

The Quaternion

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UNIVERSITY OF
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Taming the Tiger: Calculus at USF

Calculus has long had the reputation as one of the hardest courses in the college curriculum — not just at USF, but around the world. Big data, tracking the number of students who drop, withdraw, or fail (DWF), has confirmed this reputation. How To Teach Calculus has become a major topic in mathematics education.

USF is making progress using a discovery- and inquiry-based teaching method in which students work in small organized groups that solve conceptual problems under the supervision and with the guidance of “peer leaders” (usually upper division undergraduates). This method was adapted from an approach called Process Oriented Guided Inquiry Learning (POGIL), which originated in chemistry programs, where introductory chemistry courses faced the same problems.

For a course that meets for four fifty-minute sessions a week, POGIL activities will take up one of those sessions. It will not involve the nitty-gritty material covered in the other three sessions, but instead focus on concepts. For example, the session introducing derivatives will start with intuitive questions involving distance and velocity, average velocity (as represented by the slope of a secant line) versus instantaneous velocity (as represented by the slope of a tangent line), and culminate with a “critical thinking question” like: “Explain how to find the instantaneous velocity of a car at a given time (say, at $t=1$), if you are given a graph or a formula of distance the car has travelled versus time.”



Peer group sessions are led by junior and senior undergraduates — “peer leaders” — who help the groups of calculus students learn how to solve problems. Here, peer leaders prepare for one of their sessions. In the forefront, left to right, Rebecca Gonzalez, Joseph McElroy, and Serena Rampersad. Coordinator (and mathematics graduate student) Scott Grizzard is behind Ms. Rampersad.

POGIL is one of several pedagogical approaches that were developed as researchers studying knowledge and skills retention found that lecturing is inadequate. For example, one study found that students retained 5% of the material presented to them in lectures and 30% of the material presented to them in classroom presentations. On the other hand, students engaged in “cooperative learning” and applying new knowledge and skills immediately retained 75–90% of the material. Such studies encouraged innovations like Discovery Learning and Small Group Learning, and as such innovations were tried and analyzed, techniques like POGIL were developed.

At USF, Jennifer Lewis of Chemistry brought POGIL to USF, and Catherine Bénéteau of Mathematics & Statistics adapted it for Calculus I. Students were assigned roles in their group: the Leader / Manager keeps the group on task, the Presenter / Spokesperson presents the finished work to the teacher or to the class, the Recorder / Secretary keeps notes and writes things reports and digests when necessary, and the Strategist / Reflector analyzes how the group works on problems and advises more effective problem-solving techniques.

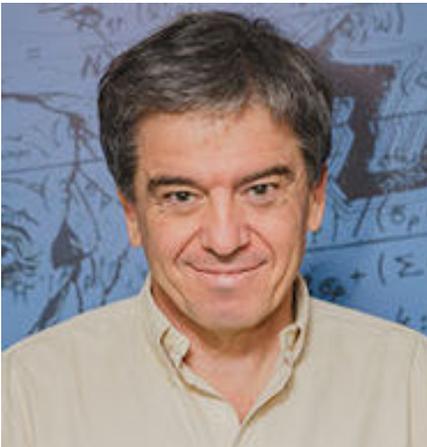
In their article in the *Journal of STEM Education*, Bénéteau et al reported that passing rates for Life Science Calculus I for sections with peer-leading was 68%, as opposed to 60% for other sections. The passing rate for Engineering Calculus I sections with peer leading was 63%, as opposed to 59% for other sections. Peer leading was subsequently expanded, and this year all mathematics major Calculus I sections have peer leading.

During the past few decades, public universities have gotten a new charge: teach calculus to an unprecedented number of students so that they can master it. The problem is not unique to Calculus and Chemistry: the National Science Foundation reported a first year retention rate of 64% in STEM fields during the 1990s, and at USF, comparing the number of declared majors versus the number of degrees awarded, approximately half of the Biology, Chemistry, Engineering, Physics and Mathematics majors eventually get baccalaureate degrees in their chosen subject. At the same time, financial constraints limit the number of instructors, so classes are getting larger.

The bottom line is that learning calculus is not really about learning a body of knowledge — it is about acquiring a skill set. Being proficient in calculus means being able to solve real problems with one of the most powerful (if difficult) toolkits ever developed. And USF is at the forefront in applying new pedagogical techniques to help our students succeed.

