Development and Change in Motivational and Self-efficacy Beliefs in Calculus: Relations With STEM Retention

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Retention in science, technology, engineering, and mathematics (STEM) disciplines continues to be an important focus in higher education, with many institutions seeking to enhance student persistence in these disciplines. Previous studies have shown that a higher sense of belonging, self-efficacy, and perceptions of the usefulness course curriculum (e.g., utility value) relate to higher rates of persistence (Tinto, 2017). However, high rates of attrition among students who initially declare a STEM major still exist (e.g., Brewer et al., 2021; Cromley et al., 2016; Doerschuk et al., 2016; Sithole et al., 2017). Previous studies have noted that students' personal characteristics such as motivational and self-efficacy beliefs, academic backgrounds, and institutional factors such as policies related to course sequencing, registration, and grading are factors that play a part in STEM retention (Cromley et al., 2016; Green & Sanderson, 2018). Students who do leave STEM degrees often cite negative experiences in introductory level courses, such as calculus, as their primary reason for leaving (Ellis et al., 2014; Rasmussen & Ellis, 2013; Seymour & Hewitt, 1997). These early courses are often framed as being gateway or "weed-out" courses (Lee et al., 2024). Previous research has noted that students often experience declines in motivation in these courses (Perez et al., 2014), with students enrolled in calculus classes reporting significant declines in their confidence, enjoyment, and desire to take additional mathematics classes (Bressoud et al., 2013; Sonnert et al., 2015).

Given that calculus is a foundational course supporting many STEM majors, it is important to investigate the nature of students' experience in calculus, changes in motivational processes and beliefs in calculus, and the role of such changes in predicting students' intention to remain in STEM. The goal of the present study is to conduct such an investigation through a longitudinal analysis of the utility value, complexity, and general and task-based self-efficacy beliefs of students enrolled in a first-semester calculus course. A survey was implemented across four time-points consistently after completion of common course exams. Our research is framed by the following questions:

- How do students' motivational and self-efficacy beliefs change over time?
- How does the nature of students' change in motivational and self-efficacy beliefs relate to their intent to remain in a STEM degree?
- How do students' motivational and self-efficacy beliefs predict their academic achievement?

Data analysis is ongoing. However, the analyses will provide insight into several key areas addressing student retention and support in STEM. By understanding the nature of change in students' motivational and self-efficacy beliefs in a first semester calculus class along with the nature of students' experiences, we can gain insights into how best to support students. Pedagogical approaches that foster and bolster motivational and self-efficacy beliefs and promote positive learning experiences may be beneficial in promoting persistence.

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