Community College Undergraduate Research using a Student-Driven and Student-Centered Approach

June 25, 2024

2024 ASEE Annual Conference, Portland Oregon

Elizabeth Adams, PhD, PE, and Gabriel Cuarenta-Gallegos

California Polytechnic State University, San Luis Obispo and Cuesta College

History of LSAMP

Congress authorizes and establishes the Alliance for Minority Participation

1991 AMP

1998 LSAMP

2022 1st Cuesta Cohort

1 — 2 — 3 — 4 — 5

1996 Gabi Joins AMP

2021 C6 LSAMP

Cabrillo College
MONTEREY PENINSULA College
CUESTA COLLEGE
ALLAN HANCOCK COLLEGE
C6–LSAMP California Central Coast Community College Collaborative
SBCC SANTA BARBARA CITY COLLEGE
Ventura COLLEGE
Oxnard College
MOORPARK COLLEGE

C6 (California Central Coast Community College Collaborative) LSAMP Alliance

Cabrillo College 1959

UC SANTA CRUZ

MONTEREY PENINSULA College

California State University MONTEREY BAY

CUESTA COLLEGE

LEARN BY DOING CAL POLY

ALLAN HANCOCK COLLEGE

SBCC SANTA BARBARA CITY COLLEGE

UC SANTA BARBARA

CSU Channel Islands

MOORPARK COLLEGE

EST 1925 Ventura COLLEGE

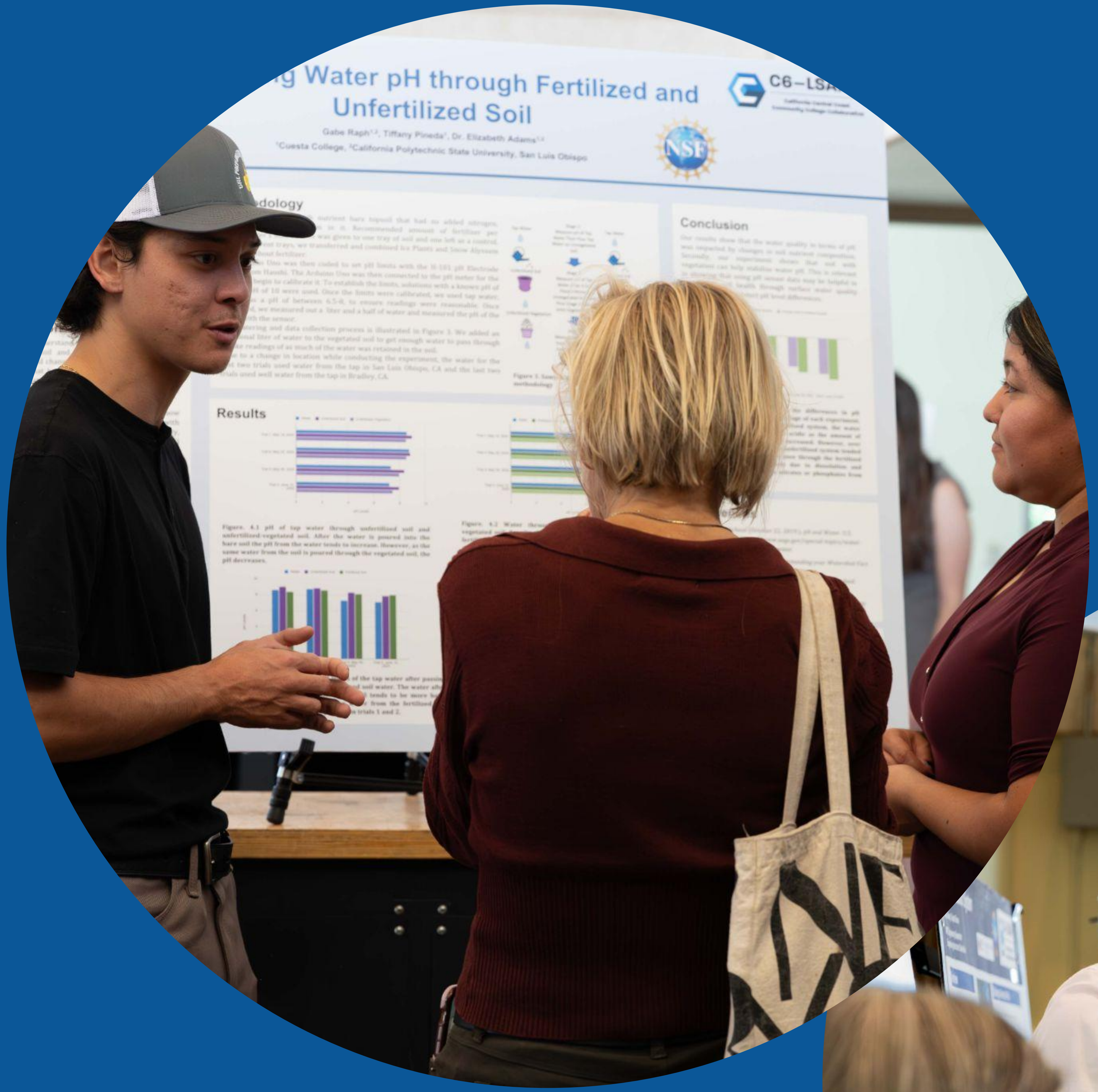
OC Oxnard College

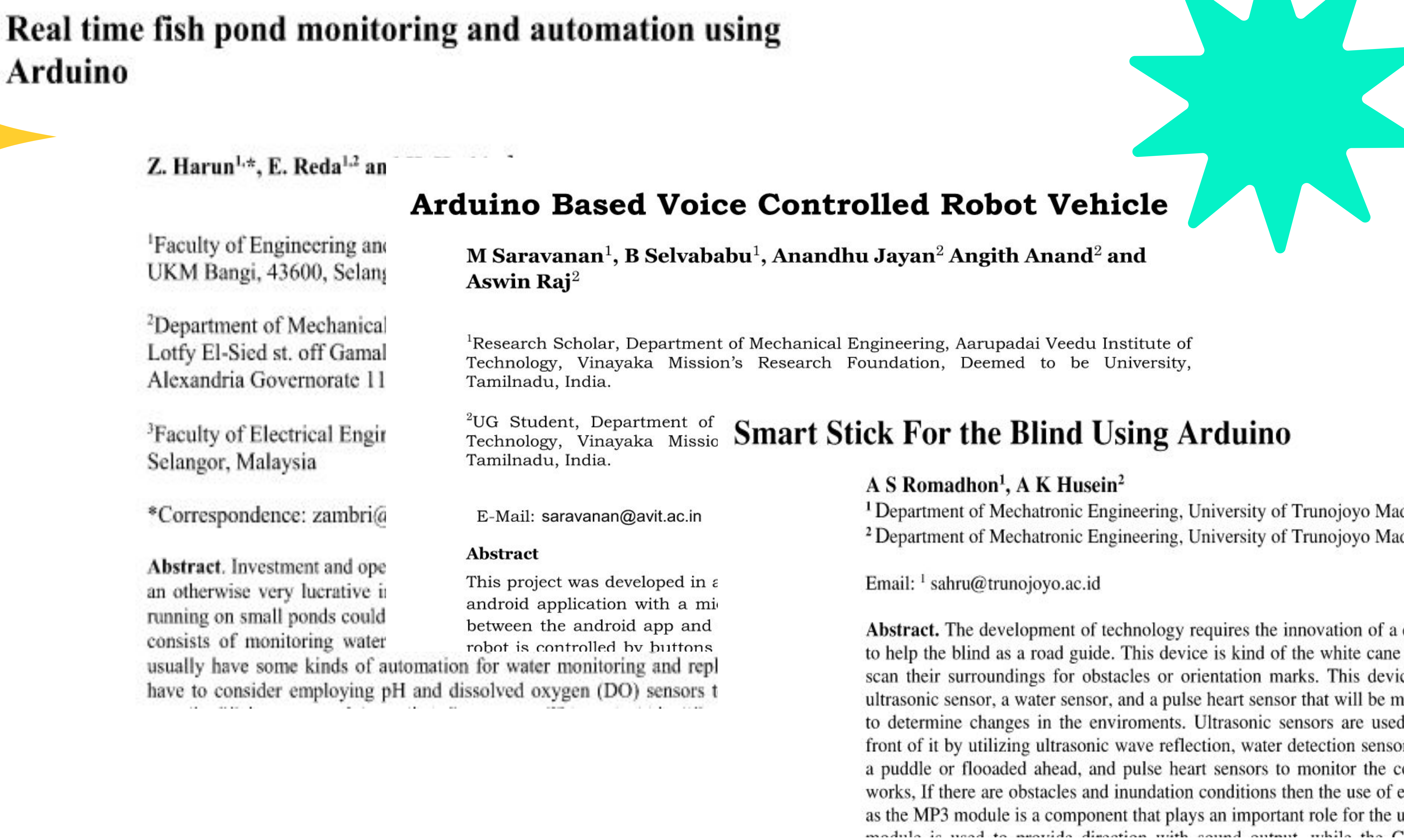
Share resources across the alliance to:

1. Narrow the success rate gap in STEM gateway courses for underserved students in STEM.
2. Increase the number of URM students transferring to universities.
3. Hold a research symposia to celebrate CC student research and project experience.
4. Increase student awareness of their academic path and their sense of belonging in STEM.

Why on-campus research?

