Instructional Lesson Plan

iHeart Sensors

Leslie A. Arriaga

Michael Stanley | Jean Larson | Daniel Gulick | Jennifer Blain Christen

LESSON DETAILS

Subject Area(s): Computer Information Systems, Intro to Technology (CIS105)

Focus Grade Level: Community College

Grade Level Range: Freshmen and Sophomores

RESEARCH BACKGROUND

Research shows that the first few of hours after birth are crucial in identifying neurological conditions in neonates to provide timely intervention. However, current methods of monitoring during this critical period rely on wired sensors. Wireless monitoring enhances neonatal care by providing flexibility, enabling healthcare providers to move freely while receiving real-time data, and promotes a positive parental experience by facilitating uninterrupted skin-to-skin bonding.

The focus of my project is to address the challenges faced in saving high-speed data wirelessly. The project objective is to provide a method that will capture and store wirelessly transmitted vital signs data from sensors to a computer. I researched the feasibility of writing my own program with Visual Studio and Python as well as researched existing programs. In conclusion, I accomplished my objective by using the CoolTerm app along with the existing hardware provided - ESP32 boards and sensors (thermometer, ECG/PPG, CO_2, pH probe). The code for the sensors was previously written by a past SenSip participant.

LESSON SUMMARY

SUMMARY

Students are introduced to embedded sensors through a micro lecture and various hands-on activities. During the micro lecture, students are familiarized with vocabulary words and explore my SenSip research experience through videos and pictures. Afterwards, students partake in a vocab game, brainstorm examples of embedded sensors they encounter during their daily life, and present their examples to the class. This helps students connect class learning to their real lives. Students then use their own phones and download an app that utilizes the embedded sensors to capture their own heartbeats. Students will export their data from the app, plot it in Excel, and 3D print their heartbeats in our MakerSpace. The culmination will be a slide presentation showcasing their knowledge of embedded sensors, the heartbeat graph, and their 3D printed creation.

Timeframe: 50-to-70-minute class session for in-class activities plus assigned homework, but can be adjusted to your own timeframes

Modality: In-person, online, hybrid

Notes: Students must have prior knowledge of Excel

MATERIALS AND EQUIPMENT

SOFTWARE NEEDED (free or free version)

1. Vocabulary game – Kahoot
2. Heartbeat app – Phyphox (Use option "Acceleration w/o g")
3. Real World Talk – Flip
4. Heartbeat data plotting – Excel (Google Sheets - free)
5. Heartbeat 3D prep – Tinkercad
6. Final project showcase – Powerpoint (Google Slides - free)

ATTACHMENTS

Lesson – iHeart Sensors (Sample lesson provided. Edit as needed. Please credit Leslie Arriaga)

EDUCATIONAL STANDARDS

COMMUNITY COLLEGE FACULTY

The following standards are for CIS105 per Estrella Mountain Community College and Maricopa Community College District.

1. Describe Website Technology
2. Use the Internet to communicate, collaborate, and retrieve information.
3. Describe the steps in planning and implementing technology solutions.
4. Determine when technology is useful and select the appropriate tool(s) and technology resources to address a variety of tasks and problems.
5. Identify terminology and the uses of technology in business and society, including limitations.
6. Describe how technology is used in the departments of a business and in various career paths.
7. Use word processing, spreadsheet, database, and presentation software.

