

Results of a Summer Enrichment Program for Pre-freshmen Minority Engineering Students

Yacob Astatke, Craig Scott, Kemi Ladeji-Osias, Grace Mack

Abstract

This paper will discuss the results received from the use of an internal math placement method for minority engineering students that participated in a summer bridge program in the School of Engineering at Morgan State University (MSU). The Foundations of Mathematics (FOM) is a free summer program that enrolls incoming freshman engineering majors in a five week online math course. It has been in operation since 2000. The goal of the program is to improve the students' basic mathematics skills, while preparing them for the university's entrance placement exams. The students receive and complete their weekly math assignments online. They also come to our campus on Saturdays to receive one on one tutoring and mentoring. Proper course placement, specifically math courses, is critical for engineering students, as it has been proven to have an effect on their retention, length of time to attain a degree, and overall success. The importance of accurate placement is even more crucial when attempting to improve the success rate and retention of minority engineering students. The paper will explain in detail the structure, layout, and methodology of the program, and look at possible further implementation of this math placement method for all engineering and other science, technology, engineering and mathematics (STEM) students at our university. The paper will also provide a brief analysis of the results from the use of the math placement method for the FOM program participants, as well as a comparison of these results versus students who did not participate in any summer enrichment program.

Key words: Online math course, summer enrichment program, improve engineering retention

I. Introduction

According to government data, about half of the students who enter college in the United States will not make it to graduation. Although several factors are causing students to leave college without a degree, most surveys have shown that the two main reasons are poor academic performance and financial hardship [1]. Courses in mathematics and science that are usually required by students enrolled in the Science Technology Engineering and Mathematics (STEM) areas are some of the most challenging for many students. According to a study conducted by the Brown Center on Education Policy at the Brookings Institution, the level of mathematical skill of half of the college student body is similar to that of struggling eighth-grade algebra students. The study showed that a large percentage of college students were incapable of carrying out basic arithmetic calculations such as the order of operations, fractions, percentages, etc... Many colleges and universities have set up advising centers and tutoring services to improve student retention.

The biggest concern since the implementation of the math placement exams by our university has been the increasing number of engineering students who are being placed in

remedial math courses such as Math-106 (Basic Algebra). The “Foundations of Mathematics ” was implemented in the summer of 2000 to help tackle the problem. The goal of the online course is twofold: its first goal is to improve the math skills of freshmen engineering students. The second goal of the online course is to prepare the students for the university mathematics ACCUPLACER placement exams [2]. Having a web-based online math course can help facilitate that task by allowing prospective engineering students currently in high schools or middle schools in preparing for their engineering curriculum by acquiring the correct math skills. Several universities have started using online courses to offer remedial courses to their prospective students while they are still in high school [3],[4]. The use of online courses is increasing tremendously because they offer the most flexible and cost-effective way of reaching out to prospective college students [5].

Table I: FOM Course Outline

<p>Module I: Arithmetic and Basic Algebra</p> <ul style="list-style-type: none"> • Multiplication and Division of Fractions • Fractions and Mixed Numerals • Working with Decimal Numbers • Intro to Real Numbers and Algebraic Expressions • Solving Basic Equations and Inequalities
<p>Module II: Intermediate Algebra Part I</p> <ul style="list-style-type: none"> • Operations with Polynomials • Factoring Polynomials • Graphs of Equations: Data Analysis • Systems of Equations
<p>Module III: Intermediate Algebra Part II</p> <ul style="list-style-type: none"> • Inequalities • Rational Expressions and Equations • Radical Expressions and Equations • Quadratic Equations and Functions
<p>Module IV: Functions and Graphs</p> <ul style="list-style-type: none"> • Functions and Graphs Part I • Functions and Graphs Part II with Applications • Exponential and Logarithmic Functions • Trigonometric Functions

Some of the topics covered in the five-week web-based online FOM course are shown in Table I. The purpose of the web-based course is to prepare the pre-engineering students so that

they can avoid being placed in the lowest possible remedial math course: Basic Algebra (Math-106). The program aims to place the majority of its students in the Pre-Calculus remedial math courses called Math 141 (one semester) or Math 113 (two semester) . Some of the FOM students also get placed in the required math course called Calculus I (Math-241). Our school of engineering also offers another summer enrichment program that is residential called the Pre-freshmen Accelerated Curriculum in Engineering (PACE). The main problem with the PACE program is that it can only accept a limited number of students (around 30), because it requires additional funding to provide housing, and other expenses for the participants. On the other hand, the FOM program can accept and support as many students as needed with a small increase in funding and support.