- Eliminate equitable access barriers, e.g. monetary and location constraints.
- Include more students and all different types of students.
- Less of a logistical challenge.





Real time fish pond monitoring and automation using Arduino

Z. Harun[1,*], E. Reda[1,2] an

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Lotfy El-Sied st. off Gamal
Alexandria Governorate 11

[3]Faculty of Electrical Engi
Selangor, Malaysia

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Abstract. Investment and ope
an otherwise very lucrative i
running on small ponds could
consists of monitoring water
usually have some kinds of automation for water monitoring and repl
have to consider employing pH and dissolved oxygen (DO) sensors t

Arduino Based Voice Controlled Robot Vehicle

M Saravanan[1], B Selvababu[1], Anandhu Jayan[2] Angith Anand[2] and Aswin Raj[2]

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Abstract

This project was developed in a
android application with a mi
between the android app and
robot is controlled by buttons

Smart Stick For the Blind Using Arduino

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Abstract. The development of technology requires the innovation of a
to help the blind as a road guide. This device is kind of the white cane
scan their surroundings for obstacles or orientation marks. This devic
ultrasonic sensor, a water sensor, and a pulse heart sensor that will be m
to determine changes in the enviroments. Ultrasonic sensors are used
front of it by utilizing ultrasonic wave reflection, water detection senso
a puddle or flooaded ahead, and pulse heart sensors to monitor the c
works, If there are obstacles and inundation conditions then the use of e
as the MP3 module is a component that plays an important role for the u

Spring Semester

Arduino Starter Kits

2 Weeks

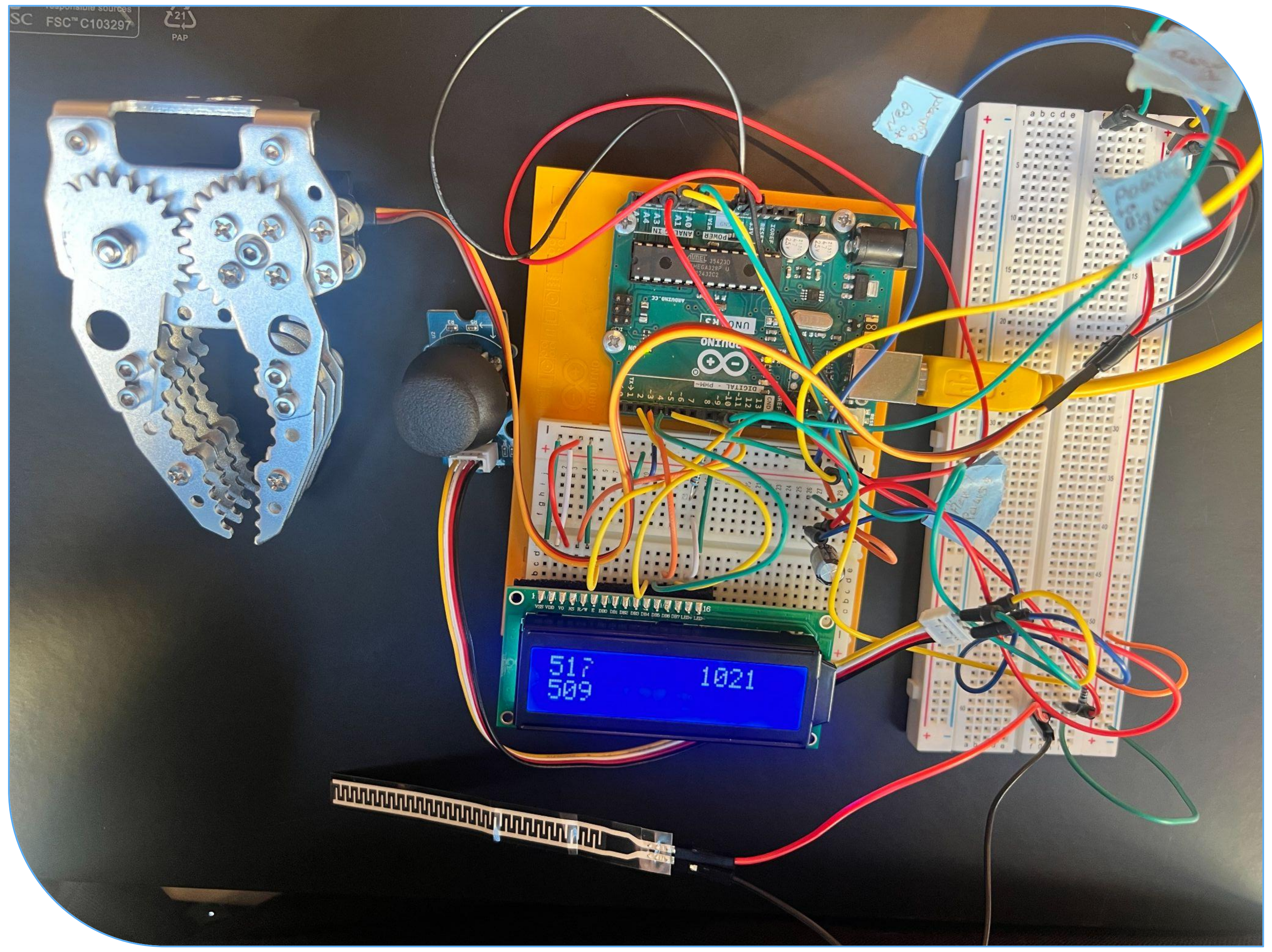
Literature Review

2 Weeks

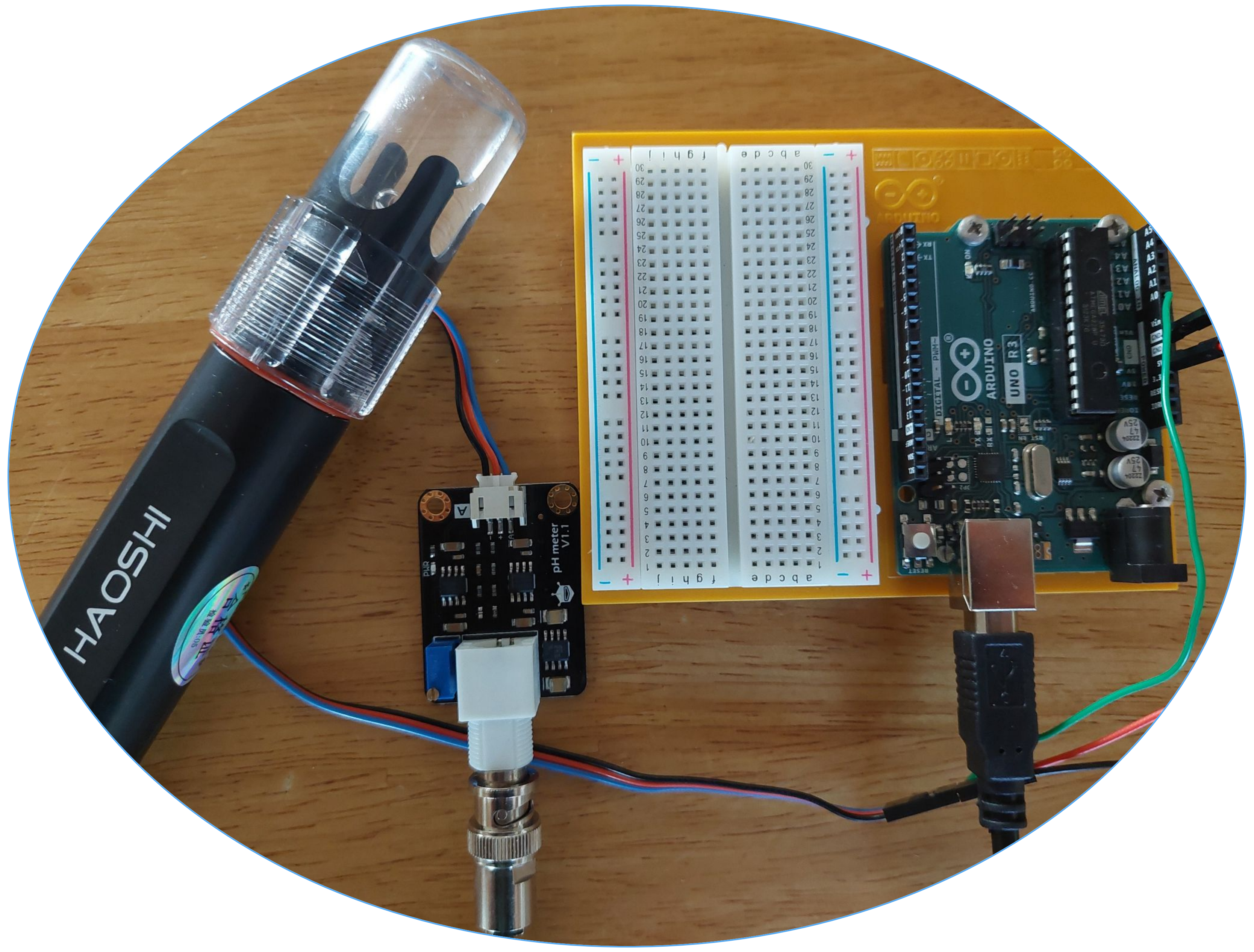
Brainstorm Session

1 Week

Will using a flex sensor for robotic applications be more precise than using a thumbstick?



