Active vs. Traditional Learning in Calculus I

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In this poster, we describe an ongoing study on the effect of active learning in Calculus I. We compare the achievement gap between underprepared and prepared students in the active versus traditional setting. Data comes from 16 sections of Calculus I during the 2017 – 2018 academic year, targeting the concepts of limits, continuity, differentiability, and area. We present our study design and initial findings; we look forward to feedback as we enter the latter half of our project.

Keywords: Calculus, Active Learning, STEM, Achievement Gap

Calculus I is a foundational class in the degree plan of nearly all science majors. Calculus is a crucial benchmark in the path to a STEM education; however, many students rely heavily on memorization and repetition as paths to success in mathematics. These techniques fail when they are asked to explore the abstract concepts *of limits, continuity of functions, differentiability,* and *area*. One pedagogical approach to increasing student understanding and mastery is active learning. Active learning activities provide a setting for students to learn in cooperation with others, thus placing them in an excellent environment to construct complex mental frameworks (Bransford et al., 1999; Vygotsky, 1978). Existing literature supports the idea that active learning techniques can increase student learning outcomes significantly (Freeman et. al, 2014; Bressoud, 2011; Haak et. al, 2011; Boaler & Greeno, 2000). In this project, we study active learning specific to the calculus classroom, and target the population of students who enter with deficiencies in algebra, trigonometry, and/or pre-calculus. We explore the following questions:

- Do students who are underprepared for calculus perform better than their calculus-ready peers after learning in an active classroom versus a traditional classroom?
- Does the performance gap between underprepared and calculus-ready students change to a different extent in an active classroom as compared to a traditional classroom?
- Do students identified as underprepared for calculus have a more favorable perception of mathematics after learning in an active classroom as compared to a traditional classroom?
- Do students who learned in an active classroom see more success in Calculus II than those learning in a traditional classroom?

In this study, we compare student learning outcomes in four classrooms employing active techniques to outcomes in four traditional lecture-based classrooms in each of Fall 2017 and Spring 2018. We administer a pre-test assessment and initial survey in each classroom. We use the pre-test to identify students with weak preparation and to gauge students' attitudes and mindsets towards mathematics. The active sections discuss each of our target concepts: limits, continuity, differentiability, and area, using an exploratory activity, discussion, and follow-up assignment. The traditional sections cover the same content, but from a lecture approach. We assess learning outcomes by scoring performance on in-class exams and administer a post-test and survey (Carlson, Oehrtman, & Engelke, 2010). The survey will assess the changes in students' attitudes and mindsets about mathematics, as well as ask them to self-assess their preparedness for Calculus II. We intend to collect data regarding participants' persistence and success in Calculus II. At the conclusion of this project, we hope to better inform teaching practices in calculus at our institution.

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