scale (90-100=A, 80-89=B, 70-79=C, 60-69=D, below 60=F), and were required to obtain a grade of C to pass the course.

Two months prior to the beginning of the fall semester, the instructor began creating and self-recording video lectures using the iPad 3rd generation tablet computer, the Explain Everything application, the Movo Pm10 Lavalier microphone, and the Jot Script stylus. For some videos, the instructor used Camtasia on a MacBook computer to record the actual computer screen as well as the lecture notes and narration. The instructor created 35 lecture videos that illustrated concepts and example problems from seven chapters of the textbook. The instructor uploaded each video to YouTube.

On the first day of school, both sections were instructed on how to log in to the classroom computers, and were guided through the registration process for MyMathLab, which offers a temporary access period in which all registered students have full access to the website for 14 days. The instructor explained that with the purchase of a new textbook, each student would receive an access code that would grant him or her permanent access to the course content in MyMathLab. The instructor used the podium computer and projector to give the students a brief guided tour of the MyMathLab website, which has many resources, including the course syllabus, syllabus addendum, instructor contact information, lecture videos, animated examples, an online textbook, etc. This time was also used to demonstrate how homework, quiz, and test answers are to be entered on the MyMathLab website, and students were walked through the registration for the Remind text messaging system that the instructor uses to send short mass text messages to students. The students in the flipped class were also encouraged to download any of several free QR reader apps that are available for smart phones and mobile devices.

On the second day of class, the instructor gave both sections a department-formulated pre-test, which consisted of the first 12 problems that appear on the departmental final exam for the Basic Mathematics course. The students were not told that the problems were from the final exam, but they were instructed to complete all 12 problems as best they could. Each section was given 45 minutes to complete the 12 problems, and the students were each issued a TI-30XIIS calculator. The instructor collected the pre-tests, which were graded and stored to compare with the post-test results. The flipped class was instructed to bring a set of headphones or ear buds for subsequent class meetings, so that they could unobtrusively view lecture videos as needed.

On the third day of class, the traditional class began to receive lectures during each class period and was instructed to complete the online homework for that day's content on the same night or as soon as possible before the next class meeting. The teacher delivered the lecture content by wirelessly connecting an iPad Air to an Apple TV device, and by writing the lecture notes onto the iPad Air with a Jot Script Bluetooth stylus. Using these technologies allowed the instructor to face the students while lecturing, and it also provided the means to save lecture notes exactly as they were delivered in class so that they could be converted to pdf files and printed or emailed to students as needed. At the beginning of class on the third day, the flipped class was instructed to take out their notebooks, and the instructor showed the first lecture video on the projector, pausing periodically to instruct the students on how to take notes. After the video, the students were to work as many of the homework problems as they could for the duration of the class period. The instructor visited with each student to offer assistance, and students were encouraged to ask for instructor or peer assistance as needed. Students were instructed to complete the first homework assignment and to watch and take notes of the next lecture video before the next class meeting. From the third day forward, the instructor placed at each exit a printout of a QR code that linked to the URL of the next video lecture. The students were encouraged to scan the QR codes with their smartphone apps to have immediate access to the lecture content for their next assignment.

The semester proceeded with the traditional students receiving lectures and taking notes in class and being assigned homework and quizzes outside of class, and with the flipped class viewing lectures outside of class and doing homework and engaging in other individual and group activities such as Tell Me What to Write and Math Rumors in class. Some of the activities used in the flipped class made use of technologies such as mobile devices and Pearson's Learning Catalytics, and some activities were hands-on individual and group activities such as puzzles, algebra tiles, and group competitions. After each chapter's content was completed, each section was given chapter tests in class using MyMathLab. Each class took six chapter test using MyMathLab in class. All eligible students took the final exam at the same time in a large electronic classroom.

## 4. RESULTS

The final exam was given to both sections using MyMathLab, and each student was issued a TI-30XIIS calculator. The first 12 problems of each student's final exam were the same as the pre-test, and were graded and compared to the pre-test grades. Table 1 and Table 2 show the pre-test and post-test results from the traditional class and the flipped class respectively. On the day of the final exam, 32% of the traditional class took the final exam, and 85% of the flipped class took the final exam. In both sections, all students who took the final exam passed the final exam and passed the course. Students who did not take the final exam are not included in the table or the data.

**Table 1:** Traditional Class Pre-Test and Post-Test Results

| Student | Problem numbers incorrect on pre-test | Pre-test grade (% correct) | Problem numbers incorrect on post-test | Post-test grade (% correct) | +/- Change |
|---|---|---|---|---|---|
| 1 | 1,2,3,5,6,8,10,11,12 | 25 | 11 | 92 | +67 |
| 2 | 1,3,4,5,6,7,8,10,11,12 | 17 | All correct | 100 | +83 |
| 3 | 1,3,5,6,8,9,10,11,12 | 25 | 6,11 | 83 | +58 |
| 4 | 1,2,3,4,5,6,7,8,9,10,11,12 | 0 | 8 | 92 | +92 |
| 5 | 1,3,5,6,8,10,11,12 | 33 | All correct | 100 | +67 |
| 6 | 1,3,4,5,6,8,10,11,12 | 25 | All correct | 100 | +75 |
| 7 | 1,2,3,5,6,7,10,11,12 | 25 | All correct | 100 | +75 |
| 8 | 1,3,5,6,8,9,10,12 | 33 | All correct | 100 | +67 |
| 9 | 1,2,3,5,6,8,9,10,11,12 | 17 | 6,12 | 83 | +66 |
| 10 | 1,3,4,5,6,8,10,11,12 | 25 | 6 | 92 | +67 |