How is the pH of water affected when passing through through fertilized and unfertilized soils

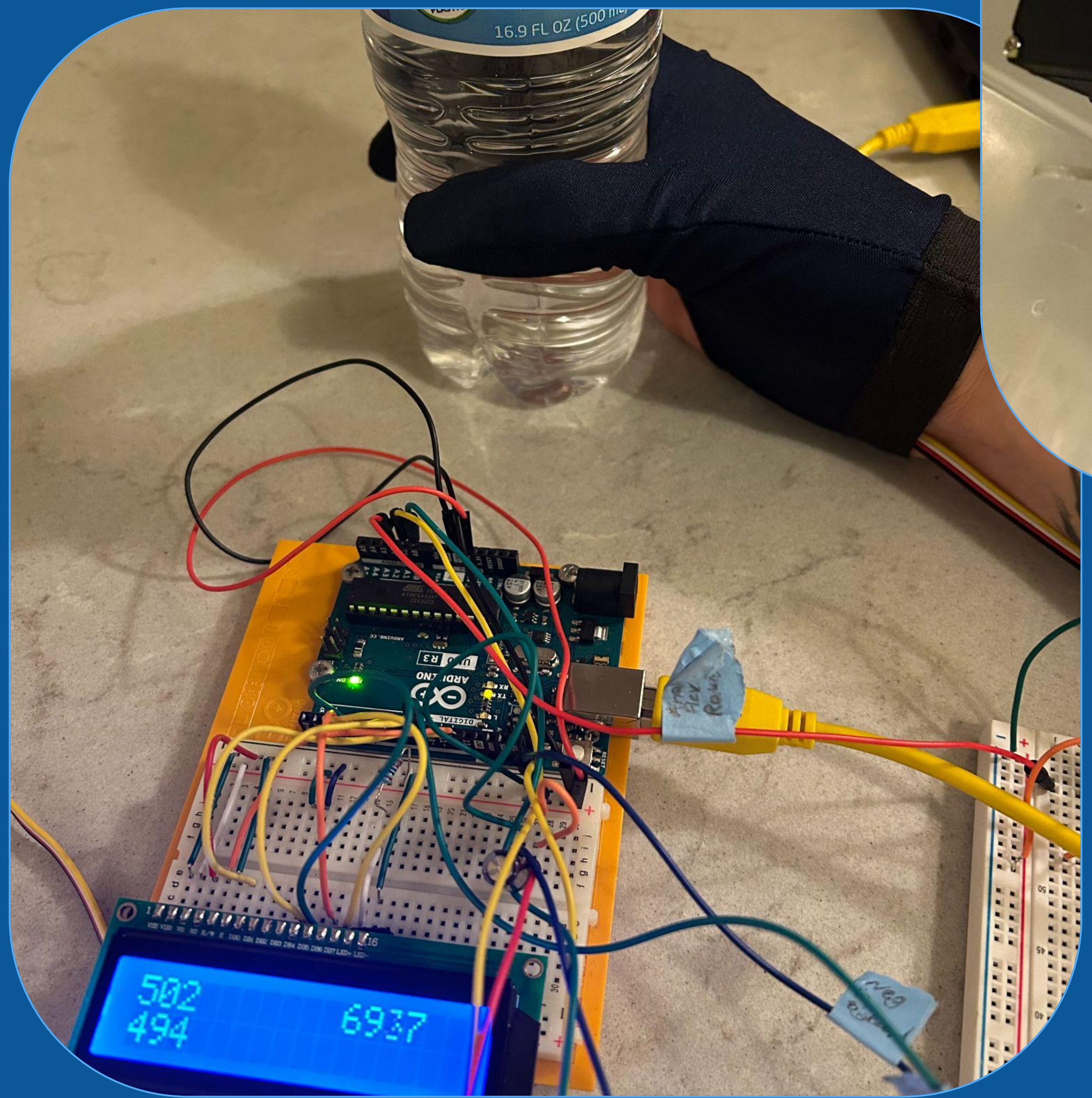


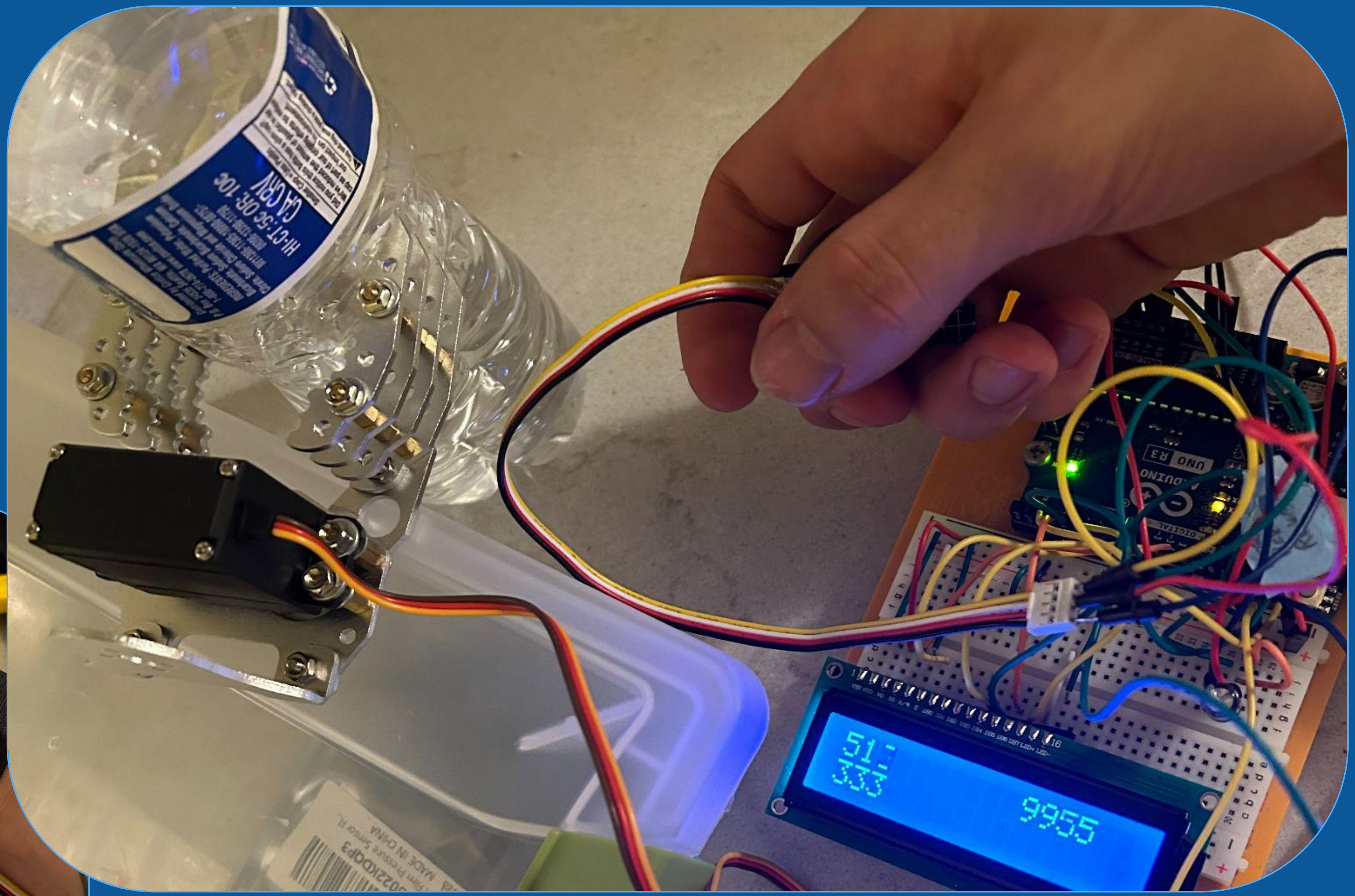
Spring Semester

Select Research Topics	Develop Research Questions	Build Experiment
1 Week	**2 Weeks**	**4 Weeks**

