SeaGlide_TEAM	Sensors, Serials, Methods	Lesson # 8-9 (60 minutes each)

Description:

Technology is rapidly evolving and is becoming more integrated into our everyday lives. It is used in many ways to work smarter, not harder. However, technology is helpful to a certain degree -- it is useful when it is utilized properly and optimally. Hence, the more we learn about technology, the more use we can get out of it. Our goal is to write Arduino code to program our SeaGlide. In this unit, we are going to begin learning about the basics of coding sensors and the use of methods in Arduino. This lesson is adapted from the Sensors, Serial, and Methods lesson provided by the U.S. Navy's SeaGlide DropBox.

Students will be able to:

- Code and use sensors with an Arduino board
- Code to calibrate sensors with an Arduino board
- Apply methods to coding in Arduino

Students will understand:

Students will understand why sensors are important and how they can use them. They will understand how to code a sensor so that they can be used on an underwater glider. Students will also understand how to code and calibrate their on sensors and why calibration is important. Using Methods is also an important skill in coding an underwater glider. Students will learn this skill so they can apply it in later lessons.

Key Definitions & Concepts [1]:

- **Bits:** unit of information size
- **Voltage Divider:** a set of resistors that split that split a voltage based on resistance
- **Sensor**: a device used to measure and collect data about a physical property
- **Serial Communication:** digital means of understanding what the processor is thinking
- **Methods (functions):** allows for the code to be broken up into tasks

Standards [Copied from: 2]:

1A.CS.02: Use appropriate terminology in identifying and describing the function of common physical components of computing systems (hardware)

3A.CS.01:Explain how abstractions hide the underlying implementation details of computing systems embedded in everyday objects.

3A.AP.13: Create prototypes that use algorithms to solve computational problems by leveraging prior student knowledge and personal interests.

	Background Information	

Prior Knowledge:

- Prior Python and Arduino lessons
- Prior Circuit lessons

Science Practices [Copied from: 3]:	**Core Ideas [Copied from: 4]:**	**Cross Cutting Concepts [Copied from: 5]:**
● Developing and Using Models ● Using Mathematics and Computational Thinking	● Developing Possible Solutions ● Optimizing the Design Solution	● Cause and Effect ● Systems and Models

Possible Preconceptions/Misconceptions:

Students may not realize how pertinant sensors are in their everyday life. They may think that sensors are only used in science experiments. In reality, sensors are used in our everyday lives, such as smoke detectors, thermometers, climate control systems, within cars, etc. Through completion of this unit plan, students will gain critical understanding about the functionality and applicability of sensors, and of the ways in which methods serve useful in programming.

	Lesson Plan - 5E(+) Model	

Engage: Lesson #1: Sensors [1]

Students will individually complete a brief *Review Quiz* on concepts from the previous arduino unit. This worksheet allows students to recall important information from previous days that are applicable within this unit plan. It is important for students to be able to recall this information so they can apply these understandings throughout this module's completion. The instructor should allow for students to complete the *Review Quiz* worksheet individually for 5 minutes, then facilitate an open class discussion to review students' answers and address any misconceptions as necessary. This section should take 10 minutes to complete.

Engage: Lesson #2: Serial & Methods [1]

Students will individually complete a brief *Review Quiz* on concepts from Lesson #1: Sensors within this unit plan. This worksheet allows students to recall important information from previous days that is applicable within this unit plan. It is important for students to be able to recall this information so they can apply these understandings throughout this module's completion. The instructor should allow for students to complete the *Review Quiz* worksheet individually for 5 minutes, then facilitate an open class discussion to review students' answers and address any misconceptions as necessary. This section should take 10 minutes to complete.

Explore: Lesson #1: Sensors [1]

Part I: Introduction

Students will fill out the *What is a Sensor?* worksheet in pairs. This worksheet asks questions to get students thinking about sensors, why they are important, and how they are used in everyday life. This helps students have a better thought process and background for when they are actually coding sensors in an arduino to use for a SeaGlide. The instructor should allow for students to complete the *What is a Sensor?* worksheet for 5 minutes, then facilitate an open class discussion to review students' answers and address any misconceptions as necessary. This section should take 10 minutes to complete.

Part II: *Benchmark Lesson*: Coding Sensors

Students will work in pairs to complete the activities section *2.1 Sensors* of the Arduino Unit 2 packet provided by SeaGlide, Sensors, Serial, and Methods. Reference the *Teacher Notes* attachment for materials lists and other information for this unit plan. Also, reference the *Instructor's Guide* to see how the packet should be read aloud while including stopping points for questioning, activities and explanations.

