

WIP: The Retention Impacts of a Math Bridge Program for Incoming First-Year Engineering Students at a Regional Public University

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Abstract

Math preparation is an essential part of pre-degree readiness for engineering students and often incoming freshmen struggle retaining these important pre-Calculus concepts for successful completion of Calculus courses and beyond. In 2005 at the University of Z, the Math Bridge program was developed to help refresh Algebra and Trigonometry skills for incoming freshmen STEM students. After the completion of this program, students are given the opportunity to take or retake the Math Preparation Exam (MPE) to potentially start college at a higher math level than they otherwise would be advised to take. Similar preparatory math programs are used across America and Canada to prepare students in engineering for the heavy math workload the degree requires. Since 2020, the University of Z has allowed test optional enrollment with no restrictions on declaring a major in the College of Engineering and an incoming freshman. In this paper, the authors examine the impact of the program by evaluating the performance related to course success and overall retention of freshmen students after completing the Math Bridge program compared to other students in the College. Of the students who participated in the Math Bridge program from 2020-2025, around 30% were able to move to a higher math class by retaking the MPE, saving tuition cost and time to graduation. The cohort of students who participated in the Math Bridge program were, on average over a 5 year period 4.2% more likely to be retained at the University.

Introduction

Math preparation is a key indicator of success for incoming freshmen in engineering programs [1]. Indicators of this success can include retention in the engineering college, retention at the university and successful completion of the degree within 4 years [2]. To address math preparation, some engineering colleges have integrated precalculus coursework into the engineering curriculum [3]. Other programs, like the Engineering College at Texas A&M, have developed Math Bridge programs to help students who are coming into the program without proper math preparation [4].

The adoption of Math Bridge Programs lies in the need to provide remedial education at American universities. Research indicates that a significant proportion of incoming students—estimates often exceed 60% in community colleges—are referred to developmental education, a pathway associated with high attrition and delayed graduation [5]. Math Bridge Programs function as an intervention, typically occurring in the summer preceding the freshman year. Unlike traditional developmental courses which consume a full semester and tuition dollars without yielding degree credit, bridge programs utilize a "bootcamp" model ranging from one to six weeks. Modern iterations frequently employ adaptive courseware to diagnose specific knowledge gaps—such as deficiencies in intermediate algebra or trigonometry—allowing for rapid content mastery [6].

Empirical evidence suggests that bridge programs contribute positively to student success metrics, particularly regarding retention and degree completion. In a study of a five-week summer bridge program, Murphy et al. [7] observed that participants demonstrated significantly higher 6-year graduation rates compared to a control group. These programs are also increasingly pivotal in STEM retention efforts. A meta-analysis found that university STEM bridge programs yielded a medium-sized effect on first-year cumulative GPA and significantly improved first-year retention rates [8]. The success of these interventions is often attributed not merely to content acquisition, but to the social benefits of the bridge model, which fosters self-efficacy and integrates students into the university's academic support network prior to the onset of the fall semester [9].

Math bridge programs for engineering students are intensive, transitional programs designed to solidify an incoming student's mathematical foundation and ensure they are calculus-ready for their university studies. Typically held during the summer, these programs address the common gap between high school math and the demanding expectations of college engineering courses. The core curriculum focuses on an intensive, rapid review of prerequisite topics like advanced algebra, trigonometry, and pre-calculus concepts, often taught with an applied engineering context to demonstrate real-world relevance. A significant outcome is the opportunity for students to improve their standing on the Math Placement Exam (MPE), allowing them to place directly into higher-level courses, which saves time and avoids the cost of remedial coursework. Ultimately, participation in these bridge programs has been shown to positively impact students' first-year GPAs and overall retention rates within challenging STEM majors like engineering. Math bridge programs have shown success in helping undergraduate engineering students start at a higher math level, which helps students move to engineering courses quicker [10]. Math bridge programs at other institutions have shown success in helping students start at a higher math course level, with students achieving a similar pass rate as other students, in spite of some struggles with course load [11].

The Math Bridge Program in the College of Engineering at the University of Z has been run since 2005, and is available to incoming engineering freshmen. Since 2020, the University has allowed test-optional enrollment generating cohorts of students that have a decrease in math preparatory skills. The program is offered to all incoming students the week prior to the beginning of the Fall semester for a fee to cover expenses. Students are permitted to move into campus housing early as well. The program involves on-campus math tutoring from a faculty member in the Department of Mathematics at University of Z, with the help of two or three current engineering students who have completed Calculus 2. The program not only supplies math review curriculum by an instructor, but the students are provided the opportunity to develop a learning community with upper-classmen peer mentors that can lead to an increased sense of belonging, which has been shown as an important factor to increase retention. The

week-long program involves Pre-Calculus Algebra instruction the first two days, followed by Trigonometry instruction the next two days, with the Math Placement Exam offered on the final day.

Methods

To assess the effectiveness of the Math Bridge Program in the College of Engineering at the University of Z, data from 2020-2024 was assessed. The total number of students who participated in the Math bridge program was then compared to the total number of students who chose to take the Math Placement Exam (MPE) after completing the program. The participants of the program had already enrolled in Fall courses, so the math course they were currently enrolled in was determined by the ACT scores or other methods. If participants chose to take the Math Placement Exam after the Math bridge program and the score allowed them to place in a more advanced math course that they were currently enrolled in, that would be a benefit in time to graduation and overall cost. The number and percentage of participants who increased the math course enrolled was also collected and analyzed. Further, the students who were retained after completing the Math bridge program were compared to the overall retention of the College of Engineering during the same period. This analysis included the retention or graduation to 2025 of both groups for all cohorts; meaning that each cohort was assessed over a 1, 2-, 3-, 4-, and 5-year period and included in the overall average.

