Diagnosing Diabetes: An Integration of Computer Science and Engineering Principles into a High School Biomedical (Biology) Classroom

Mohammed Patel
Cypress Creek High School, Orlando, Florida

Summary

- Thirteen middle and high school teachers from the Central Florida area participated in the 2019 Collaborative Multiple Engineering Design Experience for Teachers (CoMET) at the University of Central Florida (UCF). The CoMET program lasted 6 weeks and teachers were exposed to concepts via engaging lectures and guided research activities.
- Teachers worked on developing a multidisciplinary lesson plan to integrate the CoMET experience with a classroom connection.
- This year's theme for CoMET was the "Internet of Things" (IoT).

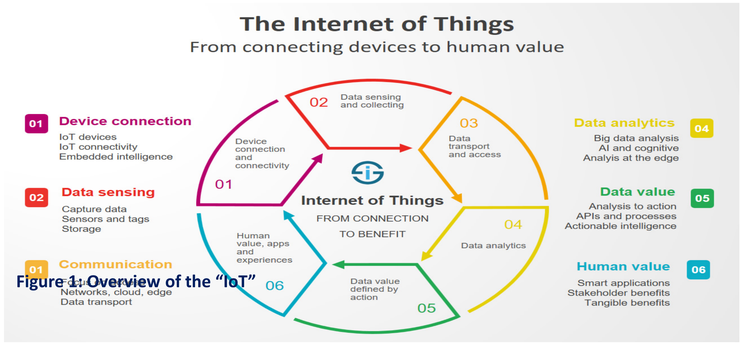


Figure 1: Overview of the "IoT"

Research Activities

I. **Module 1**: Design Fabrication of Environmental Sensors (Dr. Cho and Dr. Lee)
II. **Module 2**: Hardware Platform Module: Embedded Systems Track & FPGA Programming Track
III. **Module 3**: Software and Networking (Dr. Turgut)
IV. **Module 4**: Mobile (Android) Software Programming (Dr. Turgut)

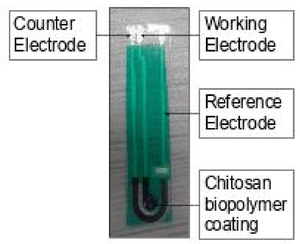


Figure 2: Screen Printed Sensor

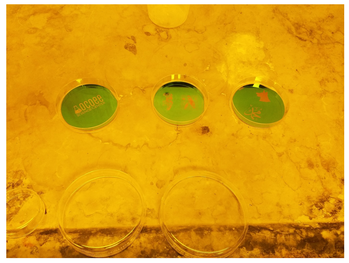


Figure 3: Images printed onto a silicon wafer using microlithography in the clean room.

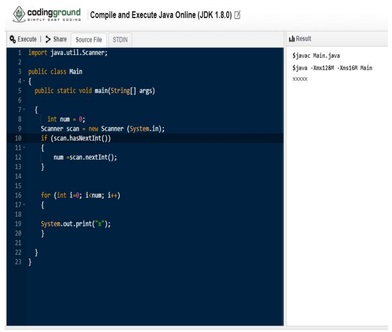


Figure 4: Java Programming

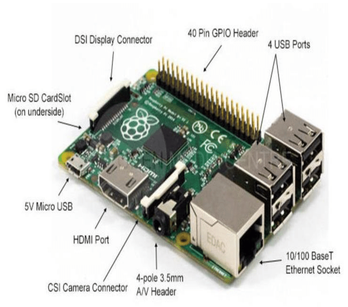


Figure 5: Raspberry Pi 3

Lesson Plan

Introduction: Diabetes is a widespread disease which affects over 400 million people in the world today compared to 100 million people in the 1980's and this number continues to increase. According to the World Health Organization (WHO), diabetes was the seventh leading cause of death in 2016. High glucose levels lead to even more deaths than diabetes and half of all diabetic deaths before the age of 70 are linked to high glucose levels. Other complications of diabetes related to uncontrolled blood glucose are blindness, kidney failure, heart attacks, stroke and lower limb amputation. This is why it is necessary to have better and earlier detection protocols to prevent, detect, and diagnose diabetes.

Students diagram feedback loops to demonstrate understanding of how the pancreas functions like a sensor. Students draw basic circuit on to paper-based sensors (pH paper) which will be used to "sense" blood glucose levels (pH 3,6,7,9 solutions) in 3 patients. Students use "nanosensors" (pH indicator solution) to detect insulin levels.

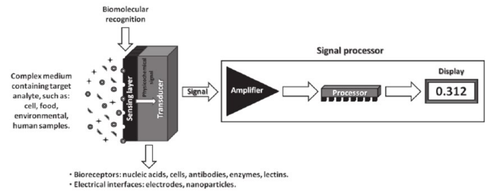


Figure 6: Students will be mimicking this process using theirs simulated glucose sensors.

Students devise a data collection protocol to collect glucose and insulin data using a Java based program to "process" the data.

Figure 7: Students input electrical signal values into Java program to generate glucose data. Students can also input color change values into program to determine insulin data (optional).

The students will generate a graph using the output data generated by the Java program to analyze glucose and insulin trends to determine diagnosis.

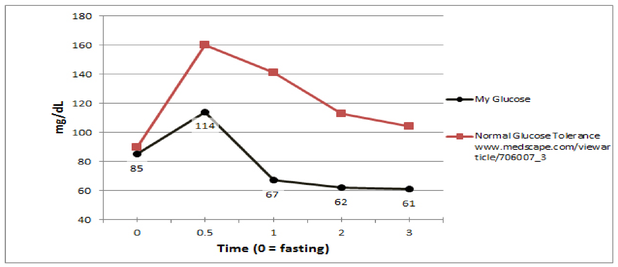


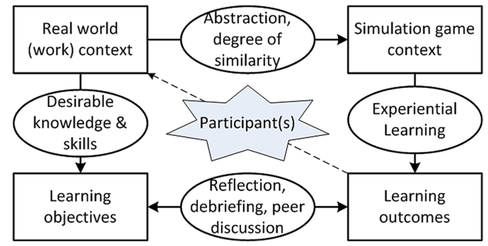
Figure 8: Students will have 1 graph displaying both trends for all 3 patients.

Motivation and Inspiration

- Employers often lack a cite of a "skills" for entry-level employees i.e. there is a knowledge to skills gap that exists. The economic impact of increasingly smarter devices has the potential to change the needs of the workforce and as a consequence the skills required of students to remain competitive in the future workplace.
- It is important for students to make connections with what they are learning to current research and industrial practices.
- Students in high school typically struggle with data analysis and experimental design.
- Many students enrolled in higher level biology or biomedical courses at the high school level rarely interact with computer science or engineering principles.

Figure 9: Simulating a real experience is a form of active learning.

Implementation Strategy



Research suggests that students learn better when making connections to the real world. This simulation based activity will allow for students to integrate real world context while performing a glucose tolerance test on fictional patient blood plasma. This activity involves inquiry based learning and provides opportunities to develop 21st century skills

Acknowledgments

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