ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Paper ID #20903

Work in Progress – Helping First Year Students Start on Track in the Mathematics Sequence

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Abstract **- Most incoming freshman take the Mathematics Placement Test before joining New Jersey Institute of Technology (NJIT). The outcome of this test determines the level of mathematics (calculus I or a remedial pre-calculus course) they begin with in their first semester. For students in Newark College of Engineering (NCE) at NJIT, by design, the mathematics placement drives the remainder of their courses as well. This means that poor performance on the Mathematics Placement Test easily adds 1-2 semesters to students' overall graduation time. This also has a strong impact on the retention and graduation rates within NCE. Clearly, if more students perform better on the Placement Test, then higher the retention and graduation rates will be. This work-in-progress paper takes a look at various reasons due to which students do not do well on the Placement Test. For each of these reasons identified, NJIT has implemented various initiatives to help students start on track in their first semester. Some of these initiatives include 1) developing sample placement tests for students to practice under the same environment as the original test, 2) making a placement calculator for students to input the scores from the practice placement tests to determine their likely mathematics placement, 3) establishing a strong outreach to educate students about the impact of their mathematics placement on their engineering curriculum and motivating them to do better on the Placement Test, and 4) Engineering Mathematics Summer Boot Camp. The authors would like to present data about these projects and initiatives and would like to get input and feedback on how these can be polished to perform better going forward.**

Index Terms – Placement exam, math preparation, summer boot camp, pre-calculus courses, supplemental instruction, tutoring and peer mentoring.

INTRODUCTION

As a standard practice in many four-year colleges, NJIT requires new incoming first-year students to take a mathematics placement examination before their orientation. The result of the placement examination is used to gauge the student's background and competency in various mathematics topics and determine the level of mathematics (calculus I or pre-calculus courses) the student will begin in his/her first semester. For engineering students in the Newark College of Engineering (NCE) at NJIT, this is particular crucial; as the calculus sequence is a prerequisite to courses in engineering topics. Any delay in the completion of the calculus sequence would have drastic impact on the student's time to graduate. Figure 1 shows the additional pre-calculus courses needed for NCE students who do not start at the recommended starting point. Students that are placed in MATH108 may take up to a year or even more before they can take courses related to engineering.

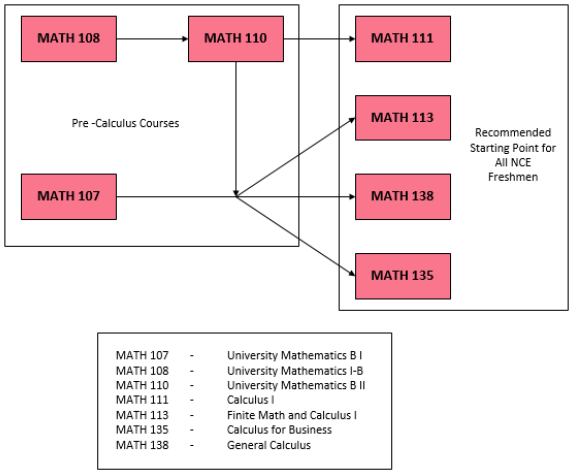

FIGURE 1
PRE-CALCULUS COURSE SEQUENCE

This work-in-progress paper investigates some of the reasons why students do not do well on the NJIT placement test. For each of these reasons identified, NJIT has implemented various initiatives to help students start on track in their first semester. Some of these initiatives include 1) developing sample placement tests for students to practice under the same environment as the original test, 2) making a placement calculator for students to input the scores from the practice placement tests to determine their likely mathematics placement, 3) establishing a strong outreach to educate students about the impact of their mathematics placement on their engineering curriculum and motivating them to do better on the placement test, and 4) Engineering Mathematics Summer Boot Camp.

A thorough analysis of placement test results, and results of retakes was performed. It indicated that a high number of students were overwhelmed by the test because it was unlike anything they had faced before. There are also a number of students every year that perform better on retakes indicating that they did not take the placement exam seriously or lacked practice in general. In order to help students improve their performance on placement tests, NCE Dean's office at NJIT developed practice tests and placement calculator.

In order to help first year students placed into either Math 108 or Math 110 better understand what their placement means for their respective degree plans, NJIT spent a great deal of time and effort developing and implementing marketing strategies. All deposited students were provided information about how to register for the Mathematics Placement Exam if they did not already have Advance Placement or transfer credits. At open house events our team would review the importance of math for STEM majors, the impact on graduation timeline and what options are available to students to prepare and/or catch up during the summer before their first full time semester. In addition to this, a student who received placement into Math 108 or Math 110 would immediately see information about their summer options (retake the placement exam, attend a community college course equivalent, or attend the Pre-Calculus Summer Boot Camp) in a placement email, followed by a letter sent to the home address on file. During summer orientations we provided an additional layer of follow up and education during breakout sessions that directly explained what their placement means for their math at NJIT, their degree, and their graduation time line.

