SeaGlide_TEAM	Temperature	Lesson #2 (60 minutes)

Description:

For this lesson, you will be assuming the role of an environmentalist. You and your colleagues are concerned about the effects of global warming on the local water bodies. After a meeting with your manager, you decide to test the temperature of the water from two locations nearby, and compare the two readings to determine how the location, surrounding wildlife, and/or industries and factories affect the average temperature of streams. You will have to interpret and analyze your findings and state how the water's surroundings affect the water temperature. The focus of this lesson is on the data collection using the provided temperature sensor.

Students will be able to:

- Understand the necessity for sensors
- Properly utilize sensors to collect data
- Find trends found in the data and interpret what these trends mean
- Figure out reasons for any usual data found. It could be because of environmental reasons or human interference in natural processes
- Determine how temperature affects living things in that area
- Determine ways to improve conditions if they are bad, or find methods to preserve and maintain current conditions if they are good

Students will understand:

In this lesson, students will go out and experiment on a real, existing water body. They will record several data and students will be questioned based on their findings. Successfully completing this exercise will ensure that students learn all of the learning goals. Using sensors to test and gather data is an essential part of any and all scientific procedures. Studying output data reveals if a system is functioning the way it is supposed to, or if there are issues that need fixing. In the case of a natural entity, collected data show trends that are observed and studied to determine the state of that entity. For example, using a temperature sensor on various water bodies can illuminate how global warming affects different areas.

Key Definitions & Concepts: [1]

- **Sensor:** a device which detects or measures a physical property and records, indicates, or otherwise responds to it
- **Vernier Computer Interface:** a Vernier device that connects a Vernier sensor to a computer to display the results
- **Vernier Temperature Probe:** a device that measures temperature
- **Logger Pro:** a data collection and analysis software for Windows and Mac. This is the platform on which the collected data is displayed, and the interface provides users with several options to analyze the presented data

Standards: [Copied from: 2]

4.1.10.B: Explain the consequences of interrupting natural cycles.

4.1.10.E: Analyze how humans influence the pattern of natural changes (e.g. primary / secondary succession and desertification) in ecosystems over time.

HS-PS1-5: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

Background Information

Prior Knowledge:

- Knowing how to use sensors
- Understanding the Scientific Method and how data collection is an essential part of it
- Basic arithmetic and algebraic knowledge to solve mathematical equations

Science Practices: [Copied from: 3]

- Asking questions and defining problems
- Developing and using models
- Carrying and Planning Out Investigations
- Analyzing and interpreting data
- Using Mathematical and Computational Thinking
- Obtaining, Evaluating and Communicating Information

Core Ideas: [Copied from: 4]

- Earth Material and Systems
- Human Impact on Earth Systems

Cross Cutting Concepts: [Copied from: 5]

- Patterns
- Cause and effect
- Scale, Proportion and Quantity
- Systems and system models

Possible Preconceptions/Misconceptions:

While the world debates about which of the temperature units are correct, the SI unit used in all scientific calculations is Kelvin, K. The temperature probes can be set to detect temperatures with any of the three possible units: Kelvin, celsius or fahrenheit.

Lesson Plan - 5E(+) Model

Engage:

Students will be working with a temperature sensor during this lesson. To understand the need to measure and collect temperature, students must understand the importance of temperature. The instructor will hand out the *Temperature* worksheet and the students will need about 5 minutes to complete it with a partner. This worksheet will help the students understand that temperature can affect

all systems and that keeping a measure record of temperature changes can help troubleshoot issues. The instructor should facilitate an open class discussion to review students' responses and address any misconceptions as necessary. This section should take no longer than 10 minutes to complete.

Explore: [1]

Part I: Introduction

The instructor will distribute the *Temperature* Vernier Experiment worksheet and experiment materials. The instructor will then discuss the experimental procedure and safety protocol for the lesson. Reference the attached *Instructor's Guide* as necessary. Afterward, the instructor will allow for any questions students may have regarding the experiment. The instructor should allot 5 minutes for this.