Summer

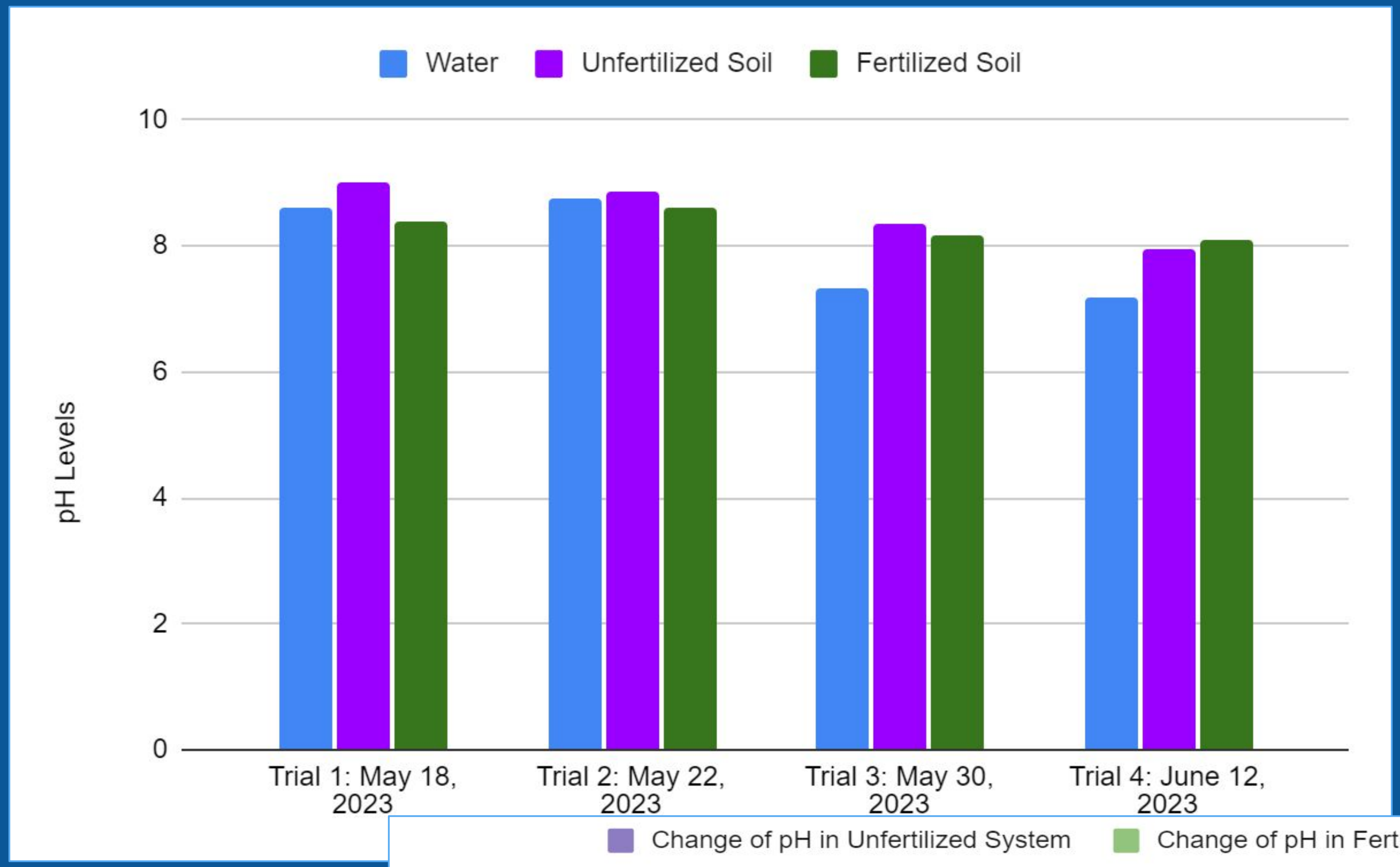
- Run Experiments
- Collect Data
- 10 Weeks