Through this portion of the lesson, students will have to wire their own circuit board, connect it to their computer and code sensors by editing stock code. Students will have to apply their knowledge about resistors from previous circuits lessons and from the prior Arduino Unit Plan to successfully complete the exercises and answer the questions within the U.S. Navy's SeaGlide packet. Further, they will answer questions about how the code should be edited for different sensors as well as explore what each sensor does. Students will make and record observations about each sensor throughout the entirety of this lesson. Hence, it is recommended for students to have a scientific notebook along with copies of the Sensors, Serial, and Methods packet for them to take diligent notes and provide answers to the posed questions. This will take 40 minutes to complete.

Explore: Lesson #2: Serial & Methods [1],[6]

Part I: Introduction

Students will watch the video A Brief History of Numerical Systems, and fill out the worksheet *Intro to Base Number Systems*. This video introduces students the idea and the concept of what a base is in regards to a numbering system. This is important since binary is a different base numbering system from the standard base 10 numbering system. The video also discusses other base systems used by programmers. Students will answer questions about the video and practice with binary. This will help students understand how binary works and what it is. Students should fill out the worksheet individually while the video is playing. The students should be given less than 5 additional minutes to review their responses with a partner. Then, the instructors should facilitate an open class discussion to review students' answers and address any misconceptions as necessary. Hence, this should take 15 minutes to complete.

Part II: *Benchmark Lesson*: Serial Communication

Students will work in pairs to complete the activities section *2.2 Serial* of the Arduino Unit 2 packet provided by SeaGlide, Sensors, Serial, and Methods. Reference the *Teacher Notes* attachment for materials lists and other information for this unit plan. Also, reference the *Instructor's Guide* to see how the packet should be read aloud while including stopping points for questioning, activities and explanations.

Through this portion of the lesson, students will utilize their wiried board and connection developed from Lesson #!: Sensors to complete this lesson. Through section *2.2 Serial* of the Arduino Unit 2 packet provided by SeaGlide, students will explore how serial communication works and how it is useful in sensor calibration. From prior Sensor Technology & Programming lessons, students should have a deep understanding in the functionality and usefulness of sensors and probes. Hence, students should be able to bridge those understandings into Arduino coding more readily. The packet includes exercises and analysis questions that students should be completing as the class progresses. Hence, it is recommended for students to have a scientific notebook along with copies of the Sensors, Serial, and Methods packet for them to take diligent notes and provide answers to the posed questions. Students will utilize stock code from the packet to calibrate their own sensors, and they will edit the code to adjust the base number system to understand how base number systems are important. This will take 20 minutes to complete.

Part III: *Investigation Lesson*: Methods

Students will work in pairs to complete the activities section *2.3 Methods Serial* of the Arduino Unit 2 packet provided by SeaGlide, Sensors, Serial, and Methods. Reference the *Teacher Notes* attachment for materials lists and other information for this unit plan. Also, reference the *Instructor's Guide* to see how the packet should be read aloud while including stopping points for questioning, activities and explanations.

Through this portion of the lesson, students will continue utilizing the circuit and connection from section *2.2 Serial* of the Arduino Unit 2 packet provided by SeaGlide. Through *2.3 Methods Serial*, students will build connections between functions and methods; they will explore the importance of hard and soft coding, and they will understand how to use methods in their codes. From prior Python lessons, students should have a deep understanding in the functionality and usefulness of functions. Hence, students should be able to bridge those understandings into Arduino coding more readily. Upon completion of this unit plan, students will be able to apply methods into a larger context of coding their underwater glider. This will take 15 minutes to complete.

Explain:

Throughout the exploration, the students will engage in discussions that inquire their understanding and knowledge of the information at-hand. Teachers should also be informally asking students to explain all topics and relevant connections throughout the entirety of this lesson when circulating the classroom. The worksheets include questions where students must explain their reasoning and troubleshoot. This gives the students an opportunity to verbalize their understandings.

Elaborate:

Coding is a very useful and real-world skill that all modern technology relies on. Students will have the chance to see how sensors, something that is common in their everyday lives, are coded and calibrated. They will explore the uses of sensors as well as the types of sensors that can be used for a range of real-world situations. Students will see how coding affects things that they may tend to neglect or not think about.

Evaluate:

Students are evaluated both informally and formally throughout the entirety of this lesson. The informal evaluations occur during the open class discussions. When the teacher is circulating the classroom, he/she is able to check for surface level understanding and make sure that the class is all on the same page by listening to students' discussions and responses. The instructor can gauge students' progress through observing whether or not they are struggling to complete the activities. The formal assessments of this lesson are the culmination of all the worksheets and review quizzes as well as whether or not the code runs properly. It is strongly recommended to instruct the students to return all documents used during each lesson for grading.