**Table 2:** Flipped Electronic Class Pre-Test and Post-Test Results

| Student | Problem numbers incorrect on pre-test | Pre-test grade (% correct) | Problem numbers incorrect on post-test | Post-test grade (% correct) | +/- Change |
|---|---|---|---|---|---|
| 1 | 1,2,3,4,5,6,7,8,9,10,11,12 | 0 | 3,8,12 | 75 | +75 |
| 2 | 1,2,3,4,5,6,7,8,10,11,12 | 8 | 6, 10 | 83 | +75 |
| 3 | 1,2,3,4,5,6,7,8,9,10,11,12 | 0 | 1,7,10 | 75 | +75 |
| 4 | 1,3,4,5,6,8,10,11,12 | 25 | 1 | 92 | +67 |
| 5 | 1,2,3,5,6,7,8,9,10,11,12 | 8 | 4,6,10 | 75 | +67 |
| 6 | 1,2,3,4,5,6,7,8,9,10,11,12 | 0 | 6,10 | 83 | +83 |
| 7 | 1,2,3,4,5,6,7,8,9,10,11,12 | 0 | 6,8,11 | 75 | +75 |
| 8 | 1,4,5,6,7,8,9,10,11,12 | 17 | All correct | 100 | +83 |
| 9 | 1,3,5,6,9,10,11,12 | 33 | 1 | 92 | +59 |
| 10 | 1,2,3,4,5,6,7,8,10,11,12 | 8 | 6,8,12 | 75 | +67 |
| 11 | 1,2,3,4,5,6,7,8,9,10,11,12 | 0 | 3,10,11 | 75 | +75 |

**Table 3:** Pre/post Test Analysis and Enrollment History Analysis

| Quantity Measured | Traditional Class | Flipped Class |
|---|---|---|
| Average grade on pre-test | 23% | 9% |
| Standard Deviation of pre-test mean | 9.53648 | 11.41928 |
| Average grade on post-test | 94% | 82% |
| Standard Deviation of post-test mean | 6.94102 | 9.05338 |
| Students that passed class | 32% | 85% |
| Students retained & enrolled in Basic Algebra in Spring 2015 | 32% | 77% |
| Students retained & enrolled in Intermediate Algebra in the two subsequent semesters | 26% | 62% |
| Students that failed or withdrew from class | 68% | 15% |
| Students who have never returned after failing or withdrawing | 29% | 8% |

In the fall semester of 2015 the instructor analyzed the pre-test and post-test results and conducted an enrollment history for each of the students who had been enrolled in the two courses in this study. The analysis is compiled in Table 3.

In the traditional class, 68% of the students either failed the course or withdrew from the course. The students who failed the traditional course typically had a very low homework and quiz completion rate, and as a result, had very poor test grades. Five of the students who withdrew from the course had never obtained the paid access to MyMathLab, which prevented them from doing any homework, quizzes, or tests after the 14-day temporary access period. This finding is consistent with the findings of Tinto [13] regarding financial strain on students. All of the students who failed, however, had obtained the permanent access to MyMathLab, but only completed a few assignments outside of class. Likewise, this outcome is consistent with Tinto [13], as students' level of commitment and adjustment to college life is brought to bear.

In the flipped class, only 15% of the students failed the course. No students withdrew from the flipped course. The students who failed the course had poor attendance, and were not in class often enough to complete the majority of their homework assignments and to participate in discussions and activities with their classmates. The lack of attendance likely made it difficult for the students to integrate with and have a sense of community with their fellow classmates and instructor, which is also in agreement with Tinto [13].

## 5. CONCLUSION

In terms of retention, the students who passed either course were more likely to continue the developmental math sequence than those who failed. This finding is in line with a study that was done at Michigan State University (1998), in which it was found that developmental students who pass have a better retention rate than those who do not complete developmental courses successfully. Furthermore, students who do not complete the first level of developmental math are much more likely to drop out of school than students who progress to the higher level developmental courses.

The study, moreover, shows that 85% of the students passed the flipped class, but only 32% passed the traditional class. This indicates the following connections, if not correlations, between flipping the class, pass rate, and retention:

- Students who pass either a traditional class or flipped class are more likely to be retained for the entire developmental sequence.
- Students in the flipped class are more likely to pass than students in the traditional class.
- Therefore, by transitivity, students in the flipped class are more likely to be retained for the entire developmental sequence.

This research suggests that flipping a Basic Mathematics course using an electronic classroom and other available technologies to engage students inside and outside of the class, as well as using some non-technology based activities in class, can impact pass rates and, consequently, affect the retention of developmental students in the community colleges.

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