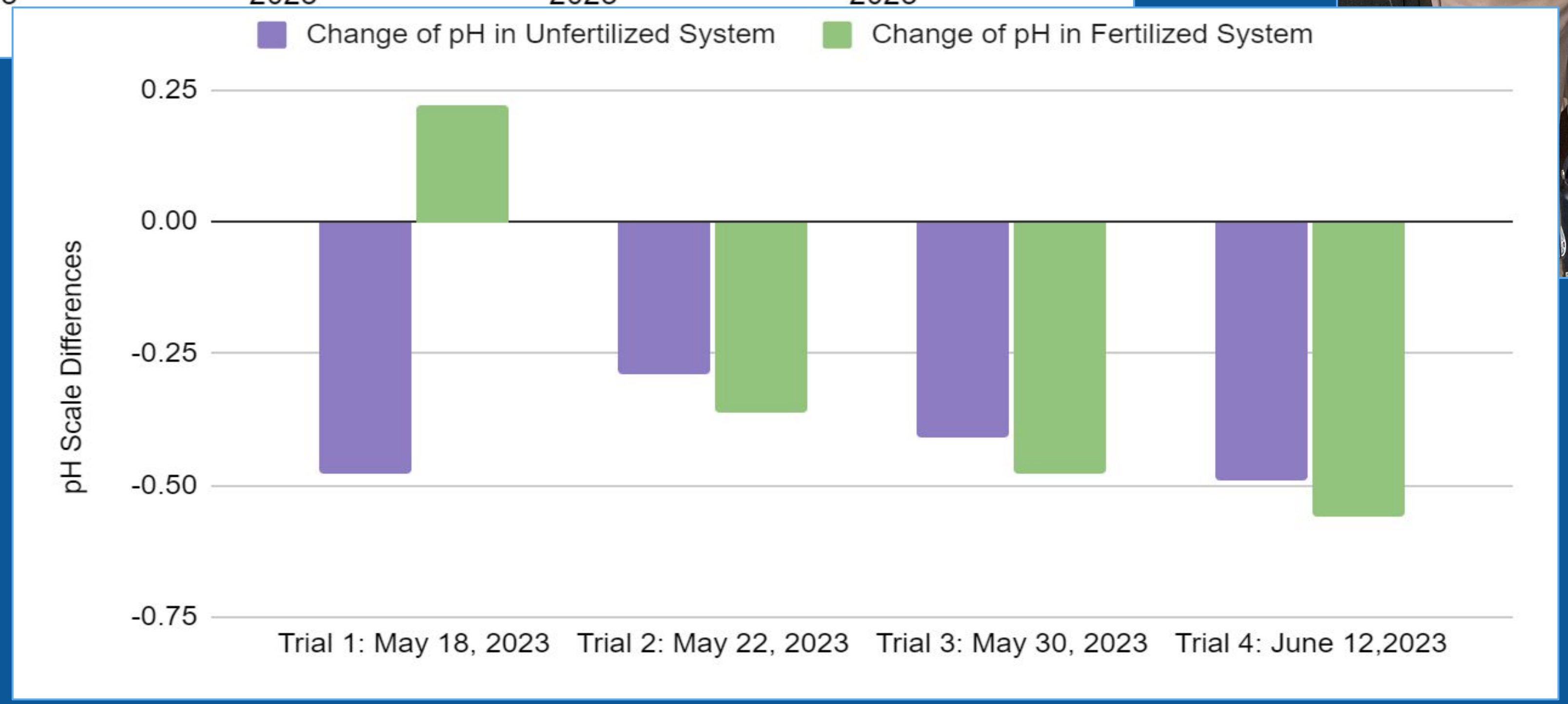


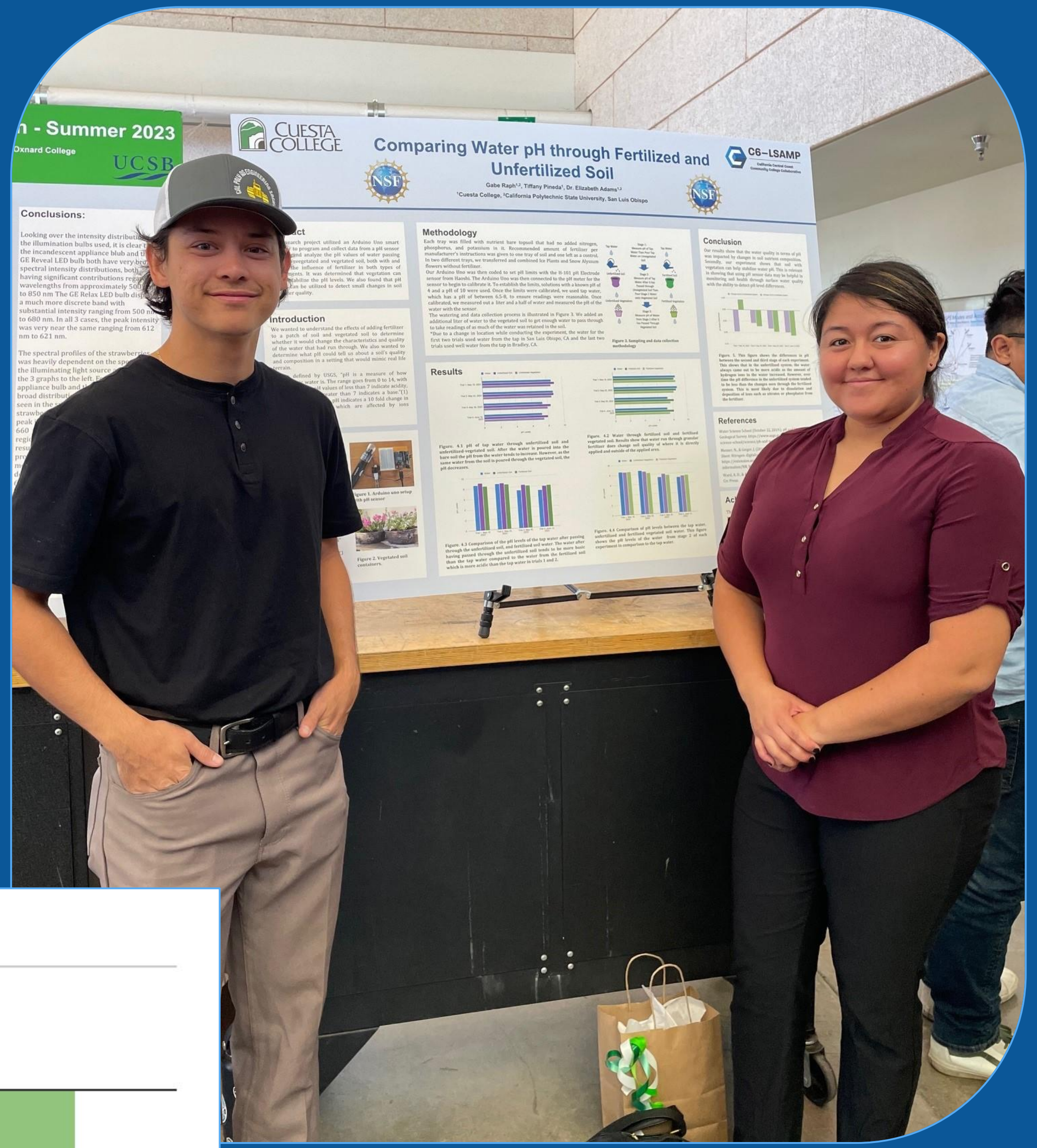


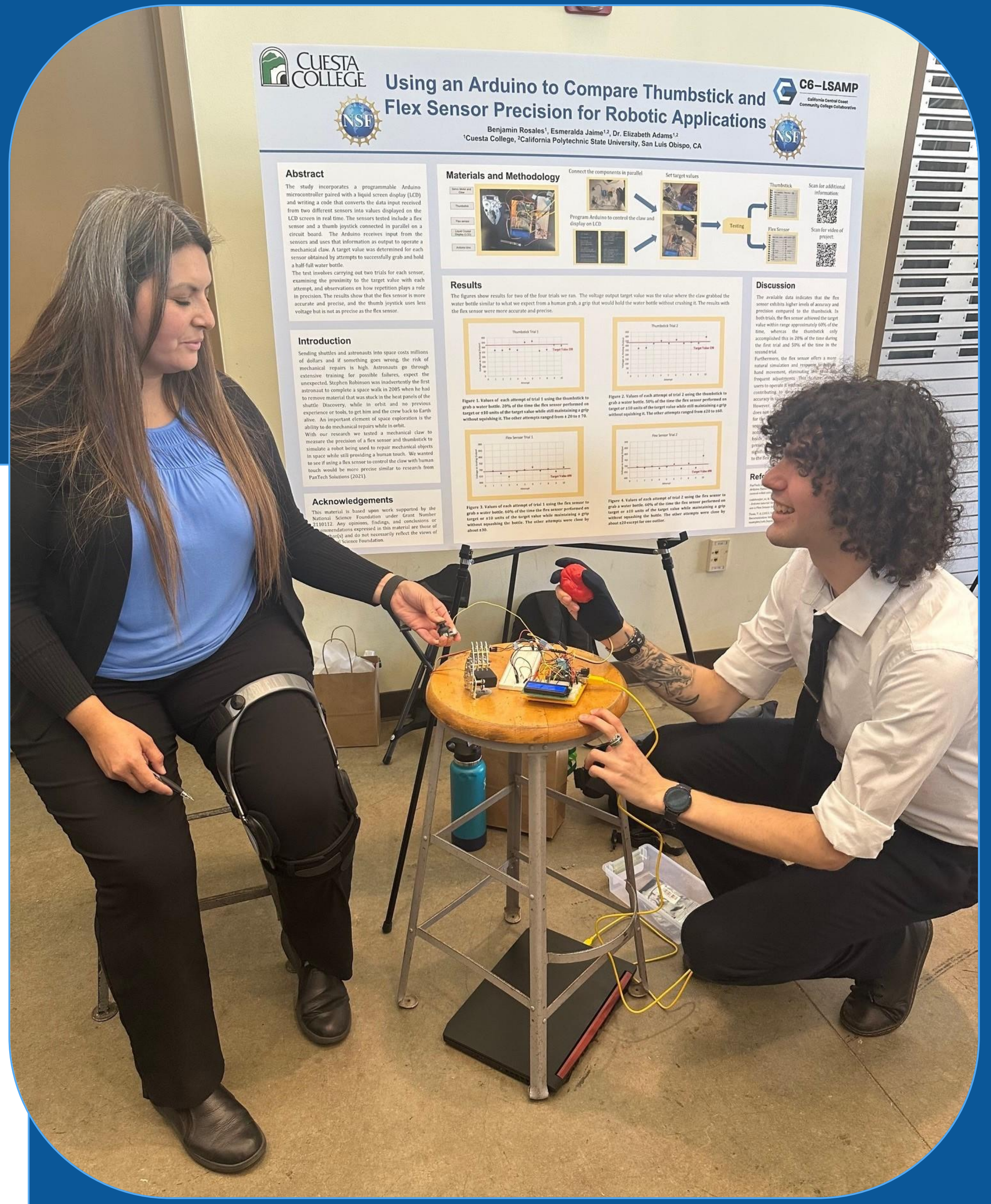
Fall Semester

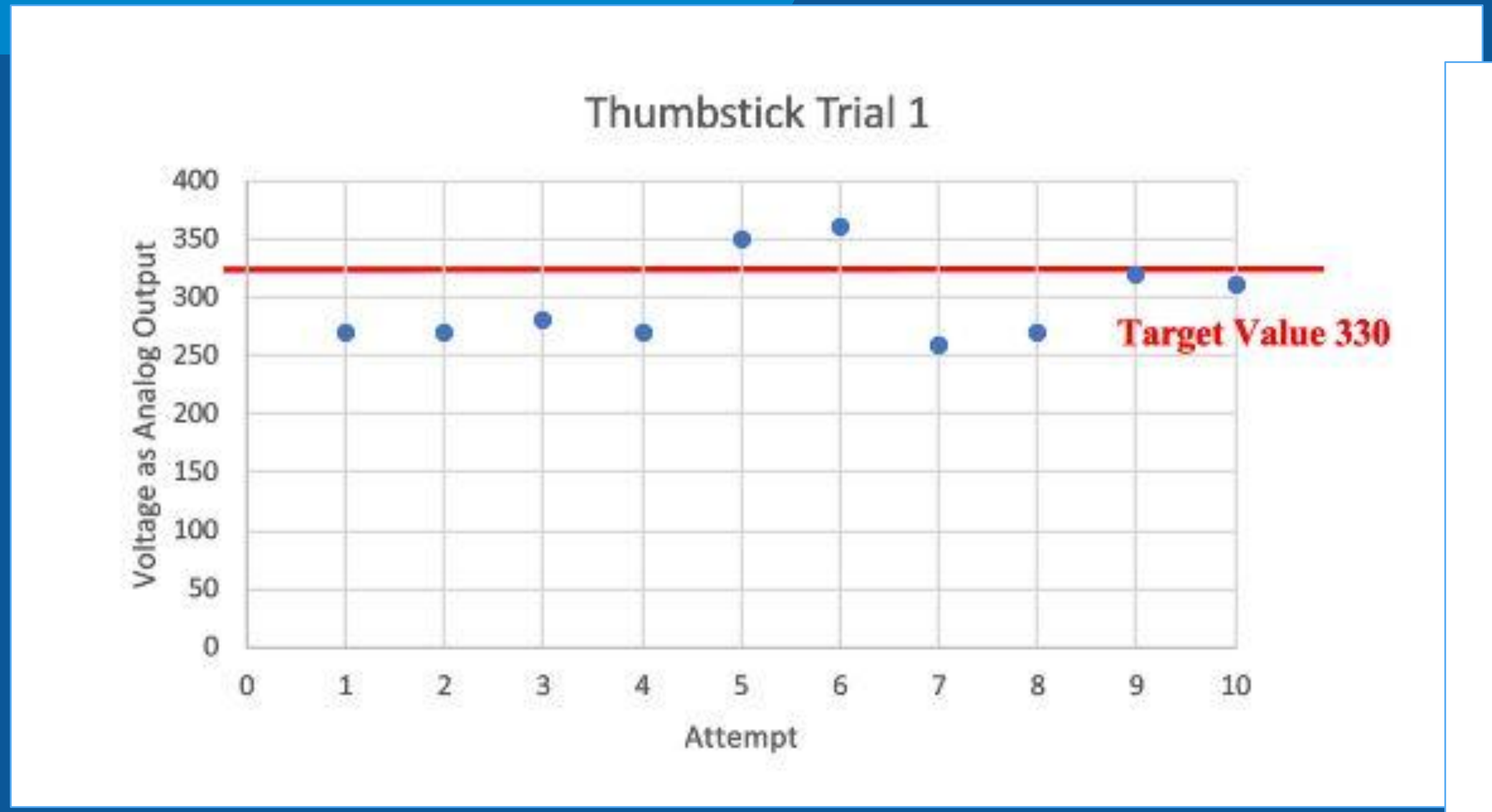
- **Data Analysis**
  3 Weeks
- **Poster Preparation**
  2 Weeks
- **Resume Updates**
  1 Week
- **Research Symposium**
  1 Day

