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Flipped Classroom in Introductory Mathematics: Data Analysis of Student Success

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INTRODUCTION
Mathematics 240 is an introduction to fundamental topics in number theory, including the real number system, prime numbers, modular arithmetic, the Euclidean Algorithm, Fermat’s Theorem, Euler’s Theorem and Euler’s Phi Function. Topics are applied to Caesar, affine, and RSA ciphers as well as the Chinese Remainder Theorem. This class is a required course for our Computer Security majors and is the prerequisite for our 300 level Cryptology course.

During the fall semesters of 2004 to 2013 this class was taught with a traditional lecture format with weekly quizzes, individual programming projects, three one-hour exams and a final examination. During the fall semester of 2015 and 2016, the class was presented using a mixture of lecture and a flipped classroom. During the fall semester of 2017 the classroom was completely flipped. Students watched video lectures before coming to class, and completed daily in-class group projects. Students also were required to complete individual and group programming projects, and had three one-hour exams and a final exam.

Analysis of the results from the mixed and flipped format as compared to those with the traditional lecture format showed significant improvement over the traditional lecture format on both the final exam as well as the final course grade. Students scored on the average one letter grade higher in the course and 11 points higher on the final exam with the flipped classroom format.

METHOD

Traditional Lecture
- Weekly quizzes
- Individual programming projects
- Three one-hour exams
- Final Exam

Mixed Format
- Mixture of lecture and flipped classroom
- Students watch video lectures before coming to class
- Weekly in-class group projects
- Individual and group programming projects
- Three one-hour exams
- Final Exam

Flipped Format
- Students watch video lectures before coming to class
- Daily in-class group projects
- Weekly quizzes
- Individual programming projects
- Three one-hour exams
- Final Exam

RESULTS

Final Exam Traditional Lecture vs. Mixed Format

Students perform better on the final exam using the mixed format (p-value = 0.0121).

Final Average Traditional Lecture vs. Mixed Format

Students overall performance was better using the mixed format (p-value = 0.0190).

Final Exam - Traditional Lecture vs. Flipped Classroom

Students perform better on the final exam using the flipped format (p-value = 0.0169).

Final Average - Traditional Lecture vs. Flipped Classroom

Students overall performance was better using the flipped format (p-value = 0.0093).

STUDENT COMMENTS

- I enjoyed the class and felt that as a math class I learned a lot more than I would normally in any class. As the first really different class in math field I feel better about learning different topics besides just pre-calculus and calculus.
- I loved the class, nothing wrong with it.
- A little instruction during class would have been helpful. Reverse classrooms courses have the disadvantage that instruction of the topic can’t be catered to what the class is understanding and what they are struggling with.
- I think going over more material in class would be beneficial. I am not a big fan of the hybrid class because it makes me feel as if I am alone in the classroom. Changing it to a traditional class that meets 3 times a week would be best for student interest and overall quality of work.
- This instructor works hard to make sure that each question is answered, no matter how many times the student may ask the question, this professor makes sure that the student has full comprehension of the topic. Always gave help when I needed it and clearly taught all of the subjects. Superb teaching style.
- Professor Frey is such a huge role model. She excels in being professional and a hard working math teacher. Always willing to extend a hand and help. She is also able to build relations with students understanding how hard her class is. She is willing to work with those who strive to exceed. Loved the Teacher. She teaches a TOUGH class, but its worth it.
- I loved the class and the professor was extremely helpful in every project we did and was very professional in everything she did.
- Professor Frey clearly had a deep understanding of the material and when asked would help pretty effectively. Forcing the students to learn the material through the use of videos doesn’t create that good of an environment and we were never taught what formulas or vocabulary actually were doing/meant, simply just how to do the math.
- I did not like the hybrid class. Professor didn't really teach except for in videos and I would of liked to know why we were doing/meant, simply just how to do the math.
- I loved the way that this class was set up. Having the assignments available online and class time designated to having questions answered worked extremely well for me as I like to do my work independently. Professor Frey was always there to help me when I needed it and she made this course very successful for me.

OBSERVATIONS

- Class attendance is VERY important.
- Student’s actively participating in the class is VERY important.
- The faculty member actively participating in the class is VERY important.
- Daily group projects followed up by weekly individual quizzes and regular exams are VERY important.
- This method leads to a lot more grading!

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