Results

Between 2020 and 2024, 58% of the participants chose to take the Math Placement Exam and 30% of those students were able to move into a higher math class. The annual values for participation in the program and the percentages are presented in Figure 1. As can be seen, there has been annual variation in the percent of students participating in the Math Bridge program who have been able to move up to an increased math class. For example, in 2020 50% of participants moved up while in 2023, 13.6% were able to move up to a higher math class. This variation is a product of the small sample size of cohorts included in this study and is dependent on numerous factors including the math readiness of the students in the cohort.

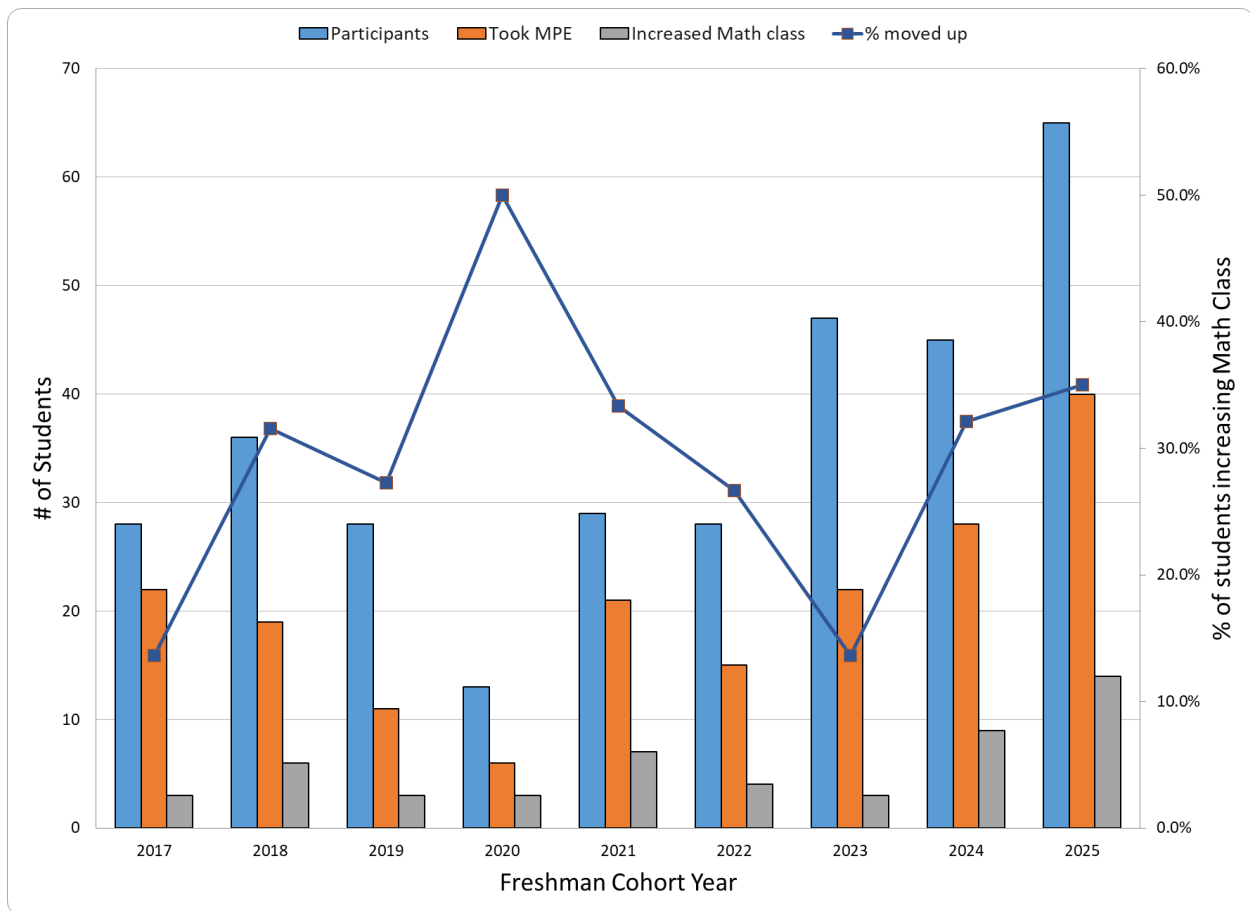


Figure 1. Math Bridge and MPE Participation and Success

Overall, from 2020 to 2024, a 4.2% greater proportion of students who completed the Math Bridge program were retained or graduated in the College of Engineering at University of Z than the general College of Engineering population during that period. Roster data for 2017 through 2019 was limited, so the retention rates related to cohorts prior to 2020 are unavailable. Further, this analysis is focused on freshmen cohorts after the test-optional policy was enforced, which has potentially altered the math-readiness of the engineering student population.

Conclusions

The Math Bridge program at the University of Z appears to have helped with efforts at retaining students who enter the College of Engineering. The Math bridge program provides incoming freshmen opportunities for “derusting” math skills, generating an increased sense of belonging, or verifying their level of math skillset. With an overall average increased retention and graduation rate of 4.2%, over the 5 year period, performance of the program compares favorably with the overall average retention of the College during the same period. Additionally, over the period 2020-2024, 30% of students who participated in the Math Bridge program were able to

increase their math testing scores and therefore be placed in a higher-level math class, saving the students time and cost. This not only increases the retention rate of these students, but reduces the financial burden on students by reducing the number of years and classes needed before graduation. Future work will analyze and compare the retention and graduation rates of cohorts from both groups and how the results of program success at this university compares with similar programs at other peer and peer-plus institutions. Further, these cohorts include a variation of math-preparedness that requires additional segmentation to generate the success of the program as well as identify the need for further intervention.

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