Math Placement and Academic Achievement: An Internal Analysis

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The results presented here offer preliminary insights into the course patterns and academic achievement of students taking entry-level math courses at Johns Hopkins University (JHU) from Fall 2017 through Fall 2021. First, we used students' math placement exam results and end-of-semester grades in their first math course to predict academic achievement when considering whether students followed their placement recommendation. Second, we compared trends in placement data and academic achievement of students taking math courses at JHU before and during the COVID-19 pandemic.

Keywords: Math Placement, Contradictory Recommendations, Entry-Level Courses

Empirical evidence suggests undergraduates' persistence and interest in majoring in STEM fields are associated with their achievement (Chen, 2013) and experiences in entry-level and first-year STEM courses (Bressoud et al., 2013; Crisp et al., 2009; Gainen, 1995, Seymour & Hewitt, 1997). Considering many students must take the recommendations of a math department (Apkarian et al., 2017), it is important that departments review their math placement processes and recommendations to students on a regular basis, a common practice of successful calculus programs (Bressoud & Rasmussen, 2015).

The Math Placement Exam (MPE) at Johns Hopkins University (JHU) is broken into two parts, MPE1 and MPE2, which provide unique course recommendations. Aggregating data from Fall 2017 through Fall 2021, we conducted a binary logistic regression using students' first-semester course grades as the outcome variable. The placement recommendation and the course a student took served as the independent, nominal variables. Our study focused on students who were recommended to take precalculus, calculus I, or calculus II.

Many students at JHU taking calculus courses are on a pre-medical track and, thus, aim to earn a relatively high GPA in preparation for applying to medical school. As a result, it was important for us to choose a grade threshold for our binary outcome variable that reflected our Department's efforts to "prepare students to be numerate citizens and productive employees" while conducting this internal review of the MPE (American Mathematical Association of Two-Year Colleges, p. 14). In turn, we chose a grade of B- or above as the grade threshold.

Preliminary results suggested that students who were recommended to take precalculus or calculus I on MPE2 were statistically significantly less likely to earn a grade of a B- or better if they took the course they were recommended for when compared to students who 'jumped' one course above their recommendation (e.g., were recommended for precalculus and took calculus I). Students recommended to take calculus I by MPE1 or MPE2 who took precalculus were less likely to earn a B- or better when compared to those recommended for calculus I who took calculus I. A similar pattern held for students recommended to take calculus II on MPE2 but who took calculus I. Finally, only for the 2020 and 2021 cohorts did students receive contradictory recommendations to take calculus I (on MPE1) and precalculus (on MPE2). The preliminary findings presented here may be used to inform other institutions in their review of how students are placed into calculus-sequence courses while considering how to measure the mathematical preparedness of students affected by the pandemic who are now entering college.

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Background and Motivation

Undergraduates' persistence and interest in majoring in STEM fields are associated with their achievement (Chen, 2013) and experiences in entry-level and first-year STEM courses (Bressoud et al., 2013; Crisp et al., 2009; Gainen, 1995, Seymour & Hewitt, 1997).

Considering many students must take the recommendations of a math department (Apkarian et al., 2017), departments should review their math placement processes and recommendations to grow successful calculus programs (Bressoud & Rasmussen, 2015).

Research Questions

1. Aggregating data between Fall 2017 and Fall 2022, where are students ending up after their placement recommendation results?
2. Are placement recommendations indicative of performance in the math class they first take?

Context

Many students at JHU taking calculus courses are on a pre-medical track.

- Only 9 (2%) did not make the grade satisfaction of a C- or better.
- 1,746 of 5,534 (31.6%) students between 2017 and 2021 did not meet the grade satisfaction cutoff of a B- or better.

Math Placement Exam

The Math Placement Exam (MPE) at Johns Hopkins University (JHU) is broken into two parts, MPE1 and MPE2, which provide unique course recommendations:

- Students with no prior calculus experience take MPE1 (makes recommendations for precalculus or calculus I).
- Students with some calculus experience, then take MPE2 (makes recommendations for precalculus, calculus I, calculus II, or one of calculus III, linear algebra or differential equations).
- If MPE2 recommends precalculus, then students go back and take MPE1.