People

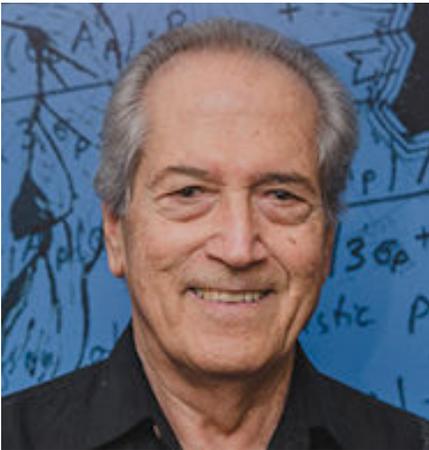
We have some news from the past few months.



Milé Krajcevski helped organize the annual Florida Section meeting of the Mathematical Association of America, which met at Polk State College in Lakeland on February 15 & 16. The MAA met jointly with the Florida Two-Year College Association and the meeting featured four plenary speakers, 46 contributed sessions, a panel discussion, and two contests. (Professor Krajcevski is the Vice President for Programs for the Florida Section.)



Clarivate Analytics (the publisher of the Web of Knowledge), lists **Wen-Xiu Ma** as one of the 90 most Highly Cited Researchers in mathematics worldwide. Research Fronts 2018, a publication of Clarivate Analytics and the Chinese Academy of Sciences, reported that “Research on nonlinear evolution equations continues to be a hot Research Front,” particularly “Solutions for typical nonlinear evolution equations and their applications.” They report that Professor Ma and his team published nearly half of the core papers in this field, including seven of the ten most-cited papers.



Manoug Manougian received the 2018/19 NASA-sponsored Florida Space Grant Consortium's \$1,000 award. The funds will support the USF Society of Aeronautics and Rocketry. Recently, Manoug was interviewed by CNN-International concerning his space program in the early 1960s at Haigazian University in Beirut, where he taught Math and Physics and initiated the Lebanese Rocket Society. During 1961–1966, he and his students produced and launched twelve one-, two- and three-stage rockets. Three of these crossed the Karman Line. In February 2018, CNN International aired the interview throughout the Middle East and beyond.