NJIT has been offering pre-calculus courses and supplemental instruction as part of summer boot camp since Summer 2015. However, several students are not able to take advantage of such camps due to financial or personal reasons. Many students also feel that this is their 'last summer' before they enter college and 'hard-work' phase of their lives. Outcomes of the pilot offering and subsequent updates were presented at past First Year Engineering Education conferences [1-2]. While offering coursework in mathematics; NJIT boot camps also offers activities and programming to get students adjusted to the college environment and the academic support that is available to them as well as help with time management, learning style, self-advocacy among other things [1-2]. Educational researchers have looked at 'Bridge to Success' programs and shown their importance in preparing students for the academic rigors of college [3-4]. Many universities have reported successful implementation of summer boot camps [3-5] and studies [6-12] have shown positive impact on student retention and persistence.

PRACTICE PLACEMENT EXAM PORTAL

Looking at the data for student performance on math placement exam for past three years, it was observed that in general, for every student placed in Calculus-I, there is one student who is placed in one of the pre-calculus courses. This is an interesting observation because the overall student profile at NCE and in general at NJIT has been improving every year. This should have resulted in more students being placed directly in Calculus-I. Although this number is growing, it is not growing in accordance with growth in students' SAT scores and high-school GPA. It was therefore concluded that students are caught off guard when they show up to take the math placement exam. There are several possible reasons for this. Two of the reasons are related to lack of preparation and the fact that students are not familiar with placement exam portal and they are not allowed to use calculators. NCE Dean's office and Placement Testing office at NJIT reached out to MapleSoft – the company that offers placement exams based on pre-set criteria. Together, we were able to develop two practice tests in each of the three categories: basic algebra, advanced algebra, and trigonometry and functions. Figure 2 and 3 show front page of the practice exam portal and one of the sample questions. Students are given unlimited attempts and shown correct answers at the end of each test. In addition, several other sample questions have been developed by NJIT Math department and are available on the home page of NJIT's Placement Testing Office.

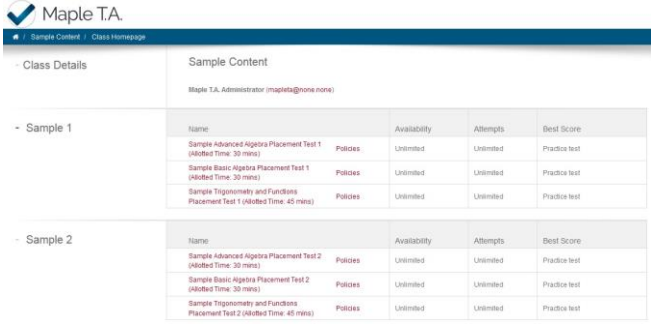

FIGURE 2

PRACTICE PLACEMENT TEST PORTAL – FRONT PAGE

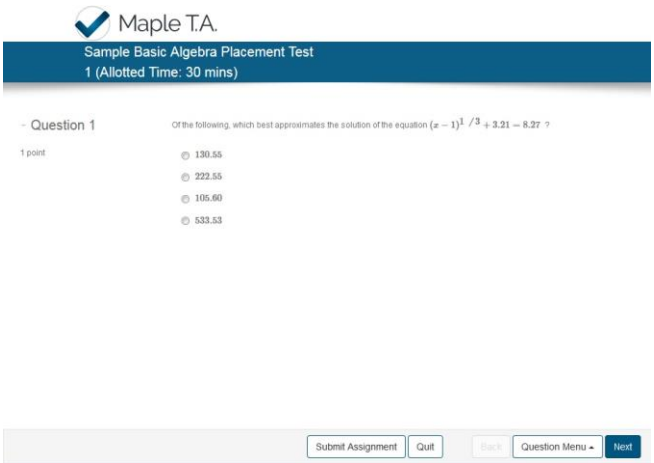

FIGURE 3

PRACTICE PLACEMENT TEST PORTAL – SAMPLE QUESTION

Although, we could not figure out a way to automatically track number of students taking these practice tests, our hope is that most students will come better prepared for the Math Placement Test and will be placed higher. We have developed a small survey to be administered during New Student Orientation scheduled for later in June 2017 (Appendix-I). This survey will give us an idea about number of students who knew about Practice Exams and took advantage of them. We will also compare placement numbers from 2017 to past years to gauge how useful practice tests have been to incoming freshmen.

ESTIMATED PLACEMENT CALCULATOR

Since its implementation, Math Placement Exam performance has been a very good indicator of preparedness in Math of incoming freshmen. Students are tested in three areas on the Placement Exam: Basic Algebra, Advanced Algebra, and Trigonometry and Functions. Very good performance on the Placement Exam will place students in Calculus-I, the recommended starting point for engineering programs. Poor performance will land them in one of the two pre-calculus courses. Although, students were always made aware of this general information; they were not familiar with exact cut-off scores for these placements. Even when these cut off scores were communicated to students, they found it difficult to follow. The cut off scores for Fall 2017 entering class, who will be tested in Spring and Summer 2017:

- For placement in Math 111 (Calculus-I):
  Adv. Alg. + Trig. >= 35
- For placement in Math 110:
  Bas. Alg. + Adv. Alg. >= 30
  AND
  Bas. Alg +Adv. Alg. + Trig. >= 45
- For placement in Math 108
  If neither of the above criteria are met.