Model

Binary Logistic Regression:

- Outcome variable: First-semester course grades categorized into two groups using a threshold of B- or better.
- Independent variables: Placement recommendation and the course a student took.

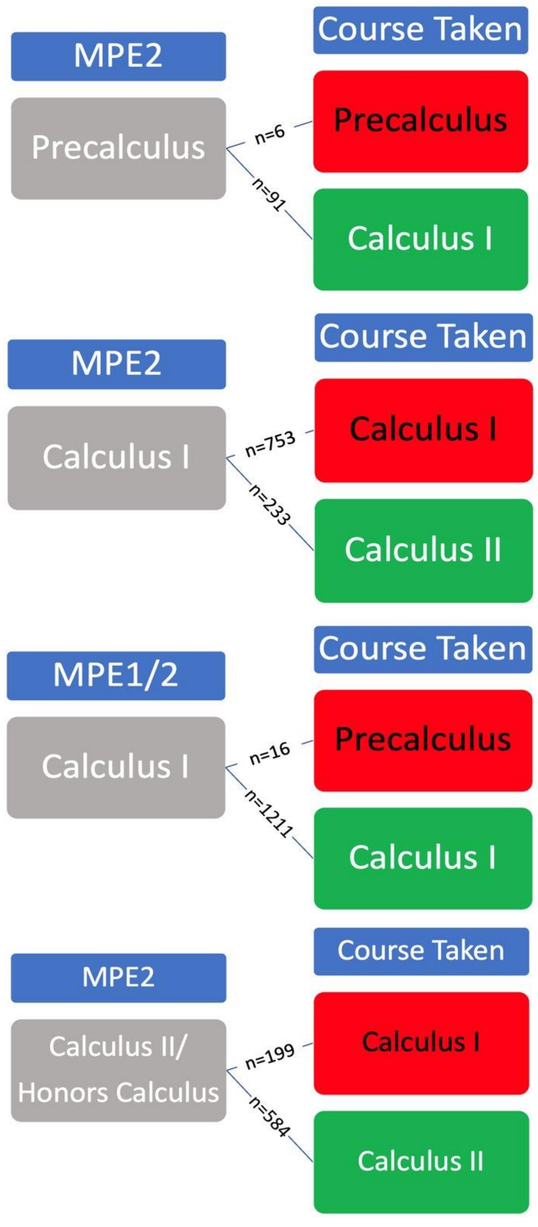
$$P(s_i) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 Rec_i + \beta_2 Take_i)}}$$

where $P(s_i)$ is the probability student i earns a B- or better considering they are recommended for course Rec_i and take course $Take_i$ (could be different from recommended course).

Results

We report on students who were recommended to take precalculus, calculus I, or calculus II.

Red - less likely to earn at least a B-
Green - more likely to earn at least a B-



Contradicting recommendations (MPE1 recommends calculus I, MPE2 recommends precalculus):

This impacts a small (n=69) group of students and only occurred in the 2020 (n=39) and 2021 (n=30) cohorts.

Conclusions and Next Steps

Strengths

MPE2 is doing a reasonable job of recommending students for calculus II or above.

Weaknesses

Neither MPE1 nor MPE2 are effectively sorting students into precalculus or calculus I.

1. Update the placement tests based on what we have learned and STEM-preparedness literature from ALEKS and "Minding the Gaps" (Kornelson et al., 2020).
2. Connect with advising (broadly) and admissions to inform changes and share outcomes.
3. Discuss a path for those who receive contradicting recommendations.
4. Continue to build peer-to-peer networks, mentoring relationships with faculty, and other outside-of-class supports found to help female and students of color remain and succeed in STEM fields of study (Ellington & Frederick, 2010; Griffin et al., 2010; Palmer et al., 2011; Seymour & Hewitt, 1997).
5. Track changes and continue tracking efficacy of recommendations from the tests.

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