Part II: *Benchmark Lesson*: Temperature Experiment

Students will work on the *Temperature* Vernier Experiment in this section. The experiment will be carried out in a lab. Students can be allowed to work in pairs if the class size is too large; however, students should be able to carry out the experiment individually. The purpose of this activity is to give students first hand experience in collecting data using a temperature probe and in using their readings to answer conceptual questions. Students are expected to follow the procedure listed in the *Temperature* Vernier Experiment to complete the lesson. Students will be working with two different samples of water, that will be labelled as 'Site A' and 'Site B', and will be provided by the instructor. The instructor should circulate the classroom to assist the students with any issues they face or with any questions they might have. This activity should take about 20 minutes to complete.

Part III: *Investigation Lesson:* Analysis

After the *Temperature* Vernier Experiment, students will be required to answer questions that pertain to the experiment and the application of the lesson goals. Working individually, students will need to invoke critical and higher-level thinking to answer these questions on the *Analysis Questions* worksheet. The content of these questions range from simple experimental details (including the learning objectives) to more complex topics (such as experimental errors within the activity). Students will also be extending the lesson topic to their SeaGlide and to understanding how the temperature of the water affects its function.

Explain:

Throughout the exploration of this lesson, students will engage in discussions and activities that seek to discover their understanding of the topic at-hand as it relates to temperature detection and calculations. Instructors should informally ask questions to promote thoughtful discussion that is designed to aid in addressing any questions or concerns that some students may have. Students are expected to formalize their answers throughout the entirety of the lesson via the worksheets and the activities.

Elaborate:

The experiment has the students measure the temperature of water from two different locations to see how they differ. The purpose of this is to introduce the students to temperature recording and to using the values to detect trends. Temperature is an essential component of every system, and fluctuations

can lead to malfunction. The need to keep temperature constant is imperative and to be able do so, one must know how to measure it. SeaGlide operators must be adept in interpreting what fluctuations in temperatures mean. While the sensors connected to the device are measuring the temperature of the surroundings, there are meters on the device that show the current working temperature of the SeaGlide. A temperature that is too high would melt the circuits, while a temperature too low would result in unresponsive devices. Also, the surrounding temperatures could affect the features of a SeaGlide.

Evaluate:

Throughout this lesson, there are both formal and informal evaluations. The informal evaluations occur throughout the exploration portions via leading and open-ended questioning, as well as through the open class discussions. The informal evaluations will allow for the teacher to gauge surface-level understanding of the students. By surveying the students during completion of the worksheets and activities, teachers will be able to hear and to address any misconceptions or misunderstandings as necessary. The formal evaluations of this lesson are the *Temperature* Vernier Experiment, and the *Analysis Questions* worksheet.

Enrich:

This lesson can be differentiated into a physics classroom as an introduction to thermodynamics. In Thermodynamics, different systems interact by the virtue of their temperature. This means that systems behave differently because of the amount of heat/thermal energy they contain. Hence, this lesson's experiment and analysis serves as a great starting point for introductory physics students to begin learning about how temperature and its fluctuations actively affect the functionality of a given system.

All associated documents are attached below

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

NOTE:

This lesson incorporates the use of the *Water Quality with Vernier by Robyn L. Johnson, Dan D. Holmquist, and Kelly Redding, Second Edition*. The SeaGlide Curriculum Team created an engagement to preface this experiment and added an additional analysis to conclude this lesson. The engagement activity is designed to pique students' interest in completing the experiment. The purpose of the analysis is to promote critical thinking techniques as students relate this lesson to SeaGlide by completing the *Analysis Questions* worksheet.

Additionally, the experiment (Experiment 1: Temperature) used during the exploration can be found in the Water Quality with Vernier lab manual, starting on page 1-1.

Name:_____ Date:_____

Temperature

1. How would you define Temperature?

2. Give two examples where increasing temperature is detrimental for a system (e.g. engine overheating). You cannot use the example as your own answer.