Enrich:

This lesson can be extended into physics because sensors and probes are used in physics laboratories all of the time. Students can code their own photoresistors to do experiments with light, light waves, and refraction when learning about optics. Coding sensors can also be used in other science laboratories such as chemistry in coding temperature and pH probes. Hence, this lesson is an excellent introduction for college-level laboratory based classes.

All associated documents are attached below

Reference *Annotated Bibliography* on the very last page of this packet

Lesson #1: Sensors Worksheets

Teacher Notes for Reference Day 1 [7]

Use the SIK Guide to access the following: (including pictures and diagrams)

- Downloading and accessing Arduino pages 4-9
- Materials list and inventory pages 12-13
- Build Guide potentiometer pages 25-28
- Build Guide photoresistor page 41-44

NOTE: Other examples are provided in this reference involving LEDs, but they are not the same as those provided from the U.S. Navy's SeaGlide DropBox. Temperature probes can be found pages 45-48.

Instructor Guide Day 1: [1]

Explore: Lesson #1: Sensors

Part II: *Benchmark Lesson*: Coding Sensors

Starting on page 14, have the students read aloud all of the information up until wiring the circuit on page 15. Then, have the students work in pairs to wire their circuit, connect their boards to the computer, and upload the code from page 16 onto their boards. It is recommended to give the students some time to explore the potentiometer.

Next, the teacher should read aloud the paragraph on page 16, stopping after each of the questions within that paragraph to gauge students' responses.

Some additional questions that should be posed to the students are as follows:

- What happens to a smart phone screen when it is placed in the sun? Why do you think this?
    - Answer goal: The screen brightens because of a light sensor
- The LED in this lesson simulates the behavior of such a screen. Does the LED change brightness well?
    - Answer goal: Yes
- How can using sensor be useful in SeaGlide?
    - Answer goal: Based on the purpose or mission of the underwater glider, sensors can help detect useful information about underwater environments. They can also be useful in relating to the underwater glider how to react in specific conditions
- What other kinds of sensors might you want to code on an arduino board?
    - Answer goal: Temperature, salinization, oxygen levels, CO2 levels

Once the open discussion is complete, the instructor should have the students work in pairs to complete the exercise at the top of page 17, i.e. "Replace the light sensor with a resistive flex sensor". The students should write in their scientific notebooks about their observations for this exercise.

Note: If time permits or if some pairs are ahead of others, they can be challenged by translating the Arduino code to run in Python. This would be a great introductory activity since the final unit plan of this module incorporates Python and Arduino together.

Name:_____ Date:_____

Review Quiz [1]

What is an LED?

What are pull-up versus pull-down resistors?

What is a NO switch?

What are global and local variables?

Name:_____ Date:_____

What is a Sensor?

What is a sensor?

How are sensors used?

Why are sensors important?

What types of sensors have you heard of before? How are they useful?

What kinds of sensors are used in your everyday life?

Lesson #2: Serial & Methods Worksheets

Teacher Notes for Reference Day 1 [7]

Use the SIK Guide to access the following: (including pictures and diagrams)

- Downloading and accessing Arduino pages 4-9
- Materials list and inventory pages 12-13

NOTE: Other examples are provided in this reference involving LEDs, but they are not the same as those provided from the U.S. Navy's SeaGlide DropBox.

Instructors Guide: Day 2 [1]

Explore: Lesson #2: Serial & Methods

Part II: *Benchmark Lesson*: Serial Communication

Starting on page 17 and ending on page 18, have the students read aloud all of the information. The instructor should give the students a few minutes review the code before uploading it to their boards. The students should work in pairs to work through the steps listed on pages 17 and 18. Since this is a continuation lesson, the students should not have to complete additional wiring or set-up. If students are having difficulty, the first step would be to check their connections. For example, the green LED should be in pin 3. So, if connected to a different pin, then the green LED will not light.

Next, have the students read aloud page 19 of the packet. Have the students work in pairs to complete the steps listed and to complete the listed exercise at the bottom of page 19. Students should be writing their observations and their answers to the exercises in their scientific notebooks throughout completion of the lesson.

Part III: *Investigation Lesson*: Methods

Starting on page 20, have the students read the paragraph aloud. It is recommended to give the students some time to take notes on this section after the open reading. It is also recommended to have the students explain the similarities and differences between methods (or functions) in Arduino versus Python. Since the students should have already completed the Python lessons, they should have a deeper understanding of what functions are and should be able to make the necessary connections to Arduino.

After this open discussion, have the students work in pairs to upload and run the provided code. The students should be taking discussion notes and writing about their observations after running a code in their scientific notebooks throughout the entirety of the lesson.

Name:_____ Date:_____

Review Quiz [1]

What is a sensor?

What is a potentiometer?

What is a photoresistor?

Name:_____ Date:_____

Intro to Base Number Systems [6]

Watch the video A Brief History of Numerical Systems and answer the following questions.

