The TERC Scholars Program: Introducing Higher Education Students to Careers in STEM Education Research

by Maria (Mia) Ong

In September 2017, the Diversity, Equity and Inclusion Office at TERC established the TERC Scholars Program (TSP) with the goal of exposing college students, particularly those from underserved communities, to careers in STEM education research. TSP is a paid internship program in which students join an ongoing research project at TERC.

On site for up to 10 hours per week, each TERC Scholar becomes an active member of the project team and works under the supervision of the project's leaders.

TERC Scholars help to advance project goals and gain STEM education knowledge by engaging in authentic research activities, such as classroom data collection, literature syntheses, instrument testing, data coding and analysis, or case study development. Scholars come from a variety of backgrounds and majors (humanities as well as STEM) and bring their own interests and perspectives to these inquiries, as they gain work experience and reflect on potential career trajectories.

Students are assigned a mentor who assists them in navigating a professional workplace and are offered multiple professional development opportunities by TERC staff. These can include attending research seminars by TERC scientists, being advised on graduate school options, and having opportunities to give research presentations. Students participating in TSP may concurrently receive independent course credit at their colleges.

Since Fall 2017, in partnership with Wheelock College and working closely with Wheelock's Interim Dean of Arts and Sciences, Dr. Detris Adelabu, TSP has hosted Yingying Zhou, Lisa Liang, and Simone Ngongi-Lukula as TERC Scholars. Each scholar has written an article reflecting on the nature of her project work and the impact that participation in TSP is having on her professional goals.

The three projects that the scholars describe are supported by grants from the National Science Foundation. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Maria (Mia) Ong, Ph.D., is a Senior Research Scientist and the Interim Director of the Diversity, Equity and Inclusion Office at TERC. She serves as the Director of the TERC Scholars Program.

STEM Education Research

ENGAGING MIDDLE SCHOOLERS WITH MEANINGFUL DATA

by Yingying Zhou

I am a senior at Wheelock College, where I have majored in Mathematics for Teaching with a minor in education. At TERC, I work with Andee Rubin and her team on the *Data Clubs for Middle School Youth* project (NSF #1742255). This research project helps students develop their interest in mathematics and science and focuses on integrating computer science and math through data science. I am working with my team to test and revise several modules that introduce middle school students to the basic ideas of data science.

One such module is about pets, which we believe will be interesting to middle school kids. The students will collect their own data (about e.g., pets, social media, illnesses) using outside sources or large datasets from websites and then present their findings to their community. The pets module needed an initial dataset to get students started. This meant designing a questionnaire and conducting interviews.

Crafting the right questions

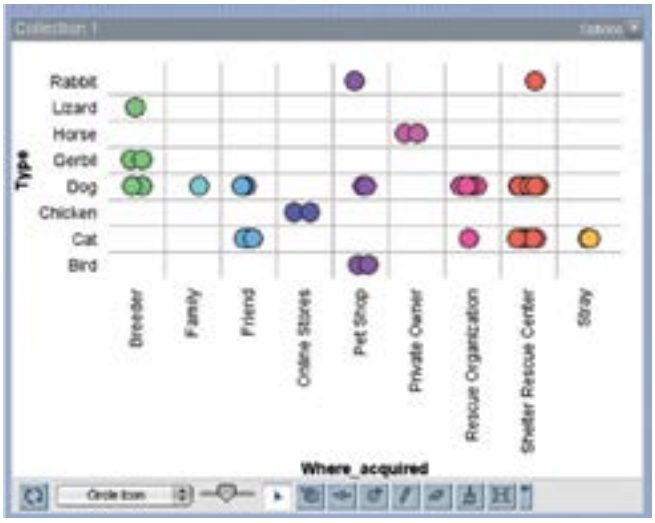
I quickly learned that it is difficult to create questions that yield good data. In my math or statistics classes, I'm usually given pre-determined questions to answer, and then enter the data, or all the data are handed to me to analyze. On the Data Clubs project, I went through a process of determining the kinds of questions I could ask that would result in quantitative data to collect.

TERC staff supported me with this process and helped me test my questions to find the right ones. I thought of creating questions about a pet's weight or how much money people spend on their pet. After testing questions with TERC staff, however, I realized the middle school students collecting data from one another might need different types of questions. They might not know the weight of their pets or how much money their family spends on pet care. Instead I designed a questionnaire about where animal owners got their pets—a question that kids this age might be able to answer more easily.

