

Summary

The RET CoMET (Collaborative Multidisciplinary Engineering Design Experience for Teachers) at UCF is designed gain knowledge about electrochemical reactions that can be used to monitor environmental pollutants through hands-on skills in microfabrication, explore open-source software resources used in the construction of IoT hardware platforms, completion of programming assignments in Java, and networking protocols used to transmit the sensory data. The products we use on a daily basis, like cellphones, apps, video games, Smart technology and computers are all a result of this Engineering Design process and the development of IoT.

The RET CoMET program immersed me in the development of the Internet of Things (IoT) that make our daily lives easier. IoT involves the seamless integration of sensors, computer hardware (FPGA), software and networks. Participating in this program made me realize that teaching students to work collaboratively is necessary, because the development of sensor technologies requires engineers, computer scientists and software programmers to all work together toward one common goal.



Research Activities

Environmental MEMS Sensor Fabrication:

- Photolithography on Silicon Wafer
- Screen printing with conductive silver, carbon, and chitosan
- Needle type micro-sensor
- Sensor testing with voltmeter



Photolithography



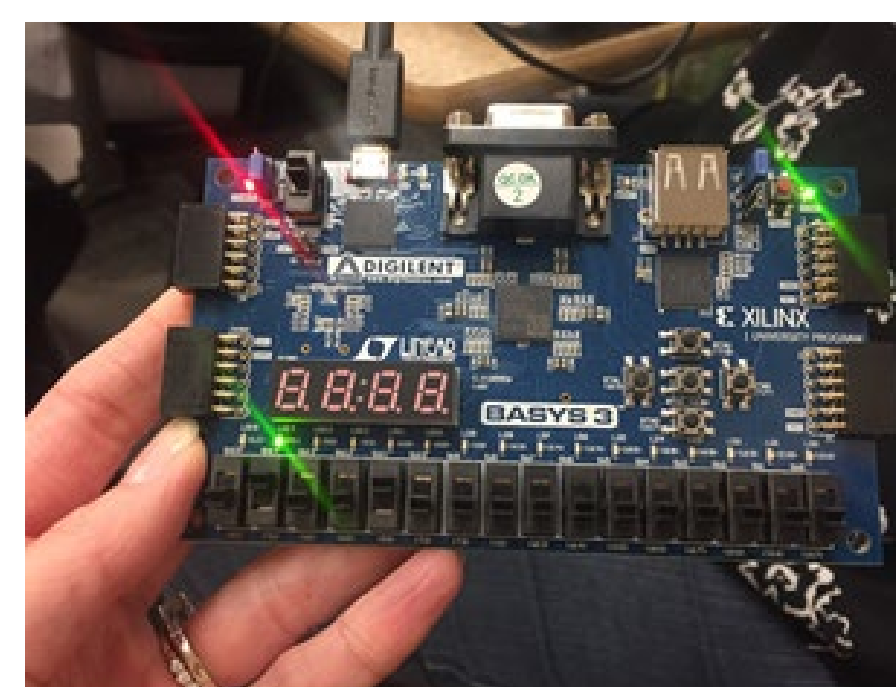
Screen Printing



Sensor Testing

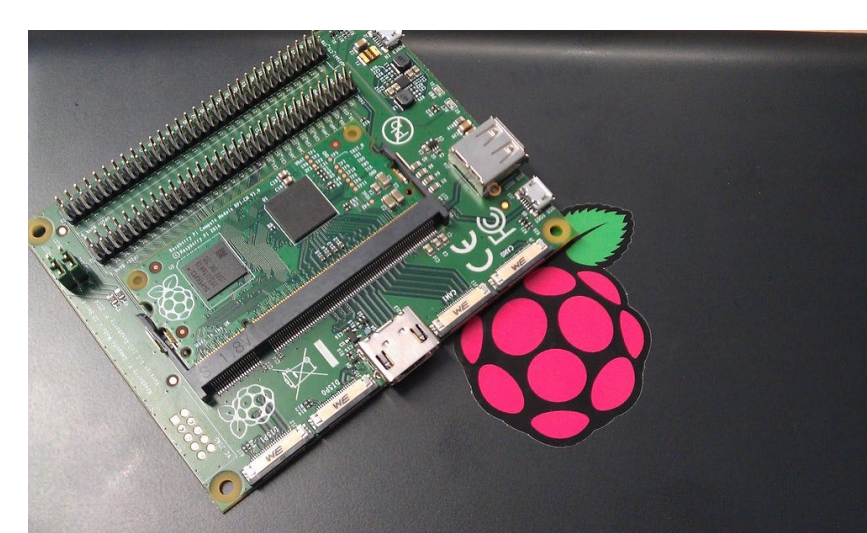
Hardware Systems:

- FPGA board (Basys-3) programmed in Verilog
- Binary Code, Logic Gates, & Truth Tables
- Basic Programming in Java "HelloWorld"
- Scratch



Software & Networking:

- Open Source Interconnection (OSI) layers and Protocols
- Command Prompts
- Raspberry PI



Mobile Programming:

- Android Studio

All research photos shown were taken by Jennifer Napolitano.
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Lesson Plan



Lesson Summary: Students will be able to carry out a scientific investigation on ocean acidification and apply their understanding of the carbon cycle, Earth's spheres and the oceans impact on our climate.