LEARNING OBJECTIVES

#	Learning Outcome	Cognitive Level	Condition	Criterion
1	**Recall** and **define** key vocabulary words related to embedded sensors.	Remembering	During the **Kahoot** activity, students will be given a list of vocabulary words related to embedded sensors	Successfully define at least 70% of the provided vocabulary words.
2	**Utilize** the downloaded app to **capture** their own heartbeats using embedded sensors.	Apply	Using their own smartphones and the **Phyphox** app.	Successfully capture and record their heartbeats using the app, demonstrating proper utilization of embedded sensors.
3	**Explain** the concept of at least one embedded sensor, its functionalities, and evaluate the limitations of using the embedded sensor in a real-life scenario.	Understand Evaluate	During their **Flip** video students will showcase their embedded sensor example.	Provide a clear explanation of an embedded sensor they encounter during their daily lives and explain what it is, how it works, and any limitations it may have
4	**Apply** data visualization techniques in Excel to **plot** the captured heartbeat data.	Create Analyze	Using **Excel** by plotting the exported data.	Create a visually appealing and informative graph depicting the plotted heartbeat data and evaluate the effectiveness of using sensors to capture physiological data.
5	**Generate** a 3D object and **print** it in the Makerspace.	Create	Using **Tinkercad** and 3D printers in the Makerspace.	Successfully print a 3D object that includes their heartbeat.
6	**Design** and **deliver** a slide presentation showcasing their knowledge of embedded sensors, the heartbeat graph, and their 3D printed creation.	Create	Using **PowerPoint** and incorporating relevant visuals.	Deliver a well-structured and visually engaging slide presentation that effectively communicates intro knowledge of embedded sensors, includes the plotted heartbeat graph, and showcases the 3D printed creation.

VOCABULARY

vocab word/phrase (lower case)	*Definition punctuated like a complete sentence even if it's only a phrase.*
Sensor	Devices that gather info from the real world and through programming can make the information available to humans in some manner
Transducer	A sensor that can convert information from one type of energy to another (eg microphone, speaker, camera, etc).
Temperature sensors	measure and detect changes in temperature, often used in applications such as climate control systems, weather monitoring, and food storage.
Pressure sensors	measure and detect changes in pressure levels, commonly used in applications like automotive systems, industrial machinery, and medical devices.
Proximity sensors	detect the presence or absence of objects within a certain range without physical contact. They are used in applications such as automatic doors, robotics, and touchless control systems.
Accelerometers	measure acceleration or changes in velocity and are commonly used in devices like smartphones, gaming controllers, and vehicle stability systems.
Gyroscopes	measure angular velocity or rotational motion and are used in applications such as navigation systems, drones, and virtual reality devices.
Light sensors	also known as ambient light sensors or photocells, detect and measure the level of light in the surrounding environment. They are used in applications like automatic lighting systems, brightness adjustment in displays, and energy-saving devices.
Humidity sensors	measure and detect the moisture content or relative humidity in the air. They find applicati in weather monitoring, HVAC systems, and indoor environmental quality control.
Biometric sensors	capture and measure biological characteristics unique to individuals, such as fingerprints, iris patterns, or facial features. They are used in applications like fingerprint scanners, facial recognition systems, and access control.
Motion sensors	detect movement or changes in motion. They are commonly found in security systems, gaming devices, and automatic lighting systems.
Gas sensors	detect and measure the presence and concentration of specific gases in the environment. They are utilized in applications such as air quality monitoring, industrial safety, and gas leak detection.

LESSON PROCEDURE

INTRODUCTION/MOTIVATION

Who has seen their own heartbeat?

How many of you have seen an ECG of your own heartbeat? Today we will be talking about embedded sensors – what they are, how they work, why they're important – and how we can use them to capture our very own ECG!

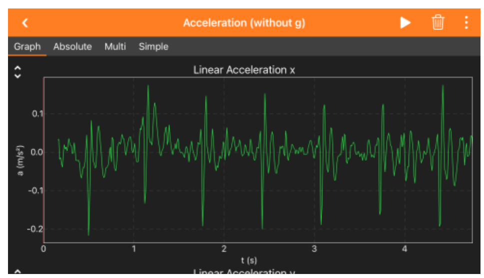
LEARNING ACTIVITIES/STRATEGIES

LESSON OVERVIEW

The lesson is numbered in chronological order. My LMS is Canvas and I typically setup my module so that the assignments are unlocked once the previous one has been submitted.