II. Overview of the FOM Program

Although the program receives 25 to 50 applications each summer, several students end-up not participating at all because of various reasons. Every summer, more than 80% of the students who participate in the program work at least 10-20 hours per week. Since this is an online course, the most important requirement is that all participants must complete at least 80% of the work to remain in the program. Hence, after 2 weeks several students are officially dismissed from the program because they only manage to complete less than 50% of the required work. It should be noted that the students still have access to the material on the website even after they have been dismissed from the program. In most cases, students get dismissed from the program because their only reason for not completing the required work was a lack of effort and/or a loss of interest in the program. Usually 50% the students who get dismissed work, and the other 50% don't work. This indicates that the key reason for dismissal is the lack of effort, discipline, and time management on the part of the student. Perseverance, discipline and time management are the key ingredients required to the success of any engineering student. Hence, if the students show us that they lack any of the ingredients during the summer course, we can help them in identifying their weaknesses and show them how to correct those weaknesses before they start taking classes in the fall semester.

For the past twelve summers, the FOM online course has been delivered over the Internet for 5 weeks. The program has an open policy, where any student who shows interest is admitted regardless of their educational background. The only requirement is that all students have access to a computer with a connection to the Internet. Usually, all of the participants have access to a computer either at home or at work. The majority of the students who participate in the program come from schools that are in the Baltimore area. Therefore, they are also required to come to MSU School of Engineering at least once a week (usually on Saturdays) for discussions, additional problem sessions, and to take in class exams. Students are given daily assignments and weekly exams to make sure that they have understood the concepts covered in the different lessons. Close to 80% of the students who live in the Baltimore area attend the weekly meetings. The students who are out of state receive help and guidance by phone or completely online using the various communication and collaboration tools (Email, Bulleting Board, Chat rooms, etc...) that come with the Blackboard Learn™ software. The grade point average and SAT scores of

the students who enrolled in the online course are always similar to the students enrolled in the PACE program, and the rest of the students who are not involved in any summer program.

Each summer, we higher several undergraduate (juniors and seniors) and graduate students to serve as tutors, and mentors to the freshmen students who are enrolled in the online course. The undergraduate and graduate students play a critical role by working closely with the freshmen students and identifying their weaknesses and strengths. They serve as excellent role models to the incoming freshmen students. They also indicate to them the true requirements of the engineering curriculum by sharing their own experience. At the end of the summer program, the mentors are very helpful in identifying the students that are at risk of failing the math placement exams. Their feedback in identifying the “at-risk” students is correct more than 90% of the time. Fig. 1 shows activities of the online students and their mentors when they attend the Saturday review sessions.



Figure 1: FOM students working with mentors during Saturday review sessions.

Benefits of the FOM Program

The FOM online course has been developed and delivered using the Blackboard Learn™ web-based course management platform. The use of the Blackboard Learn™ software to deliver the web-based course has two advantages. First, the online course will allow students to learn the math concepts at their own pace from anywhere at any time 24 hours a day, 7 days a week. They will have access to the course materials at home, or any other location, which has access to the Internet such as a public library. Second, it provides the means for upcoming freshmen students to take the course without being present on Morgan State University’s campus on a day to day basis. Blackboard Learn™ provides a large set of tools and an authoring interface that allows for the creation of sophisticated web-based courses. The course designer requires little or no technical expertise. The Blackboard Learn™ software can be used to create entire on-line courses, or to simply publish materials that supplement existing courses. The course designer provides the content of a course. Interactivity, structure and educational tools are provided by software.

Several institutions have developed and implemented online math courses. They range from high school to graduate level courses. Regardless of the complexity of the content, research has shown that online courses, if properly designed and delivered, can have the same learning outcomes as traditional lecture based courses [6],[7]. Since online courses require a greater commitment and participation from the students, it might not be attractive to all students. However, a big advantage of online courses is that they force students to become proactive learners by giving them control over the content and the pace at which they can learn.

III. Results of the FOM Program

The web-based FOM program had a total of 254 participants during the past 11 summers (Summer 2000-2010), and the results indicate that only 23% of all the students who completed the online course placed in Basic Mathematic (Math-106) remedial math course. This implies that 77% of the FOM students placed in a math class that is higher than Math-106 as shown in Table II. It should be noted that prior to 2006, the FOM students didn't take the ACCUPLACER™ Math test. These results are very encouraging, especially when they are compared to the placement results for students who didn't complete the online course, or any other summer enrichment program such as the PACE program.