Part 1: Disappearing Shells (Inquiry-Based Activity)

Introduction Activity: Students watch a short video on Ocean Acidification. Students are assigned a number, which correlates with a question from the video. At the end of the video students participate in a timed round robin to share what they have learned.

Disappearing Shells Lab Procedure:

- Students will be divided into groups of 4 to complete the lab activity.
- Students put 200 mL of salt water, salt water & acetic acid, and acetic acid in separate beakers.
- Students measure the pH of the salt water, salt water & acetic acid, and acetic acid and the mass of the seashells.
- Students place a seashell in salt water, salt water & acetic acid, and acetic acid.
- Students record qualitative and quantitative data.
- Students make a prediction about the outcome.
- Students will complete a quick survey about their prediction & level of understanding on content (pre-assessment).
- Students remove the sea-shells and record observations.
- Students will answer the data analysis questions as a group.
- Students will complete a summary of learning Exit Ticket.

Research: Close Read Article

Students will complete a close read an article on Ocean Acidification (Florida's Coral Reefs)

Part 2: Cycling Carbon

- Students log into a Nearpod Lesson on the Carbon cycle and watch video on Carbon Cycle to complete an interactive matching activity on new vocabulary.
- Students use and interactive carbon cycle diagram to complete a card sort activity on whether carbon is being added, removed or stored.
- Students complete the Carbon Cycle Journey activity and complete the record sheet.
- Students will take a Quiz on the Carbon Cycle.

Part 3: Ocean Acidification (pH & CO2 Lab)

- Students complete a Nearpod Lesson on Ocean Acidification.
- Students complete an experiment to test the effect of CO2 on the pH of freshwater and saltwater.

Lab Procedure:

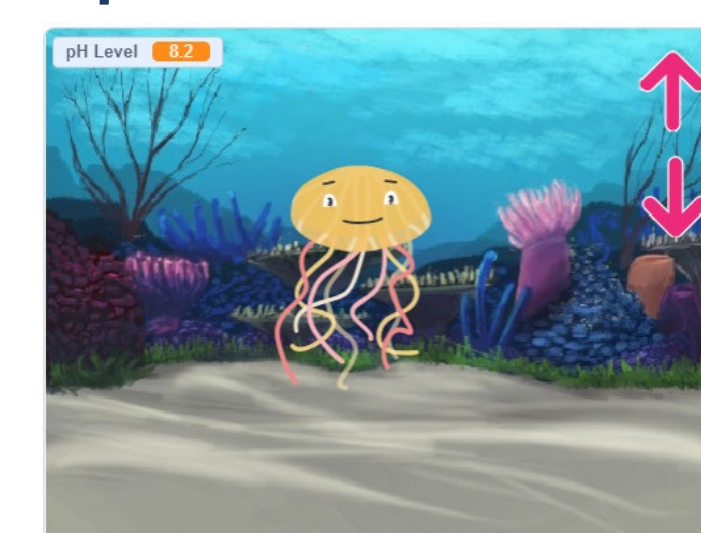
- Students will use a straw to add CO2 to 200 mL of freshwater for 1 minute
- Students will measure the pH change with a pH probe and record on data table
- Students will add more CO2 to 200 mL of freshwater for 2 minutes, 3 minutes & 4 minutes
- Students will measure the pH change with a pH probe and record on data table
- Students will repeat the same steps with 200 mL of saltwater.

Data Analysis & Conclusion

- Students will graph data using Google sheets
- Students will analyze data by answering the data analysis questions
- Students will write a conclusion to include their collected data results, the impact of ocean pH on Florida's
- Coral Reef systems, carbon cycle, and ways to reduce anthropogenic carbon dioxide.

Part 4: Technology in Science solving a societal/environmental problem

- Students will learn about the sensor technology and communications used in the study of Ocean Acidification by completing a Nearpod lesson.
- Students will write a code with Scratch that can use pH data collected by the sensor to determine if pH of the water is at a safe level.



Lesson Learned and Assumptions

- The Internet of Things (IoT) is interconnection of computing devices embedded in everyday objects connected to the internet allowing them to send and receive data.
- Development of MEMS sensors is interdisciplinary drawing knowledge from chemistry, physics, engineering, computer hardware, computer programming, and computer software.
- Photolithography MEMS sensor fabrication uses UV light and Photoresist to transfer image onto a Silicon Wafer.
- Screen Printing sensor fabrication method uses conductive metals to send and receive an electrical current to verify if a metal or chemical is present in the solution.
- Logic gates (AND, OR, NOT) are operators used in various coding syntax to perform a specific task.
- FPGA contain logic blocks that are reconfigurable to perform different operations. They are programmed for specific applications in electronic devices.
- Numerous coding languages are available from basic machine language to high level languages, like Java.
- Networking is necessary to connect all the devices and requires protocols, which are a set of rules.

Implementation Strategy

- Inquiry based learning activity
- Hands-on Lab exploration
- Close Reading Strategies
- Cooperative Learning Strategies (Round Robin, Think-Pair-Share, Chunking,)
- Scaffolding
- Graphic Organizers
- Summative Assessments (Discussion Questions, Photo Summary, Exit Tickets, Polls)
- Formative Assessments (Pre test and Post test)



Acknowledgments

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