

GIFTS: Reimagining the Early Calculus Experience

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Mary Katherine Watson is currently an Associate Professor of Civil and Environmental Engineering at The Citadel. She holds BS and MS degrees in Biosystems Engineering from Clemson University and a PhD in Environmental Engineering from The Georgia Institute of Technology. She enjoys, and has invested significantly, in the development of her undergraduate students, serving as past faculty advisor for numerous student groups. Dr. Watson is passionate about improving access to engineering education and serves as the faculty director for a scholarship program to recruit and support high-performing, low-income civil engineering students. Dr. Watson is also interested in understanding and assessing students' cognitive processes, especially related to sustainable design. Dr. Watson is the proud recipient of seven teaching awards and six best paper awards.

Dr. Simon Thomas Ghanat P.E., The Citadel

Dr. Simon Ghanat is an Associate Professor of Civil and Environmental Engineering at The Citadel (Charleston, S.C.). He received his Ph.D., M.S., and B.S. degrees in Civil and Environmental Engineering from Arizona State University. His research interests are in Engineering Education and Geotechnical Earthquake Engineering. He previously taught at Bucknell University and Arizona State University.

Dr. Timothy Aaron Wood, The Citadel

Timothy A Wood is an Assistant Professor of Civil and Environmental Engineering at The Citadel. He acquired a Bachelor's in Engineering Physics Summa Cum Laude with Honors followed by Civil Engineering Master's and Doctoral degrees from Texas Tech University. His technical research focuses on the intersection of soil-structure interaction and structural/geotechnical data. He encourages students pushing them toward self-directed learning through reading, and inspiring enthusiasm for the fields of structural and geotechnical engineering. Dr. Wood aims to recover the benefits of classical-model, literature-based learning in civil engineering education.

Dr. William J. Davis P.E., The Citadel

William J. Davis is Dept. Head & D. Graham Copeland Professor of Civil Engineering and Director of Construction Engineering at The Citadel in Charleston, SC. His academic experience includes: transportation infrastructure planning and design, infrastructure resilience, traffic operations, highway safety, and geographic information systems. His research interests include: constructing spatial databases for better management of transportation infrastructure, improving transportation design, operation, safety and construction, understanding long-term effects of urban development patterns, and advancing active living within the built environment for improved public health. He teaches courses in interchange design, transportation engineering, highway design, engineering management, geographic information systems, and land surveying. He has served in numerous leadership positions in ITE, ASCE and TRB.

Dr. Tara Hornor , The Citadel

Dr. Tara Hornor currently serves as Associate Professor and Coordinator of Higher Education Leadership Programs in The Citadel's Zucker Family School of Education. She previously served as Associate Provost for Planning, Assessment, and Evaluation and Dean of Enrollment Management at The Citadel from 2008-2019, providing leadership for the institution's strategic planning, accreditation, assessment, institutional research, admissions, financial aid, and graduate college offices. She holds a Ph.D. in Higher Education Administration from the University of Arizona and master's degrees in counseling, instructional design, and human resource management.

Dr. Kevin C Bower P.E., The Citadel

Dr. Kevin Bower is a Professor of Civil and Environmental Engineering and the Associate Provost for Academic Operations at The Citadel, Charleston, South Carolina. Dr. Bower's teaching research interests are in improving active learning environments and the development of classroom pedagogy to improve moral development in engineering students.

Re-Imagining the Early Calculus Experience

Calculus courses are often barriers to persistence in engineering. Several factors contribute to the difficulty of calculus courses, including low math self-efficacy. Self-efficacy is one's own personal judgements about their abilities to achieve specific goals. According to Bandura [1], there are several sources of self-efficacy: *mastery experiences*, *vicarious experiences*, *social persuasions*, and *physiological arousal*. We are piloting a cohort-based intervention designed specifically to improve retention of civil engineering freshmen through math self-efficacy building.

We created a new calculus experience for our pilot cohort (Figure 1). During the summer before their freshmen year, students participate in a residence-based experience to help them adapt to college life and complete Calculus I before the rigors of the academic year. To sustain students' math preparedness, while providing them with flexibility to manage other areas of academic life, we created a two-semester Calculus II sequence. During the entire experience, students have access to a peer mentor, personal coach, and supplemental instruction leader. Students also complete engineering seminars to connect math topics with future coursework and practice.

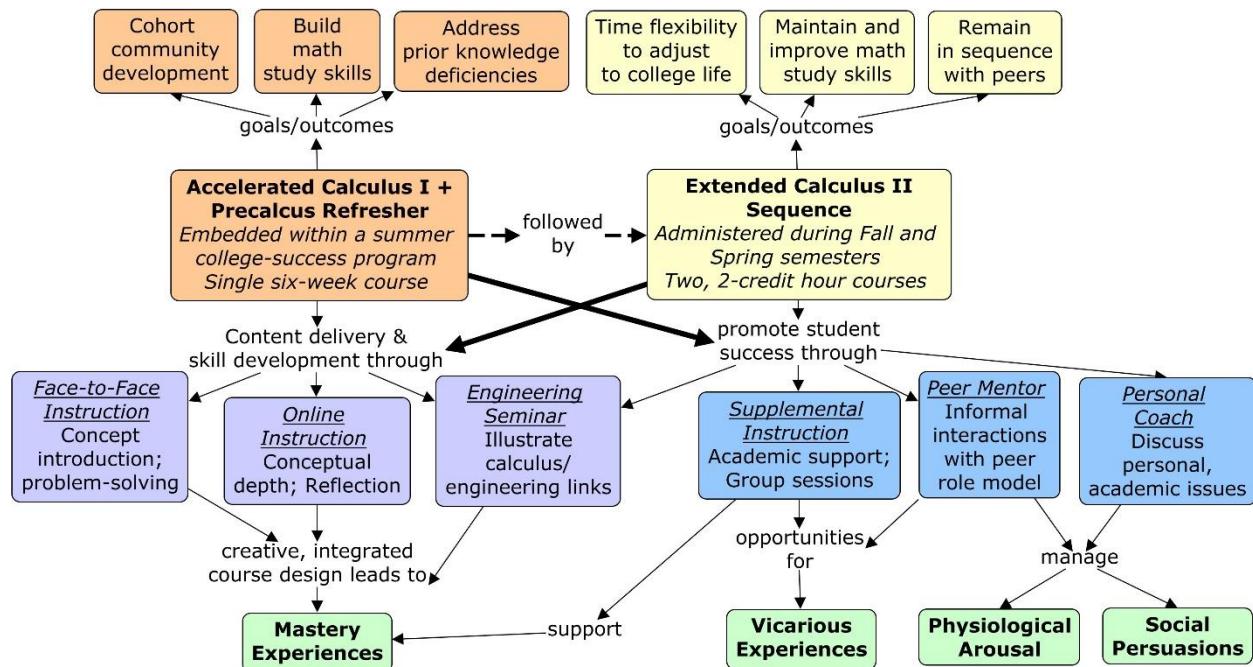


Figure 1. Pilot Calculus I/II sequence at The Citadel designed to build math self-efficacy.

We are assessing the impacts of our new calculus experience. Of the six pilot students, all completed courses with at least a "C" (Calculus I GPA = 3.33; Calculus II GPA = 3.25). Parallel Calculus I and II sections had average GPAs of 2.17 and 2.15 with DFW rates of 35% and 38%, respectively. In focus groups, students shared that they indeed valued their *mastery experiences*.

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