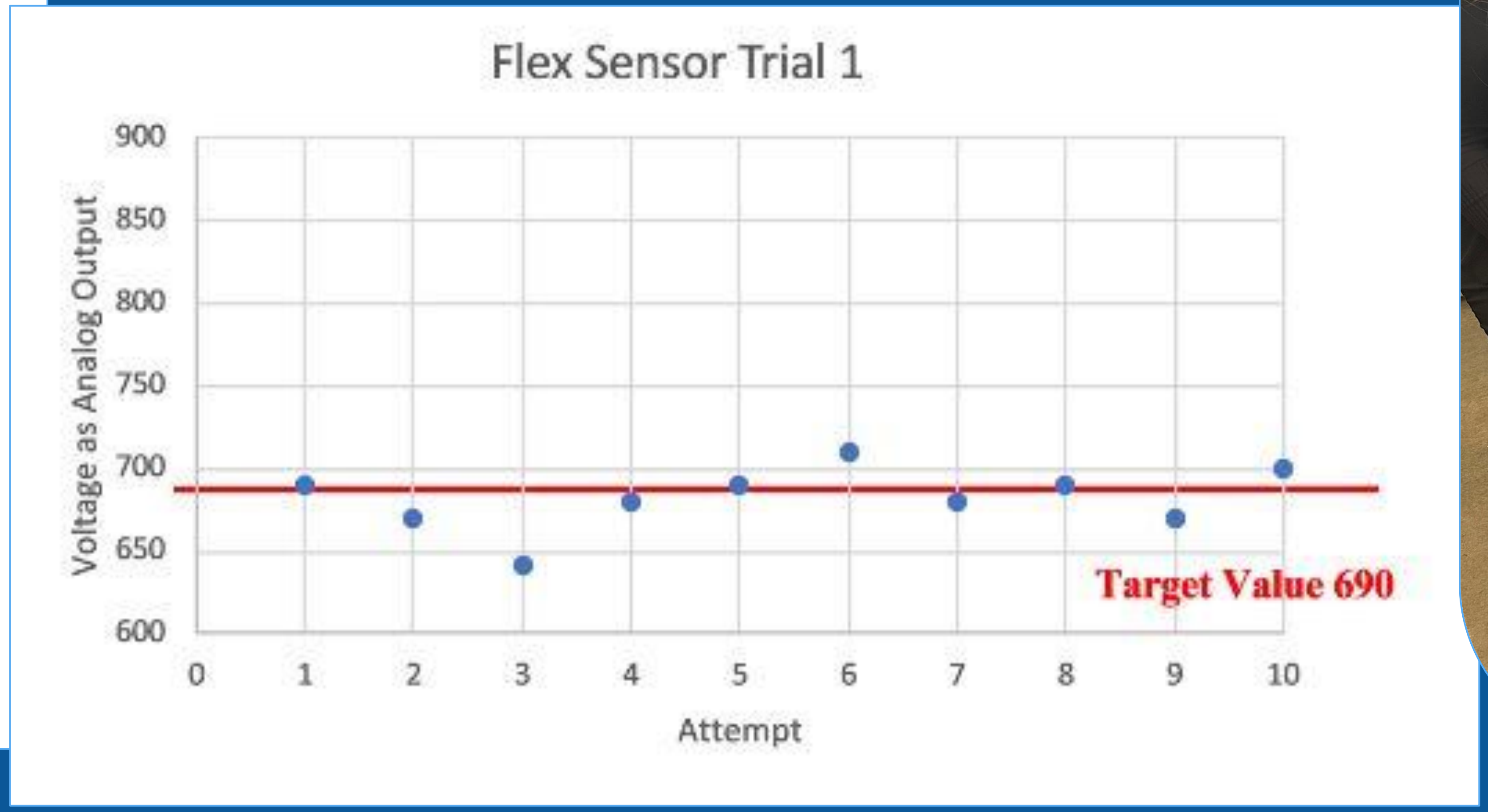












Using an Arduino to Compare Thumbstick and Flex Sensor Precision for Robotic Applications

Benjamin Rosales[1], Esmeralda Jaime[1], Dr. Elizabeth Adams[2]
[1]Cuesta Community College, San Luis Obispo, CA, [2]Cal Poly, San Luis Obispo, CA

C6–LSAMP
California Central Coast Community College Collaborative

Abstract

The study incorporates a programmable Arduino microcontroller paired with a liquid screen display (LCD) and writing a code that converts the data input received from two different sensors into values displayed on the LCD screen in real time. The sensors tested include a flex sensor and a thumb joystick connected in parallel on a circuit board.
The Arduino receives input from the sensors and uses that information as output to operate a mechanical claw. A target value was determined for each sensor obtained by attempts to successfully grab and hold a half-full water bottle.
The test involves carrying out two trials for each sensor, examining the proximity to the target value with each attempt, and observations on how repetition plays a role in precision.
The results show that the flex sensor is more accurate and precise, and the thumb joystick uses less voltage but is not as precise as the flex sensor.

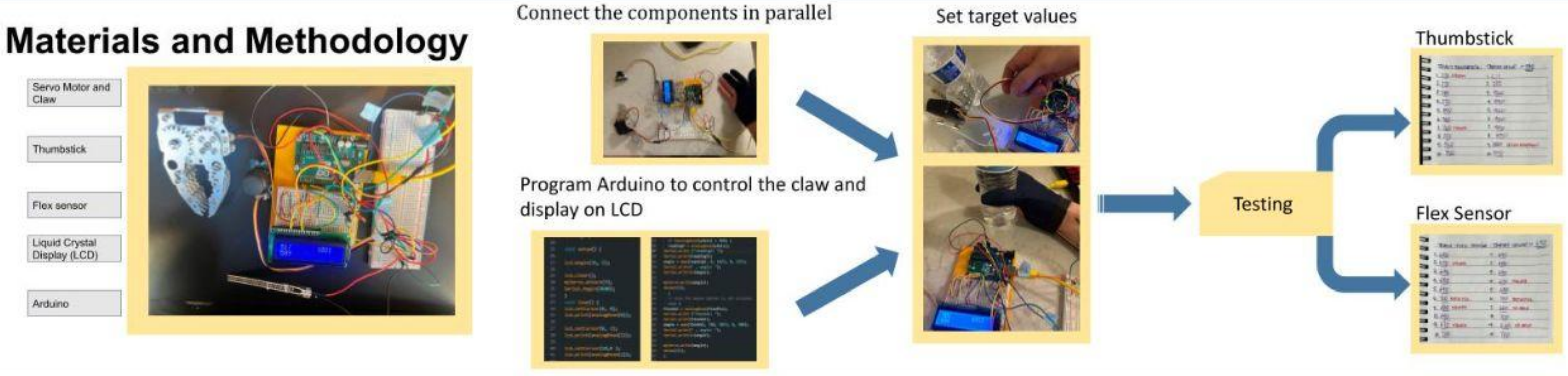
Introduction

Sending shuttles and astronauts into space costs millions of dollars and if something goes wrong, the risk of mechanical repairs is high. Astronauts go through extensive training for possible failures, expect the unexpected. Stephen Robinson was inadvertently the first astronaut to complete a space walk in 2005 when he had to remove material that was stuck in the heat panels of the shuttle Discovery, while in orbit and no previous experience or tools, to get him and the crew back to Earth alive. An important element of space exploration is the ability to do mechanical repairs while in orbit.
With our research we tested a mechanical claw to measure the precision of a flex sensor and thumbstick to simulate a robot being used to repair mechanical objects in space while still providing a human touch. We wanted to see if using a flex sensor to control the claw with human touch would be more precise similar to research from PanTech Solutions (2021).

Acknowledgements

This material is based upon work supported by the National Science Foundation under Grant Number 2110112. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Materials and Methodology



Scan for additional information:

Scan for video of project:

Results

The figures show results for two of the four trials we ran. The voltage output target value was the value where the claw grabbed the water bottle similar to what we expect from a human grab, a grip that would hold the water bottle without crushing it. The results with the flex sensor were more accurate and precise.

Figure 1. Shows values of attempt of trial 1 using the thumbstick to grab a water bottle. 20% of the time the flex sensor performed on target or ±10 units of the target value while still maintaining a grip without squishing it. The other attempts ranged from ± 20 to ± 70.

Figure 2. Shows values of attempt of trial 2 using the thumbstick to grab a water bottle. 50% of the time the flex sensor performed on target or ±10 units of the target value while still maintaining a grip without squishing it. The other attempts ranged from ±20 to ±60.

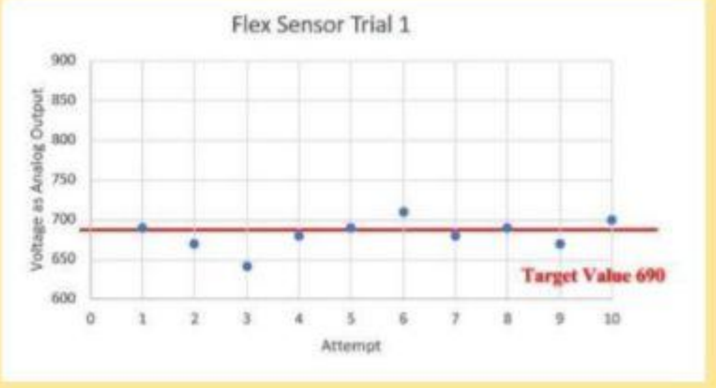


Figure 3. Shows values of each attempt of trial 1 using the flex sensor to grab a water bottle. 60% of the time the flex sensor performed on target or ±10 units of the target value while maintaining a grip without squashing the bottle. The other attempts were close by about ±30.

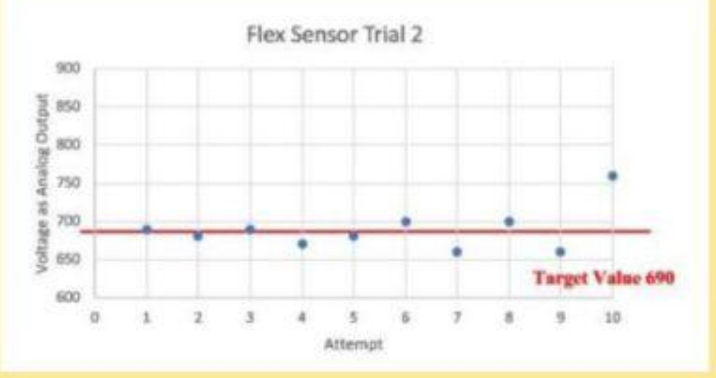


Figure 4. Shows values of each attempt of trial 2 using the flex sensor to grab a water bottle. 60% of the time the flex sensor performed on target or ±10 units of the target value while maintaining a grip without squashing the bottle. The other attempts were close by about ±20 except for one outlier.