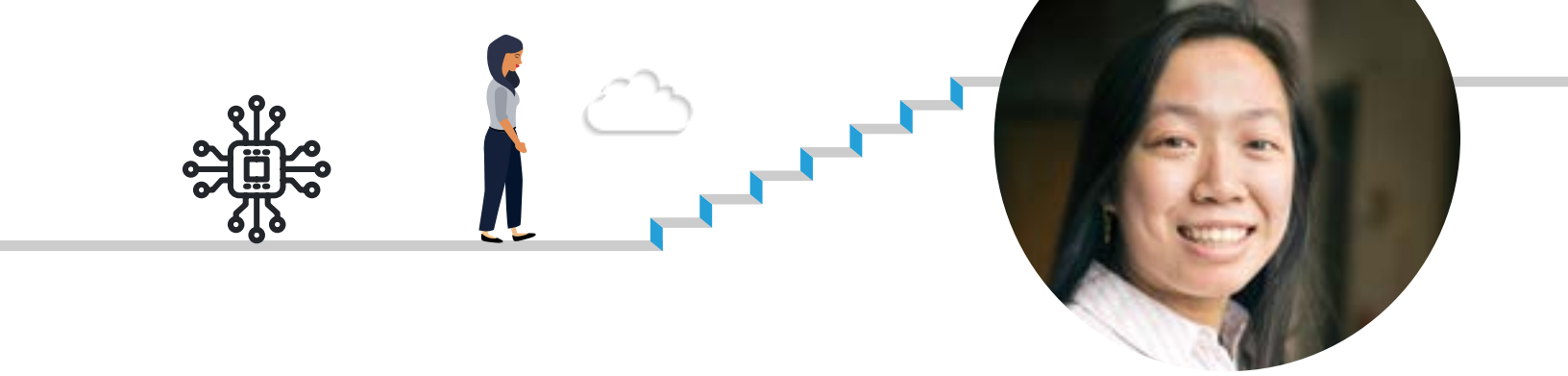
Building lessons to engage students

Next, I implemented and revised the questionnaire by talking to 50 TERC staff members. This helped me learn how to prepare for and interview people for research. Then, I entered the data into TinkerPlots, a data visualization and modeling tool designed for middle school students, and conducted an analysis of the data. The resulting graph (see Figure 1), shows that most of the TERC staff's pets are from shelter rescue centers. The data I compiled and analyzed will now serve as the starter dataset for the pets module.

The most important thing I have learned in the TERC Scholars Program is how to find topics that students are interested in and to create lessons around those topics, in order to encourage students to discover their passion for STEM. As I develop my teaching career, I will use this knowledge as I create lesson plans for my students.



Initial dataset for pets module shows that most TERC staff got their pets from shelters.



PLAY AND QUESTIONING AS A PATH TO LESSON PLAN DESIGN

by Lisa Liang

As a junior and first-generation college student at Wheelock College with a double major in Visual Arts and Elementary Education, I have been with Eli Tucker-Raymond's team on two projects that are centered around making. *Investigating STEM Literacies in Maker-spaces* (*STEMLiMs,* NSF #1422532) looks at how people in makerspaces use representations in their work. *Integrating Computational Making Practices in STEM Teaching* (NSF #1742091) supports 6th to 12th grade teachers with computational making practices in their physics, biology, and mathematics classrooms.

When I graduate from Wheelock, I plan on becoming an elementary school teacher or an arts teacher. I work in the making lab at my campus, and I'm interested in how making can be integrated into classroom learning. With Eli's team I had the opportunity to explore electronic circuit building and work out how to build an effective lesson plan.

Getting confident with circuits

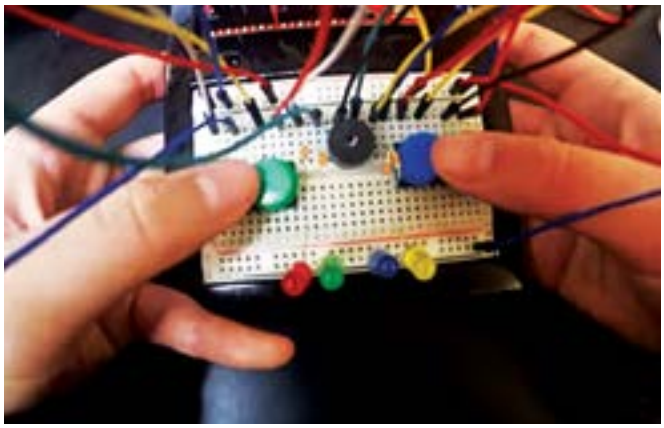
I was assigned to help our team test the usefulness of the Arduino for teachers. The Arduino is an open-sourced hardware development platform for building electronics projects; its physical programmable circuit board makes it great for beginners. When Eli first told me that I would be working with the Arduino, I felt intimidated. I had never explored circuits or understood how they worked. Despite my nervousness, I tackled the Arduino and found myself loving it.