<u>Session 1 – In Class</u>

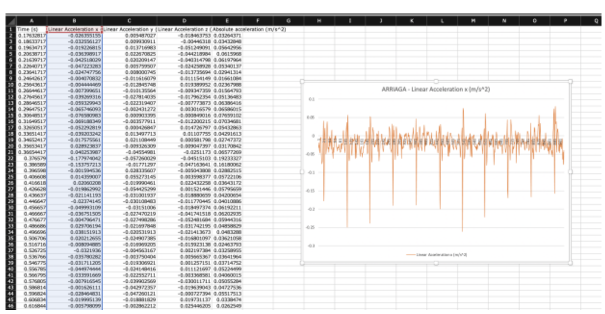
1) Micro Lecture - Intro to Embedded Sensors *(see Attachments)*
   a) What are sensors?
   b) Vocabulary
   c) Showcase my SenSip experience and explain the importance for wireless vital signals monitoring
2) Activity – Vocabulary Game
3) Activity - Heartrates
   a) Students download Phyphox
   b) Take their own heartrate with the App
   c) Export the data as an Excel file
   d) Rotate the phone to landscape mode and take a picture of the Linear Acceleration (x) as shown on right. This will be for their Presentation showcase.



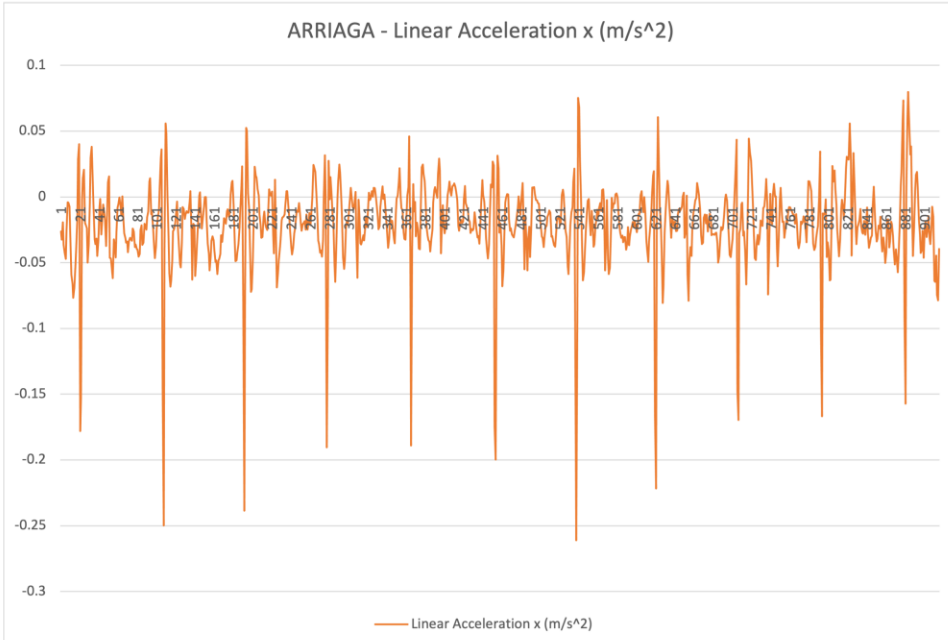
<u>Session 2 – In Class + Homework</u>

1) Assignment 1 – Real World Talk (RWT) – Show me the sensor
   a) Using the Flip app, students record a video of themselves identifying and demonstrating an item encountered in their daily life that contains embedded sensors.
   b) Note - This RWT is part of a series where I ask students to showcase different things depending on the subject we are learning (i.e. apps, hardware, coding, etc)

2) Assignment 2 – Graph heartrate data in Excel
   a) Students will graph the data they exported from the Phyphox app. Only show the "X" graph line in the graph as shown.



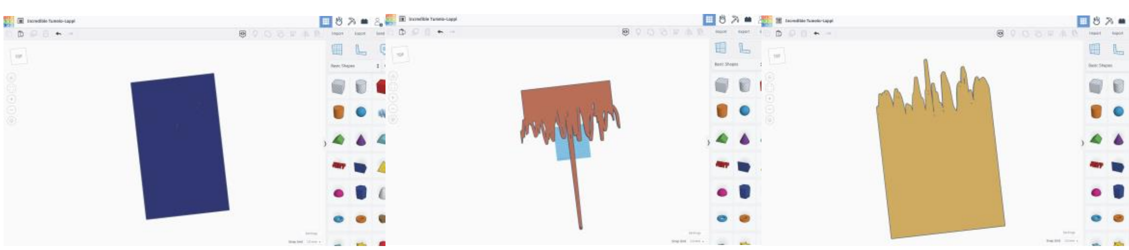
b) Export the graph as shown below. Students may want to change the appearance.