Some students and advisors found these criteria a little complicated to follow and asked for a simple tool that will translate placement scores into estimated placement. In response to this request, University Information Systems department at NJIT developed a web-tool where students can input their practice or Placement Exam scores and the output will be their estimated placement. Figure 4 shows this web-tool in action.

We are using Google Analytics to track usage of this website. This data will help us find out how useful this tool has been. As of May 31, 2017, this website was accessed over 300 times and by 175 unique users. The authors plan to keep tracking this data and present most up-to-date number at the conference presentation.

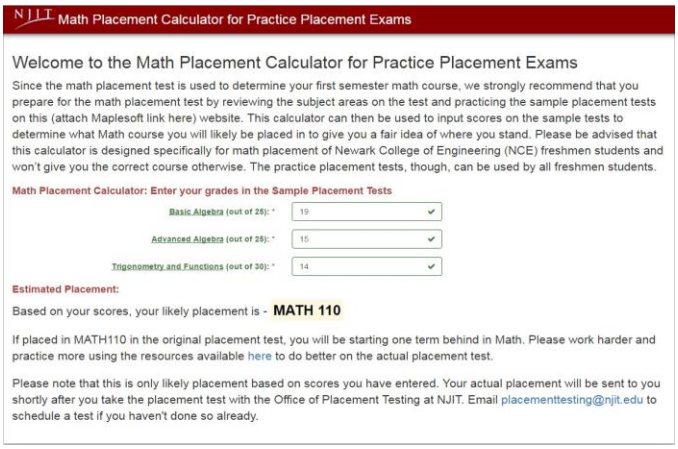

FIGURE 4

ESTIMATED PLACEMENT CALCULATOR – SHOWING RESULTS FOR MATH-110

SUMMER BOOT CAMP 2016 OUTCOMES

In the summer of 2016 the Pre-Calculus Summer Boot Camp completed its second program cycle. In the 2016 program, a total of 38 students enrolled in three pre-calculus courses: MATH107 (University Mathematics B I), MATH108 (University Mathematics I-B), and MATH 110 (University Mathematics B II - Trigonometry and Differential Calculus). As indicated in Figure 6, 35 students moved to next course in Mathematics sequence by securing C or better grade, 1 student withdrew and 2 received D or F grades and were unable to move to next course. The total number students enrolled, is lower than past years and a reason for concern. Students are offered a number of options to address their placement in pre-calculus courses and the boot camp is only one of them. As mentioned earlier, a lot of students are unable to take the boot camp because of financial or personal reasons, but do choose to retake the placement test and/or take an equivalent course at a community college near their residence.

When this cohort was asked to rate their experience with the course, workshops and supplemental instruction the overall feedback from respondents was very positive. Of the students who participated in the Pre-Calculus Summer Boot Camp 88% rated the supplemental instruction "good" to "great" and 87% of the students rated the program overall as "good" or "great". Qualitative feedback included the following themes:

- Gaining insight into academic life
- Learned how to manage college workload
- Learned better study habits
- Sense of being prepared
- Confidence in mathematics education

In looking at student's academic performance combined with student satisfaction and qualitative feedback the program appears to have strong initial impact on students' academic performance. While this initial impact is

encouraging it will be important to continue to review, track and analyze the long term impact on student academic performance and retention compared to students who do not participate in this program. NJIT's boot camp has been offered one more time this summer and will provide basis for a comprehensive analysis of short term and long term impact. Result of this analysis will determine the future of the program. Although, NJIT will continue to offer pre-calculus courses during summer entire as part of boot camp or stand alone courses.

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APPENDIX - I

NCE – New Student Orientation Survey

1. Did you know about the practice placement tests before attending this session?

☐YES ☐NO

2. Have you taken at least one of the available practice tests?

☐YES ☐NO

3. If you answered yes to question 2, please rate the helpfulness of the practice tests on a scale of 1-5 (1 being least helpful and 5 being most helpful)

☐1 ☐2 ☐3 ☐4 ☐5

4. Did you know about the placement calculator before attending this session?

☐YES ☐NO

5. Have you used the placement calculator to calculate your estimated placement?

☐YES ☐NO

6. If you answered yes to question 5, please rate the helpfulness of the placement calculator on a scale of 1-5 (1 being least helpful and 5 being most helpful)

☐1 ☐2 ☐3 ☐4 ☐5

7. Do you have any suggestions to improve the practice placement tests and/or the placement calculator?