Table II: FOM Math Placement Results for Summer 2000-2010

Number of students	Number of students placed in each math course			
	MATH 241 (Calculus I)	MATH 141 (Pre-Calculus I&II)	MATH 113 (Pre-Calculus I)	MATH 106 (Basic Math)
Summer 2000 to 2005 Total # of students → 119	39 (37.7%)	25 (28.1%)	26 (13.1%)	29 (21.1%)
Summer 2006 to 2010* Total # of students → 135 * Start of ACCUPLACER Placement Exams	3 (2.2%)	40 (29.6%)	62 (46%)	30 (22.2%)
Summary of Results from 2000 - 2010				
Total students 2000-2010 → 254 students	42 (16.5%)	65 (25.6%)	88 (34.6%)	59 (23.2%)

The results of mathematics placement scores for the years 2003 to 2008 are shown in Fig. 2 and Table III. They indicate the following: only 23.4% of the students enrolled in the FOM online math course placed in Math-106, whereas 43.1% of the students who didn't participate in any summer enrichment program placed in the same Math-106 course. However, for the Math

241 (Calculus) and Math-141 (Pre-Calculus) courses, the FOM online math students had a successful placement rate that was twice as high when compared to the students who didn't participate in any summer enrichment program.

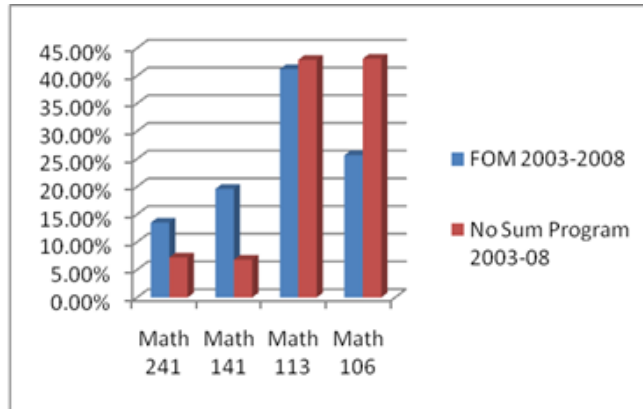


Figure2: Math Placement score results for 2003-2008

The results prove that if students are given the opportunity to review their math concepts properly, and they take the initiative to do so, they can do extremely well on their placement exams. It also means that they have a higher chance of graduating in 4-5 years. The results are very significant for the school of engineering because the majority of the students who graduate in 4 to 5 years start out in either Math-241 or Math-141. Therefore, one way we can improve the graduation rate of engineering students is by expanding summer enrichment programs such as FOM and PACE, so that the majority of the students place in either Math-241 or Math141. Analysis of the math background of the ECE graduating class of 2008-2009 proves that fact. 54% of the graduating class started in Math-141 or Math-241 and required an average of 4.8 years to graduate. 26% of the students are transfer students and required an average of 3.5 years to graduate. However, only 9% of the students in the graduating class started in Math-106 and required an average of 7.3 years to graduate.

Table III: Comparison of Math Placement Results for Summer 2003-2008

Math Placement Scores for Incoming Freshmen Engineering Students					
	MATH 241 (Calculus I)	MATH 141 (Pre-Calculus I&II)	MATH 113 (Pre-Calculus I)	MATH 106 (Basic Math)	TOTAL
FOM Online Program	20 (13.51%)	29 (19.59%)	61 (41.22%)	38 (25.68%)	148
No Summer Program	35 (7.22%)	33 (6.88%)	208 (42.89%)	209 (43.09%)	485

At the end of each summer program, the students are given an evaluation form and exit survey. The evaluation form is used to assess three things: their interest in mathematics, the overall program, and to get comments and recommendations for the online course. 90% the students indicate that the weekly Saturday meetings are very helpful because they allow them to obtain personal tutoring and detailed explanations to any concept that is covered by the course. Here is a summary of the results obtained from the participants:

- More than 80% of the students worked more than 10 hours per week, and studied less than 10 hours per week while taking the online course.
- More than 85% of the students rated the summer online math program very good and excellent.
- 100% of the students indicated that they would recommend the “Foundations of Mathematics” summer online math program to other students.
- More than 90% of the students found the “Foundations of Mathematics” summer online math program useful, or very useful.

IV. Conclusion

Unlike the PACE program, which can only be implemented during the summer time, the FOM online course can be offered to high school students who plan to attend MSU School of Engineering during the Fall and Spring semesters. This will allow MSU School of Engineering to recruit students who have the right math skills before they start taking courses on campus. For those students who don't have the right math skills (i.e. not ready for Calculus I), but still want to attend MSU School of Engineering, the online course can be used to help them acquire those skills during the summer period before they attend MSU.

The results of the evaluation forms that are completed by the students at the end of each summer session are also very encouraging. The students indicate that the lessons are very thorough and concise, and the assignments are challenging. Overall, they all felt better prepared to take the placement exams after completing the online course. They all felt that, although the weekly comprehensive unit exams are very challenging, they prepared them well for the final exams. They all felt that the staff was very supportive and helpful. In conclusion, all of the students agreed that the FOM online course and the overall program were excellent. The most important impact of the FOM online course was summarized by the following comment from one of the participants: “It saved me at least one year of school.”

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