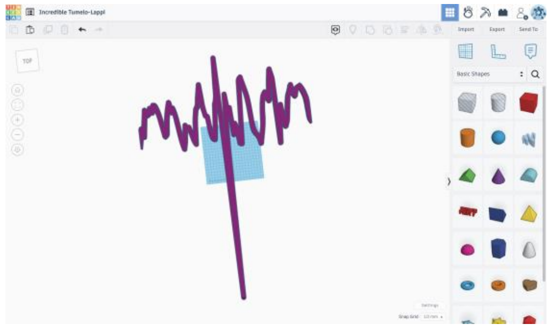
c) *Optional for 3D print.* Student chooses 1 cycle of heartbeat in the graph and takes a screenshot.
   (1) Students may need to drag the graph to the right to enlarge it
   (2) Make the line thinner
   (3) Delete the x-axis numbers and graph lines.

d) Submit
   (1) Image of graph
   (2) *Optional for 3D print.* Screenshot of the cycle chosen

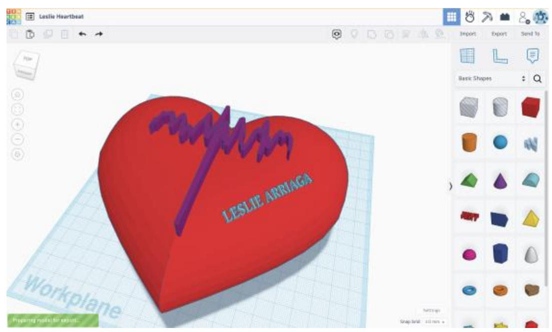
3) Assignment 3 (*optional*) – Use Tinkercad to prepare Excel graph to 3D print heartbeats
Note: The heartbeat cycle screenshots must be in SVG format to upload to Tinkercad. I accomplish this by taking the student screenshots and using Adobe Illustrator (not free). You can use [Adobe Express] for free to do this conversion but when I tried to import, it didn't work correctly. Other free option - [Gimp.] Below are samples of images not properly converted to SVG.



a) Students must create an account in Tinkercad and go through the [Tinkercad Tutorial.](Tinkercad Tutorial)
b) I will distribute each student their SVG screenshot files and each will upload their heartrate cycle into Tinkercad. Tinkercad will automatically generate the 3D object.



c) Students will incorporate their ECG cycle into a heart or other shape. They can create the other shape or use an already made one. Students must include: heartrate cycle, 2 other shapes, letters or numbers.



4) Assignment 4 – Use PowerPoint to create a presentation
   a) Slide 1 – Name, class, date, professor
   b) Slide 2 – Briefly explain embedded sensors, what types are there, which type did we use in class to capture heartbeat
   c) Slide 3 – Showcase your heartbeat Phyphox screenshot
   d) Slide 4 – Showcase your heartbeat Excel Graph
   e) Slide 5 – Showcase your 3D design and 3D print

CLOSURE

How cool was it to use embedded sensors to capture something that is happening inside our bodies (unseen), graph it, and now have a tangible item to represent the entire process. It may seem like magic, but in reality it's a lot of engineering and science. Throw in a little art into the mix and now we have our 3D print. Now anytime you see your 3D print it should remind you of your heartbeat and all the tech we used to bring that 3D print to life.

ASSESSMENT

FORMATIVE ASSESSMENT

Note – View the Learning Outcomes for a list of the Criterion

1) Lesson/Vocab recall – Kahoot
2) Successfully obtain ECG graph/data from app - Phyphox
3) Creation of graph from successfully obtained ECG data – Excel
4) Design of 3D print object – Tinkercad + Makerspace

SUMMATIVE ASSESSMENT

1) Project Showcase – PowerPoint

CONTRIBUTORS

INDIVIDUALS

Jean Larson – Suggested the Phyphox app

REFERENCES

Lecture slide template – SlidesCarnival

Phyphox app

SUPPORTING PROGRAM

RET Site: Sensor, Signal and Information Processing Algorithms and Software
Sensor, Signal and Information Processing Center (SenSIP), in partnership with Arizona State University and the National Science Foundation.

FUNDING ACKNOWLEDGEMENTS

This project is funded by the National Science Foundation (NSF) Award 1953745. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect those of the NSF.