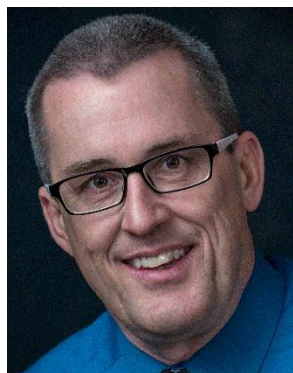


## Modernizing the Calculus Curriculum: The Product Rule

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Calculus 1 students from two urban community college campuses, one in the southwestern and one in the northwestern United States engaged in a series of task-based interviews. One task focused on student conceptual understanding and application of the product rule. After analyzing video data of all ten interviews, three major themes emerged: students' attempt to remember rather than to make sense, students' inability to recognize the need for a product of two varying quantities, and students' inability to conceptualize how two changing quantities are changing in tandem. In this article, we provide a description of the product rule task that was the focus of the interview and showcase the ideal ways of thinking envisioned from students' responses. Next, we unpack the aforementioned themes that emerged from the video data analysis. Finally, we share ideas for a pedagogical response to the issues that emerged from the research and encourage a response that is consistent with our vision for modernizing the mathematics curriculum.

Keywords: modernizing curriculum, the product rule, teaching calculus, student thinking



**Scott Adamson** is an award-winning mathematics professor, who strives to help students develop mathematical reasoning and persistent problem solving as they work to make sense of big mathematical ideas. He holds bachelor's and master's degrees in mathematics education from Northern Arizona University and a PhD in curriculum and instruction (emphasis on mathematics education) from Arizona State University. Scott currently teaches students at Chandler-Gilbert Community College, where he structures the classroom environment so that students are afforded the opportunity to actively make sense of mathematics, and he strives to develop enthusiastic learners in the classroom. He tells his colleagues and himself that we need to stop teaching mathematics and start teaching students! Certainly, we will teach our students the beauty, wonder, and utility of mathematics, but we must realize that the positive relationships that we build with our students are most important! In 2017, Scott gave a keynote address at the opening session of the American Mathematical Association of Two-Year Colleges, which led to a TEDx Talk called "*Is it 1957 or 2018?*"

**April Ström** is a mathematics professor at Chandler-Gilbert Community College, one of the Maricopa County Community Colleges in Arizona, where she has taught for over 27 years. April received her PhD in curriculum & instruction (emphasis in mathematics education) from Arizona State University, and she holds MA and BA degrees in mathematics from Texas Tech University. April's research background in mathematics education, coupled with her passion for teaching and learning, has prompted her to engage in various leadership roles in



national organizations, such as the U.S. National Academies of Sciences, the Mathematical Association of America (MAA), and the American Mathematical Association of Two-Year Colleges (AMATYC). April currently serves as the Principal Investigator for the NSF-funded Teaching for Prowess project, which focuses on implementing active learning in the first two years of college mathematics. April also co-led the writing of the “*Classroom Practices*” chapter of the 2017 MAA *Instructional Practices Guide* and served on the steering committee for the 2018 AMATYC *IMPACT* guide, both of which aimed to elevate active learning in mathematics in higher education.



**Scot Pruyn** is a mathematics instructor at Clackamas Community College in Oregon City, Oregon, where he has taught for over 10 years. Scot’s background in education started at the University of Kansas, where he earned his bachelor’s in secondary mathematics education and master’s in mathematics and worked as a tutor, teaching assistant, and graduate teaching assistant for several years. This background led him to understand the value in building connections with students and finding opportunities to engage in discussions, where students can communicate their thinking about mathematics. In his journey to becoming a student-focused instructor, Scot found the AMATYC organization a great resource. In 2020, he and his department were awarded an amazing opportunity in the form of the Teaching for PROWESS grant, an NSF-funded project focused on increasing the use of active learning in mathematics departments. He has worked towards this goal over the past several years as Co-Principal Investigator of the project.