Discussion

The available data indicates that the flex sensor exhibits higher levels of accuracy and precision compared to the thumbstick. In both trials, the flex sensor achieved the target value within range approximately 60% of the time, whereas the thumbstick only accomplished this in 20% of the time during the first trial and 50% of the time in the second trial.

Furthermore, the flex sensor offers a more natural simulation and response to human hand movement, eliminating the need for frequent adjustments. This feature allows users to operate it without extensive training, contributing to time-saving and enhanced accuracy in space applications.

However, it is important to note that this does not imply a lack of accuracy or usability for the thumbstick in space. In fact, after the second consecutive trial, the thumbsticks accuracy improved by 30%. The thumbstick holds value in scenarios where energy preservation is critical, as it demands significantly less voltage to operate compared to the flex sensor.

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codebender_cc, & Instructables. (2017, October 6). *How to use a Flex Sensor - Arduino tutorial*. Instructables. https://www.instructables.com/How-to-use-a-Flex-Sensor-Arduino-Tutorial/

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Fall Semester

Fall Semester

Comparing Water pH through Fertilized and Unfertilized Soil

Gabe Raph[1,2], Tiffany Pineda[1], Dr. Elizabeth Adams[1,2]

[1]Cuesta College, [2]California Polytechnic State University, San Luis Obispo

Abstract

This research project utilized an Arduino Uno smart controller to program and collect data from a pH sensor to collect and analyze the pH values of water passing through unvegetated and vegetated soil, both with and without the influence of fertilizer in both types of environments. It was determined that vegetation can help to stabilize the pH levels. We also found that pH sensors can be utilized to detect small changes in soil and water quality.

Introduction

We wanted to understand the effects of adding fertilizer to a patch of soil and vegetated soil to determine whether it would change the characteristics and quality of the water that had run through. We also wanted to determine what pH could tell us about a soil's quality and composition in a setting that would mimic real life terrain.

pH as defined by USGS, "pH is a measure of how acidic/basic water is. The range goes from 0 to 14, with 7 being neutral. pHs of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base."(1) Each integer change in pH indicates a 10 fold change in H^+ ion concentration which are affected by ions dissolved in the water.

Materials

- Arduino Uno smart controller
- Potentiometer pH sensor by Haoshi
- 1 cu. ft. topsoil with no added nitrogen, phosphorus, or potassium
- MiracleGro Shaking Feed All-Purpose Plant Food
- Calibrating solutions of pH 4 and pH 10
- 4 trays, 12" diam. x 3" h.
- Storing solution of KCl
- Ice Plants and Snow Alyssum

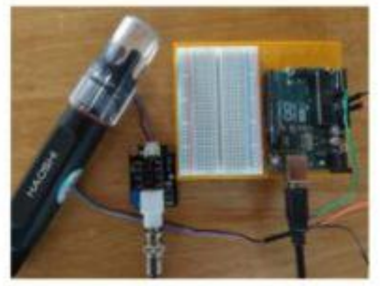

Figure 1. Arduino uno setup with pH sensor

Figure 2. Vegetated soil containers.

Methodology

Each tray was filled with nutrient bare topsoil that had no added nitrogen, phosphorus, and potassium in it. Recommended amount of fertilizer per manufacturer's instructions was given to one tray of soil and one left as a control. In two different trays, we transferred and combined Ice Plants and Snow Alyssum flowers without fertilizer.

Our Arduino Uno was then coded to set pH limits with the H-101 pH Electrode sensor from Haoshi. The Arduino Uno was then connected to the pH meter for the sensor to begin to calibrate it. To establish the limits, solutions with a known pH of 4 and a pH of 10 were used. Once the limits were calibrated, we used tap water, which has a pH of between 6.5-8, to ensure readings were reasonable. Once calibrated, we measured out a liter and a half of water and measured the pH of the water with the sensor.

The watering and data collection process is illustrated in Figure 3. We added an additional liter of water to the vegetated soil to get enough water to pass through to take readings of as much of the water was retained in the soil.

*Due to a change in location while conducting the experiment, the water for the first two trials used water from the tap in San Luis Obispo, CA and the last two trials used well water from the tap in Bradley, CA.

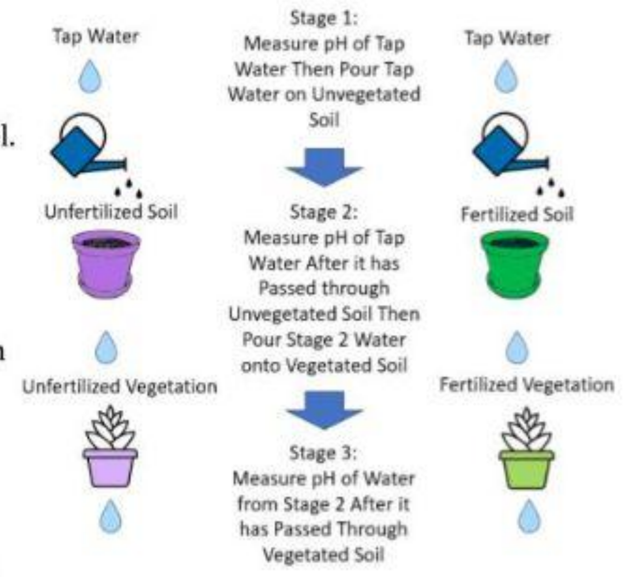

Figure 3. Sampling and data collection methodology

Results

We found that the pH of the water through the non fertilized system and the fertilized system differed due to the addition of the granular all purpose plant feed. The pH of the direct runoff from the bare fertilized soil was more acidic.

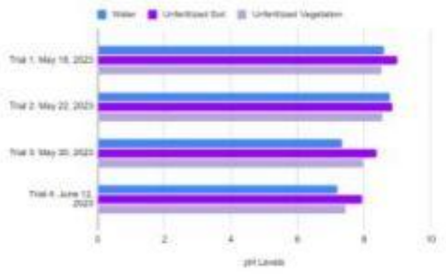

Fig. 4.1 pH of tap water through unfertilized soil and unfertilized-vegetated soil. After the water is poured into the bare soil the pH from the runoff tends to increase on the pH scale (becomes more alkaline). However, as the same water from the soil is poured through the vegetated soil, the pH decreases (becomes more acidic).

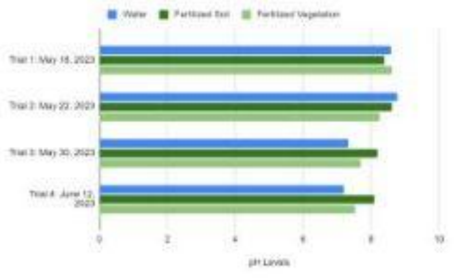

Fig. 4.2 Water through fertilized soil and fertilized vegetated soil. Results show that water runoff through granular fertilizer does change soil quality of where it is directly applied and outside of the applied area.

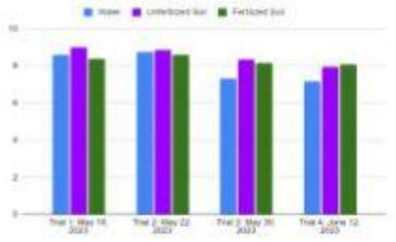

Fig. 4.3 Comparison of the pH levels of the tap water after passing through the unfertilized soil, and fertilized soil water. The water after having passed through the unfertilized soil tends to be more basic than the tap water compared to the water from the fertilized soil which is more acidic than the tap water in trials 1 and 2.

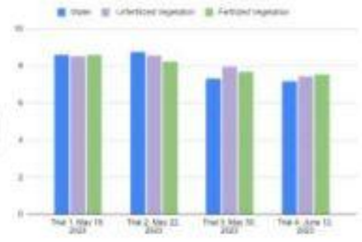

Fig. 4.4 Comparison of pH levels between the tap water, unfertilized and fertilized vegetated soil water. This figure shows the pH levels of the water runoff from stage 2 of each experiment in comparison to the tap water.

Conclusion

Our results show that the water quality in terms of pH was impacted by changes in soil nutrient composition. Secondly, our experiment shows that soil with vegetation can help stabilize water pH. This is relevant in showing that using pH sensor data may be helpful in monitoring soil health through surface water quality with the ability to detect pH level differences.

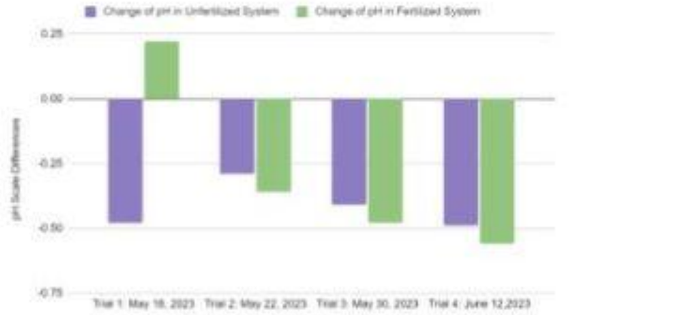

Fig. 5. This figure shows the differences in pH between the second and third stage of each experiment. This shows that in the unfertilized system, the water always came out to be more acidic as the amount of hydrogen ions in the water increased. However, over time the pH difference in the unfertilized system tended to be less than the changes seen through the fertilized system. This is most likely due to dissolution and deposition of ions such as nitrates or phosphates from the fertilizer.