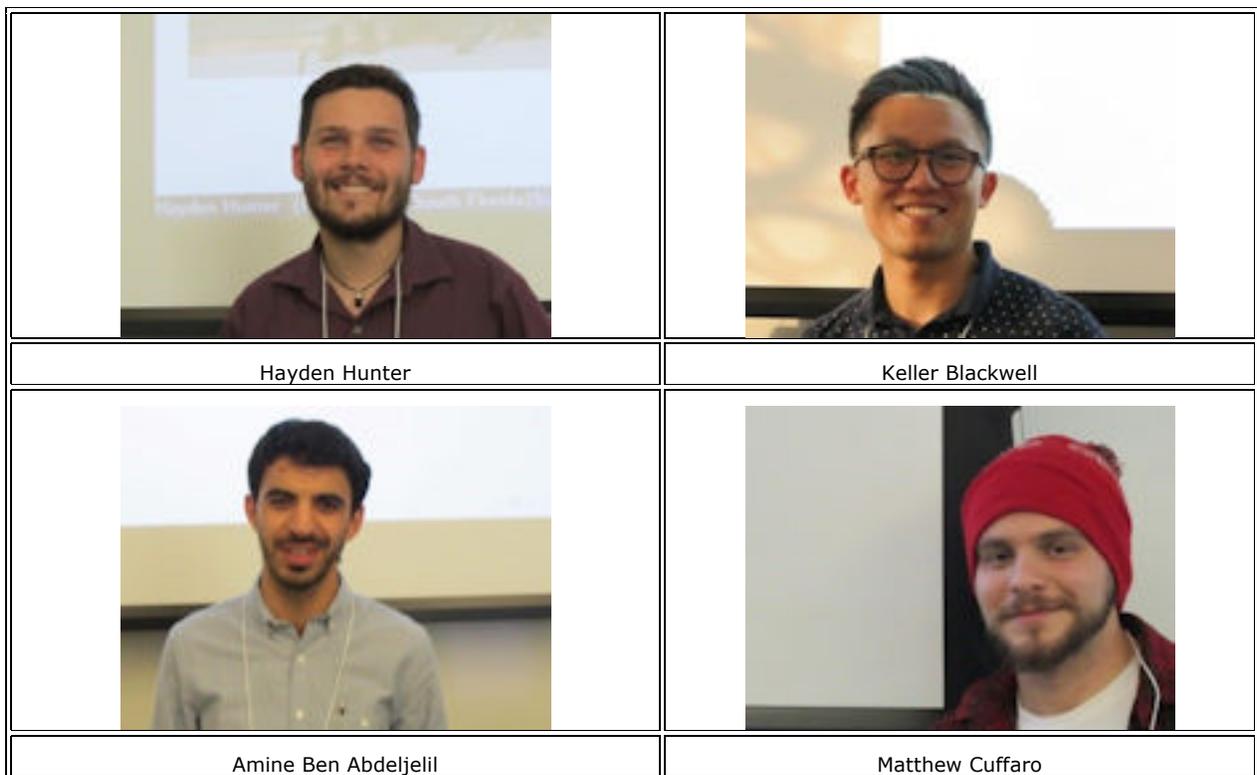


We regret to report the passing of **Wai Cheung (Stephen) Suen**, a good friend and colleague, on February 6, 2019. Stephen came to USF in 1993 and retired in 2016. He was educated in the United Kingdom, receiving his doctorate from the University of Bristol in 1985 under Geoffrey Grimmett. He then taught at the City University of Hong Kong and later Carnegie-Mellon University, before coming to USF in 1993. His research area was combinatorics and algorithms, and he specialized in applications in the “probabilistic method” in which, for example, one demonstrates the existence of an object by proving that in a certain experiment, there is a nonzero probability of finding it. He was one of 511 mathematicians worldwide to have co-authored a paper with Paul Erdős (“On the size of a random maximal graph,” published by *Random Structures and Algorithms*), and therefore have an “Erdős number” of 1. He was a revered teacher: one of his students said, “Stephen Suen once told me that he believed that by being a professor and educating students he was able to contribute positively to the world in general and that it made him feel fulfilled in a sense. Anyone who knew him would probably agree that he did indeed make a difference.” Another wrote that, “He was able to explain complex problems with passion and bring so much fun to it! [We] used to joke that only Dr. Suen can give you five problems for homework that take sixty hours to do... But we were so happy we went through that experience!” In 2014, he assumed the position of associate chair, and the Department is grateful for his service. He retired in 2016. Stephen is survived by his two sons, Daniel and Johann.

Students

USF Math Club met during the Fall 2018 semester for pizza and mathematics, and student presenters included mathematics undergraduate student Christopher Car, who spoke on “Logic Puzzles for Analytical Thinkers” and mathematics graduate student Nathan Hayford, who spoke on with “Geometry in Physics”. Attendance was good at each meeting, in particular to the Oct 19 presentation “Integrated Mathematical Oncology – Can calculus cure cancer?” by Dr. Heiko Enderling of the Moffitt Cancer Center Mathematical Oncology Department.

The club organized a group outing to the Mathematics Association of America Suncoast 2018 meeting at USF Saint Petersburg on December 7. Student presenters included math undergraduates Hayden Hunter with “Subgraph Deletion in 4-Regular Graphs and their Genus Ranges”, and Keller Blackwell with “Fundamental Solutions to Drift p -Laplacians in a Class of Grushin Spaces”. Mathematics graduate student Amine Ben Abdeljelil spoke on “Generalized Derivations Of Ternary Lie Algebras”, and USF mathematics alumnus Matt Cuffaro spoke on “Hegel's Topoi”.



Club president Micaela Newman, Vice-President Galib Hoq, and Treasurer Hayden Hunter all did a good job. Due to graduations, in the spring 2019 semester, math undergraduates Thomas Veith and Sabrina Downing will take over for Galib and Hayden as Treasurer and Vice-president, respectively.

The Epsilon Chapter of Pi Mu Epsilon co-hosted the Fall/19 Hillsborough County Math Bowl on November 14. Over 300 high school students and their teachers visited USF to participate in a half-day of individual and team high-school math competitions. Overall competition sweepstakes winners were: (1) King HS; (2) Middleton HS; and (3) Robinson HS, among 28 schools participating.

PME student leaders this year are Sabrina Downing, Hayden Hunter, and Keller Hunter, as President, Vice-President, and Treasurer, respectively.

The *Quaternión* is an annual publication of the Department of Mathematics & Statistics at the University of South Florida-Tampa. The *Quaternión* is available online at

<http://www.math.usf.edu/quaternion>

The department serves the community by teaching students, conducting research that will help build the future of Florida, and providing outreach services.

We'd Like to Hear from YOU!

The Department of Mathematics & Statistics would like to hear from alumni, friends, collaborators, members of the community, and fellow explorers of and guides to the world of mathematics and statistics.

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