At first, I followed the directions for building projects in the instruction booklet, like how to make a blinking LED light. Then I went on to modify the circuit codes to get different results, such as changing the order of the blinking lights. I kept a journal on what I was doing and questions I had, which let me track my thought process while putting the circuits together. I documented problems, researched questions online, and recorded how I tackled and debugged my designs.

Questions and play are science skills

Developing my own skills with the circuits and working through my questions led me to create a lesson plan on the circulatory system for fourth graders using the Arduino. Modifying the code makes the LED light blink like a heartbeat. A buzzer could be substituted to create a heartbeat buzz for those who are auditory learners. The lesson plan covers several days of a life science class and incorporates plenty of opportunity for students to play with the materials and ask questions.

My work at TERC has helped me to rethink how I feel about science and teaching in general. I grew up being "taught to the test," but that is not an effective way to teach especially with science. Teachers need to gain science skills and practices, especially the practice of asking good questions, to have effective science lessons. Students need to play with their materials, instead of always being taught from textbooks. Going forward, I look forward to passing on the skills and practices I have gained at TERC to my future students.



Lisa playing Simon Says with the Arduino

STEM Education Research

INCLUSIVENESS THROUGH ROBOTICS: DESIGNING BIOMIMETIC ROBOTS

by Simone Ngongi-Lukula

I joined the TERC Scholars program as a senior at Wheelock College with a double major in Political Science and Global Studies. I have been working closely with Gillian Puttick and Debra Bernstein on *Designing Biomimetic Robots* (NSF #1742127), a project that aims to introduce middle school students (grades 6-8) and teachers to biomimetic design in a classroom setting. Biomimetics, also referred to as biomimicry, uses inspiration from nature to create new technological designs. Our team is designing and studying a four-week long curriculum that encompasses biology, robotics, engineering design, and computer programming.

The goal of this project is to have students from various academic backgrounds engaged in conducting hands-on design practices. Executing this project in the classroom will give us a better idea of the different approaches that students take when faced with design challenges. In addition, studying other robotics curricula will help us do a better job of developing our own curriculum.

Researching robotics potential

As part of my research role on the team, I set out to identify and locate other existing robotics curricula, by looking into a series of research studies done by various scholars and educators. This investigating helped me better understand the kinds of research that have already been done and possible areas of future research. I was amazed by the range of research that has been done at various academic levels. The field of robotics is constantly transforming.

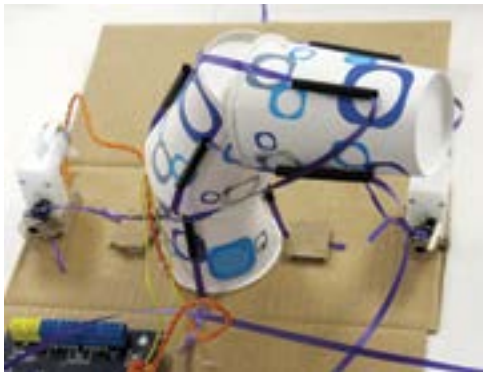
The study that I found most interesting was done by Bradley Barker and John Ansorge of the University of Nebraska. It focused on the increase in achievement scores of youth ages 9-11, after a robotics curriculum was implemented in their afterschool program (Barker & Ansorge, 2007). Reviewing this study made me extremely eager to begin the design phase of the *Designing Biomimetic Robots* project. I was ready to see the influence that robotics, through engineering design and computer programing, would have on middle school students.

Inspiration for a new career path

Prior to interning at TERC, I had no idea that something like biomimicry existed. What made this project intriguing to me was TERC's guiding mission of making STEM—including exciting concepts like biomimicry, and professional fields full of potential like robotics—equally accessible to all. It is my hope that projects like this one continue to develop in schools to show our youth the range of opportunities that is available to them.

Working on this project has been tremendously inspiring, and after much reflection, I have decided to pursue a career in Urban Education Policy. TERC's mission to create equal access to STEM education for all students has motivated me to be a part of the change that I wish to see in the formal education system.

REFERENCES Barker, B. S., & Ansorge, J. (2007). Robotics as means to increase achievement scores in an informal learning environment. *Journal of Research on Technology in Education, 39*(3), 229–243.



A robot mimicking the structure of an elephant's trunk