3. Give an example where low temperature is affects a system negatively.

Name:_____ Date:_____

Analysis Questions

1. What was the objective of this activity? Refer back to the data you were collecting and how you were collecting it.

2. In most experiments, the sensor or probe utilized must be calibrated. Why is this not necessary in this experiment?

3. No experiment is 100% correct or without fault. Describe at least one source of error that is present in this experiment.

4. While piloting your SeaGlide, you notice a spike in the temperature of the water surrounding the probe. List two possible reasons as to why this might occur. Defend your responses.

Name:_____ANSWER KEY_____ Date:_____

Temperature

1. How would you define Temperature?

   Students' answers will vary, but one example is the following: the degree or intensity of heat present in a substance or object.

2. Give two examples where increasing temperature is detrimental for a system (e.g. engine overheating). You cannot use the example as your own answer.

   Students' answers will vary, but some examples are as follows:

   High fevers can lead to serious medical issues including organ failure and death. High temperatures can lead to circuits overheating which can lead to machine malfunction and failure. Increasing temperatures have been linked to Climate Change, which affects living conditions for organisms, ecosystems and can eventually lead to extinction.

3. Give an example where low temperature is affects a system negatively.

   Students' answers will vary, but one example is the following: phones, computers and other technology malfunction at low temperatures.

Name:_____ANSWER KEY_____ Date:_____

Analysis Questions

1. What was the objective of this activity? Refer back to the data you were collecting and how you were collecting it.

   The objective of this experiment was to use a temperature sensor to measure and compare the temperature of water from two different sites, at least 1 mile apart.

2. In most experiments, the sensor or probe utilized must be calibrated. Why is this not necessary in this experiment?

   The probes that are being used consist of a thermistor. The resistance of a thermistor changes non linearly with the surrounding temperature. Thus, there is no way there could be any lingering features that would required calibration for accurate results.

3. No experiment is 100% correct or without fault. Describe at least one source of error that is present in this experiment.

   Answers may vary based on student response or experimental techniques.

   One source of error that gives inconsistent results could be the depth at which the probe is held. At lower depths, the temperature is generally lower.

4. While piloting your SeaGlide, you notice a spike in the temperature of the water surrounding the probe. List two possible reasons as to why this might occur. Defend your response.

   There are several reasons for spikes in temperatures underwater. One unlikely, but very real, reason could be an underwater volcanic eruption that raises the temperature of the surrounding water. Another reason for an increase in temperature could be changing underwater current. Current is very unpredictable, and it is not unlikely to have a current bring in warmer water from a different zone.

Annotated Bibliography

[1] Johnson, R. L., Redding, K., & Holmquist, D. D. (2007). *Water Quality with Vernier: Water Quality Tests Using Vernier Sensors*. Vernier Software & Technology.

This book was used for excerption within the Temperature lesson plan. The reference aided in the completion of the Explore. Test 1 in the book, the Temperature test, was excepted for the students. Pages 1-1 through 1-4 contain information, required material, procedure and a data collection sheet for the students. The following two pages were designed for the instructors, so that they are able to troubleshoot the students' questions and misconceptions. The Venier book is an excellent resource to learn sensor technology. It contains detailed experiments to test different water conditions, and determine if the findings fall within the normal range.

[2] Nsta. (n.d.). Access the Next Generation Science Standards by Topic. Retrieved January 18, 2019, from https://ngss.nsta.org/AccessStandardsByTopic.aspx

This website was used in each lesson in the Sensor Technology & Programming module to select proper national set standards for science subjects that each lesson is centered around.

[3] Nsta. (n.d.). Science and Engineering Practices. Retrieved January 18, 2019, from https://ngss.nsta.org/PracticesFull.aspx

This website used in every lesson in the Sensor Technology & Programming module to find Standards for Science and Engineering Practices 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 Sensor Technology & Programming module 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 Sensor Technology & Programming module to selecting appropriate crosscutting concepts set forth by the NSTA that apply to each science lesson.