

## Bridge Programs for Engineering Calculus Success

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*Mathematics is often the gatekeeper for students aspiring for a college degree in any field. A precalculus bridge program to improve success in the engineering calculus sequence was initiated at Texas A&M University in summer of 2010. Students who placed into precalculus were offered the program. The program was revised and additional bridges were added. Surveys were administered to examine student beliefs about college level mathematics expectations and requirements. Overall, the programs benefited hundreds of students.*

*Keywords* - calculus, bridge program

Success in engineering programs is highly dependent on mathematics knowledge, but many freshmen entering college lack the preparation needed for success in their college mathematics coursework. This deficiency limits their future career opportunities (Achieve, 2008). Bridge programs have been used to support students' mathematics knowledge and skills during the summer prior to college coursework (Conley, 2008). These programs often cost institutions considerable revenue and staff resources (Kallison & Stader, 2012). Bridge programs were often used to specifically assist first generation college students and those of low socio-economic status (Grimes & David, 1999; Inkelas & McCarron, 2006). Results have been mixed (An, 2012), but positive results have been reported (Gamoran, Porter, Smithson, & White, 1997).

A precalculus bridge program was initiated at Texas A&M University to help engineering students prepare for college level mathematics workloads. The university enrolls about 3,300 freshman engineering students each fall (60% white; 26% Hispanic; 24% female; 76% male). Students who did not meet the cut score on the Mathematics Placement Exam (MPE) for Engineering Calculus I were offered the Personalized Precalculus Program (PPP). Studies for various cohorts have shown improvement on the MPE (Morgan, Nite, Allen, Capraro, Capraro, & Pilant, 2015; Nite, Allen, Morgan, Bicer, & Capraro, 2016) and performed as well in calculus as their peers with similar backgrounds (Nite, Allen, Capraro, Bicer, & Morgan, 2016; Nite, Morgan, Allen, Capraro, Capraro, & Pilant, 2015). Students who spent more time were more successful (Nite & Allen, 2014a; Nite, Allen, Bicer, & Morgan, 2016). Results from surveys identified areas in which students lacked confidence (Nite & Allen, 2014a) and student beliefs and expectations for college mathematics study (Nite, Allen, Bicer, Morgan, & Barroso, 2017).

A bridge to Engineering Calculus II was added for continued support (Nite & Allen, 2014b; Nite, Morgan, Allen, Capraro, & Capraro, 2015), and finally, a precalculus program for students who met the cut score on the MPE (Nite, Morgan, Capraro, Allen, & Capraro, 2014). The overarching question is "What impact did the three bridge programs for engineering calculus courses have on student success in their college mathematics courses?"

Results for the bridge programs have shown a positive impact overall, with statistical significance in MPE improvement ( $p < .05$ ), and course pass rates have been acceptable. Students have difficulty with study behavior and time commitments for college mathematics. Therefore, future bridge programs should consider other factors in addition to mathematics knowledge and skills to improve success for students in college mathematics. Bridge programs to support non-STEM majors in their mathematics could be an effective strategy to improve perseverance toward completing college degrees for at-risk populations.

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