Daniel Soto Fall 2020 Sabbatical Report

My sabbatical activities for Fall 2020 centered around two manuscript submissions, two NSF grant submissions, and the development of open-source battery technology for electric vehicles.

The first paper submission is a single-author manuscript to The Journal of Open Hardware on an open-source graphing temperature recorder useful for educational activities. In my teaching, visualizations of temperature changes are a valuable teaching tool but suitable, affordable, adaptable instruments are not available. To address this gap, I started creating a device that graphs and records multiple temperatures using available open source tools. This work began in collaboration with a student with funding from MESA during the summer of 2019. I used the device in the classroom, made revisions to the device to simplify the architecture, and have used the device during subsequent semesters. As part of the dissemination, I provided a device to a local science middle-school educator and installed the software to use it on his machine.

The second paper submission is a single-author manuscript to the Institute of Physics (IOP) Physics Education journal on a prediction and observation activity on the heating curve of water. In my teaching, I'd noticed a conflation of latent and sensible heat processes and models by students and devised a prediction/observation activity using the temperature graphing instrument including both calculations and student reflections. The cohort of students participating in this activity exhibited the conflation far less than previous classes. The manuscript contains a description of the prediction/observation activity in the context of similar published thermal activities. It also contains a discussion of the student experiences after participating in the activity. I used elements of this activity in a virtual field trip series for area students in collaboration with the Sonoma County library.

The first grant submission was an NSF Innovative Technology Experiences for Students and Teachers (ITEST) grant based on the technical and pedagogical elements from my two publications. Working with a co-PI, we proposed an activity for students using the temperature measurement devices and building from that to an exploration of enviromental justice issues using data science. We hypothesized an increase in student competency belief based on mastering the technology and an increase in the perceived value of STEM subjects in addressing social issues. These socio-emotional learning elements developed for this grant will be a focus of my teaching and learning scholarship going forward.

The second grant submission was to the NSF Building Capacity in STEM Education Research Individual Investigator (BCSER-IID) opportunity. During the sabbatical I conceptualized

the grant, performed a literature search and wrote the bulk of the proposal for submission in February 2021. In response to the onset of the pandemic, I adapted my assessment technique from in-class midterms to several take-home assignments similar to individual midterm questions. These assignments were submitted in video format with students narrating their thought process. Students are allowed multiple attempts and are asked to do a metacognitive reflection as part of the repeated attempts. Based on a positive experience with this technique, I proposed a training grant to further develop the assessment technique as a way to scaffold competency belief and academic self-efficacy.

My tangible output from the sabbatical is a small battery prototype. There is significant amateur and student interest in building small electric vehicles but dominant battery assembly technique is electric welding, requiring specialized equipment. Recognizing the need for a more recyclable and accessible technique, I designed and assembled a small battery array enclosure that can be manufactured using typical maker space tools and widely available materials. I'm working with an engineer by providing feedback on an open-source battery management system for small electric vehicles. The eventual goal is an open-source battery and motor controller system that students can use to carefully measure the energy efficiency of a vehicle. This first battery prototype has a peak observed output of 5.5 kW observed and an internal resistance of 80 milliohms. This design can provide a platform for purpose built batteries by students for resilience backup power projects or EV challenges.

Most importantly, the sabbatical has allowed me to generate and articulate a vision of my research, scholarship, and creative activities over the next several years. The first area of focus is demonstrating the impact of social-emotional learning techniques in SSU classes. I'll continue to explore the socio-emotional components of learning, particularly the use of student assignments as a learning tool, socio-emotional reflection, and research artifact. The second area of focus is the continued design and demonstration of devices demonstrating thermal and electrical energy concepts and incorporating modern digital tools. These will continue to be designed for cost and ease of construction as well as to be approachable for SSU and other students. I'm also planning to integrate these themes to see if and how the reflective use of well-designed lessons using digital technology can increase student confidence and improve student outcomes.

I'm grateful to Sonoma State for the sabbatical privilege. The fall semester provided time for reflection and time to envision an academic trajectory over the next decade that integrates research and student impact and builds on the unique strengths at SSU. I look forward to executing the plan I developed during this sabbatical.