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Acknowledgements

This material is based upon work supported by the National Science Foundation under grant Number 2110112. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors(s) and do not necessarily reflect the views of the National Science Foundation.

Student Feedback

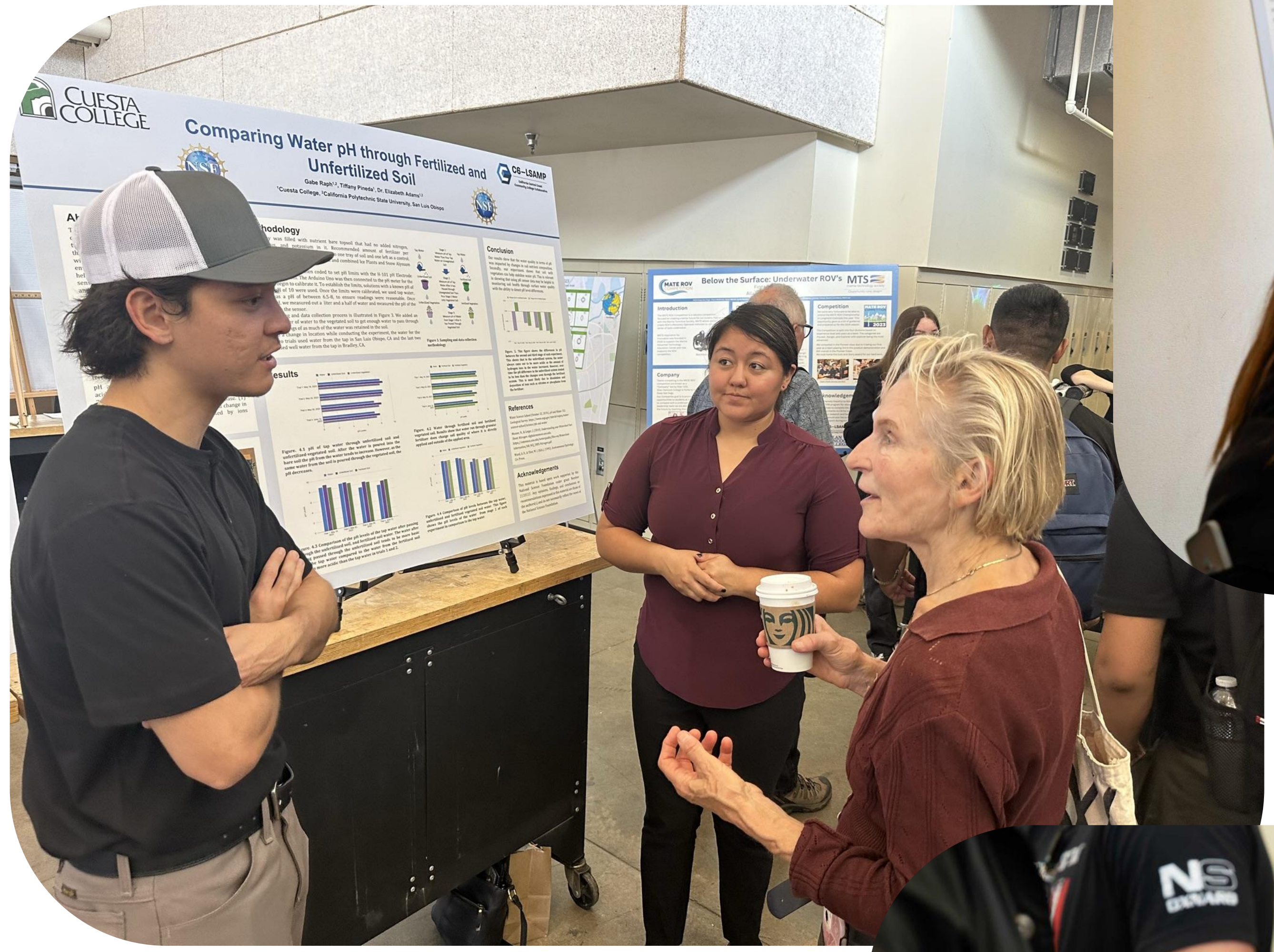
Research Confidence Before and After the Project

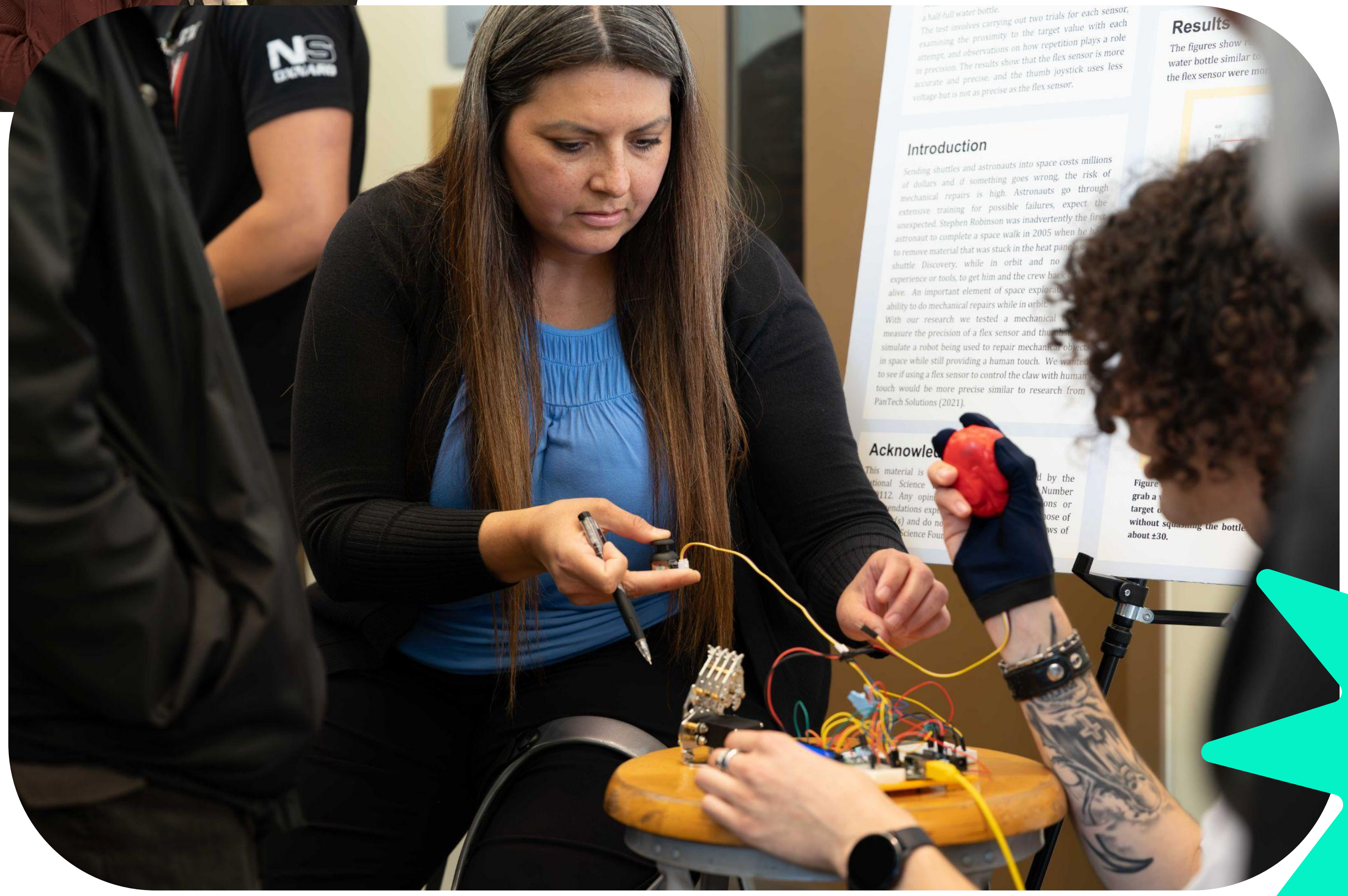
	Before	After	Difference
Student 1	6	10	-4
Student 2	4	8	-4
Student 3	6	10	-4
Student 4	3	9	-6

Mean Paired Difference: -4.5

Areas of Significant Growth

Significant Growth Areas	Percent of Students
Understanding the research process	100%
Communication Skills	75%
Team Collaboration	100%
Technical Skills	100%





Student Feedback

“It was an amazing experience that built up my confidence and understanding towards conducting STEM research! I know of the steps needed toward concentrating and refining topics of study that I'm interested in. Throughout the process, it was helpful to have Dr. Adams to help guide and advise us through areas where we were having some difficulty. It also helped having the Arduino Starter kit to better understand how to utilize it to get key information we needed for our research. **When we were able to present our research at Cal-Poly, it was fun to share our findings and process with those interested or curious while I had gained so much information from researching and conducting the experiments**.”

“This experience **helped me understand the research process** and what goes into developing a research question and experiment. I feel more confident in practicing the scientific method.”

Looking toward the Future

2023-2024

- 11 Students
- 5 Faculty
- 5 Disciplines: Biology, Chemistry, Computer Science, and Engineering
- 5 REU Projects

2024-2025

- Last year of grant cycle
- Re-apply for another cycle, emphasis on REU programs
- Serve at least 10 students
- Consider summer instead of spring

Q&A

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Gabi Cuarenta:

Liz Adams:

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