What is a base in a numerical system?

What is the most commonly used numerical system?

Why is 0 important?

What numerical systems are used most in coding?

What does it mean for a number system to be binary?

What elements are in the binary system? How are they used?

Write the number 32 in binary.

Lesson #1: Sensors
Answer Keys

Name:_____ANSWER_KEY_____ Date:_____

Review Quiz [1]

What is an LED?

An LED is a light emitting diode.

What are pull-up versus pull-down resistors?

Pull-Up Resistor: a highly restrictive path to +5V that pulls the input to HIGH when the lower-resistance path to ground (through the button) is not connected.

Pull-Down Resistor: a highly restrictive path to ground (0V).

What is a NO switch?

It electrically disconnects a circuit unless turned on. Hence, this type of switch only conducts electricity while on.

What are global and local variables?

A global variable is defined for the entire code and can be used throughout all of the code.
A local variable is defined in the loop and can only be used in the loop.

Name:_____ANSWER_KEY_____ Date:_____

What is a Sensor? [1]

What is a sensor?

A sensor is a device of some kind that collects information and data about a physical property.

How are sensors used?

Sensors are used to collect data. They are frequently used in technology to aid humans, such as thermometers.

Why are sensors important?

They give us necessary information and tell us what is going on around us. They are also useful in helping humans collect data and can be used in technology, such as phone screen's auto brightness.

What types of sensors have you heard of before? How are they useful?

Students answers will vary, but they may include pH, temperature etc. Students should have already completed the Sensor Technology & Programming module, so they should have a firm grasp about how each sensor was useful.

What kinds of sensors are used in your everyday life?

Student answers may vary, but some examples are as follows: temperature probe or thermometer, Carbon Monoxide detector, smoke detector, light adjustment on phone screen, etc.

Lesson #2: Serial & Methods
Answer Keys

Name:_____ANSWER_KEY_____ Date:_____

Review Quiz [1]

What is a sensor?

A sensor is a device of some kind that collects information and data about a physical property.

What is a potentiometer?

Potentiometers vary in resistance when turned and are commonly used in circuits as an input for tuning.

What is a photoresistor?

The photoresistor's resistance value changes in response to varying light exposure.

Name:_____ANSWER_KEY_____ Date:_____

Intro to Base Number Systems [6]

Watch the video A Brief History of Numerical Systems and answer the following questions.

What is a base in a numerical system?

The number of symbols or glyphs used in a number system

What is the most commonly used numerical system?

Base 10

Why is 0 important?

It is an important place holder and helps to avoid confusion. It makes for reliable and consistent notation.

What numerical systems are used most in coding?

Binary (or base 2), base 8, and base 16.

What does it mean for a number system to be binary?

It uses two numbers (or elements) to form larger numbers.

What elements are in the binary system? How are they used?

0 and 1

Write the number 32 in binary.
1: 1
2: 10
4: 100
8: 1000
16: 10000
32: 100000

Annotated Bibliography

[1] SeaGlide. (n.d.). Retrieved from http://seaglide.org/

This lesson plan was used for excerption within the Arduino Unit 2: Sensors,Serial & Methods unit plan. This referenced is used in completion of the explore in this unit.

[2] Standards Aligned System. (n.d.). Retrieved from https://www.pdesas.org/

This website was used in each lesson in the Arduino modules to select proper Pennsylvania State standards, which are based in Common Core, that each lesson is centered around.

[3] Nsta. (n.d.). Access the Next Generation Science Standards by Topic. Retrieved from https://ngss.nsta.org/AccessStandardsByTopic.aspx

This website used in every lesson in the Arduino Unit to find that are applicable in each lesson.

[4] Nsta. (n.d.). Disciplinary Core Ideas. Retrieved from https://ngss.nsta.org/DisciplinaryCoreIdeasTop.aspx

This website was used in each lesson in the Measurements and Data Analysis unit to select appropriate disciplinary core ideas set forth by the NSTA that are at the center of each lesson.

[5] Nsta. (n.d.). Crosscutting Concepts. Retrieved from https://ngss.nsta.org/CrosscuttingConceptsFull.aspx

This website was used in each lesson in the Arduino module to select appropriate crosscutting concepts set forth by the NSTA that apply to each mathematics lesson.

[6] TED-Ed. (2017, January 19). A brief history of numerical systems - Alessandra King. Retrieved from https://www.youtube.com/watch?v=cZH0YnFpjwU

This video is used as an instructional tool to engage students in the in the Arduino Unit 1:LEDs, Resistors, Buttons unit plan. Questions were developed based on this video for students to answer.

[7] SIK Guide. (n.d.). Retrieved from https://cdn.sparkfun.com/

This reference is used for teacher guidance. It gives them another resource to use with the lesson.