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Teaching Philosophy

"Do you just add really big numbers all day?" I prefer not to dwell on how many times I have been asked questions along those lines. When I explain that my research involves improving pictures used in medical imaging techniques similar to MRI, ultrasound, and CT, I see an instantaneous change in their expression followed by a comment such as, *"Wow! I had no idea that was math!"* Advances in technology have led to new interdisciplinary collaborations, the fruits of which are visible in our daily lives. From smartphones and GPS, to MRI and deep space exploration, to mapping the human genome and developing targeted cancer therapies; mathematics has an increasingly impactful role in daily life. These advances have led to an increasing need for new students to pursue STEM careers, yet a lack of interested and qualified individuals remains. Key to changing the situation is introducing students to an updated vision of mathematics; one that retains its beauty, but also presents itself as an integral and accessible part of life, with great utility. Through teaching I focus on three specific goals central to inspiring and empowering the next generation of problem solvers and well-rounded members of society:

1. To establish constructive student attitudes towards mathematics,
2. To provide connections to real-world applications, and
3. To hone critical thinking skills.

Many students enter math classes with preconceived, and often negative, notions about what math is, what is means to be good at math, and whether or not they are capable of success in mathematics. I grew up in a small town in northern Vermont and do not come from a long line of academics. I am undoubtedly one of the first, if not only, graduates of my high school to pursue a doctorate in any subject, let alone mathematics. These experiences keep me in touch with students and their perceptions about math. Over the course of the semester my goals are to reduce math anxiety and help students develop an understanding of mathematical language, while also engaging them in the content. Changing the dialogue from negative to positive through encouragement and positivity is an essential first step for a productive conversation. When a student is speeding down *"I can't do this!"* interstate, I encourage them to hit the brakes and break the problem down into concepts they are familiar with, while reinforcing how much they have already learned. For many students, just having someone believe they are capable of success results is their first positive math experience. As long as a student puts forth effort, I always work to help them clarify mathematical concepts, or provide guidance in extension and discovery projects in line with their particular interests.

Advances in technology over the past decades are leading to exciting breakthroughs in STEM fields on a regular basis. Bringing such breakthroughs into the classroom and connecting them to math topics they are currently learning, allows students to see creative uses for mathematics previously unimaginable. Through my teaching I strive to expose students to a variety of mathematics driven careers, empower students with the skills and confidence needed to pursue such careers, and foster creativity and student-led discovery. Providing students with weekly scientific or news articles featuring creative modern uses for the techniques developed in class has proved incredibly beneficiary. Whatever particular motivators students may have, such exposure can serve as an eye-opening experience, and lead to them to become more active participants in class discussions and more focused in their studies.

For example, I designed and taught *Calculus II for the Biological Sciences*, while at Colorado State University, with one main goal that by the end of the semester students would have the necessary skills and confidence to read a scientific journal article in their area of interest. At the end of the term, students presented their chosen articles while highlighting concepts covered in class using technology-based presentations as well as written reports. The result was that all of the students were exposed to

a vast array of applications of varied interests while also learning how to communicate effectively via mathematics.

To study math is truly to study problem solving and critical thinking. I clearly remember the feelings of inspiration, freedom, and empowerment I experienced as an undergraduate student in my first Differential Equations course at Saint Michael's College. While studying mixing problems, the connections between words describing physical quantities such as flow rates, and mathematical derivatives became both clear and important. We were encouraged to add complexity and discover how the problem changed mathematically. The number of possible changes and related questions one could not just ask, but answer, was thrilling. Through math I developed powerful problem solving techniques that have served me well, and I bring those experiences into my classroom. Modeling problems such as mixing in tanks, contamination in lakes, epidemiology, population management, and predator-prey scenarios provide tangible examples where real-world statistics for rates such as flow, birth, transition, and spread of disease can be interpreted directly into an idealized mathematical setting. Such applications provide wonderful opportunities for students to develop skills for transitioning between "words" describing an actual situation, and "math".

The predictive capability of math is immense, and through critical thinking students can determine what changes in a model might be made to produce a desired outcome. Through technology students can get a feel for the effect of their proposed changes, especially in cases where explicit solution techniques are not available. For example, my students have utilized interactive GUIs in Matlab and Maple to plot the direction fields associated with a system of ODEs of their design. Using the software they can immediately see the effects of changing initial conditions or rates on the stability and long term behavior of the system, making the process one of hands on exploration. Concepts such as sources, sinks, and limit cycles are strengthened through interactive visualizations.

Besides providing engaging tasks for students, in class I aim to develop critical thinking and problem solving skills by guiding students, providing leading questions when necessary, rather than telling them the "correct" answer or approach. Once students possess a clear understanding of the task at hand, I encourage them to recall and re-evaluate their previous knowledge to see if any can be immediately applied. If not, how might that knowledge be extended? This process of building upon previous knowledge and extending it to new problems is an essential life skill for success in their future careers.

Having taught a variety of courses ranging from first-semester calculus to differential equations, and mentoring undergraduates in interdisciplinary research projects (see CV and Research Statement), I have demonstrated my ability and passion to incorporate these goals into undergraduate mathematics education. Coupled with my interest in interdisciplinary research and strong communication skills, I have the necessary skills be an exceptional faculty member. In end of term course evaluations students rated my courses and my teaching ability very highly. The evaluations are based on a 5-point scale with a score of 5 indicating *Excellent* and 1 indicating *Poor*. The table below contains my average student rating over the 8 courses that I taught at CSU. My website (`http://sjhamilton.weebly.com`) provides further ratings and student comments.

Question	Mean Score
How do you rate the instructor's enthusiasm for teaching the subject?	4.92
How effectively did the instructor facilitate student learning?	4.86
How well did the instructor create an environment that was respectful to students' opinions, ideas and differences?	4.81
How do you rate the availability of the instructor to meet students outside of class?	4.79
How do you rate this instructor?	4.89

In my teaching, I improve students' attitudes towards mathematics, introduce real-world applications, and help students to develop critical thinking skills. These three goals work together to engage students and inspire them to learn more. Through encouragement and positive reinforcement, math anxiety can be reduced, allowing students to enter the working world with renewed confidence. As a graduate from a liberal arts college, I believe that it is important to constantly re-evaluate how one's discipline fits in with the bigger picture. My belief is that it is not enough to focus on the technical and computational side of mathematics alone, which often leads to a view of mathematics as a disparate and isolated discipline, rather that it is essential to additionally demonstrate its capacious side through innovative real-world uses. Quality teaching is dear to my heart and I am dedicated to further developing my skills. I feel both privileged and rejuvenated each time I witness a student's, *"Aha!"* moment. I look forward to many more in the future.