SeaGlide_TEAM	Turbidity	Lesson # 4 (60 minutes)

Description:

For this lesson, you will assume the role of a hydrologist, which is a scientist who researches the distribution, the circulation and the physical properties of underground waters and surface waters. Part of your job entails going into forests or wooded areas and studying the water bodies present. Here, you will be working with samples of water to determine the turbidity of the water from these areas. You will have to prepare a report based on your findings and include your interpretations of what the values mean. The purpose of this project is to observe how water quality is affected by human activity in the areas.

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
- Observe how the readings affect a SeaGlide and the wildlife in the 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 relative humidity sensor in a rainforest can show if the plants are healthy and photosynthesizing adequately etc.

Key Definitions & Concepts: [1]

- **Turbidity:** a measure of water's lack of clarity; water with high turbidity is cloudy, while water with low turbidity is clear
- **NTU:** Nephelometric Turbidity Unit, the units for measuring turbidity
- **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 Turbidity Sensor:** a device that may be used to measure the turbidity of water
- **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.

K-ESS3-3: Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

Background Information

Prior Knowledge:

- Students must be familiar with using Vernier equipment
- Ability to create graphs from a table of data and then find trends after studying the graph
- Familiarity with sensor functions and usage

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
- Roles of Water in Earth's Surface Processes
- Biogeology
- Natural Resources
- 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:

The turbidimeter must be calibrated before every use, and the accuracy of the device must be validated quarterly. The device must be cleaned with distilled water after every use as well to ensure there are no contaminations on the sensor. This way user will get most efficient and accurate results every time.

Lesson Plan - 5E(+) Model

Engage: [6]

This lesson is based on Turbidity tests and water quality. Students will carry out turbidity tests on samples of water and use their data to answer questions and for critical thinking. Before students begin the experiment, they must complete this section which is intended to give them a clearer idea of what turbidity is. The instructor should hand out the *Turbidity* worksheet and students will have about 5

minutes to complete it with a partner. The instructor should facilitate an open class discussion to review students' responses and address any misconceptions as necessary. This section should last less than 10 minutes.

Explore: [1]

Part I: Introduction

The instructor will give a brief overview of the *Turbidity* Vernier Experiment. The instructor will distribute materials, go over safety guidelines, and answer any questions that students may have prior to experimentation. The instructor should allot 5 minutes for this.

Part II: *Benchmark Lesson*: Experiment

Students will work on the *Turbidity* Vernier Experiment individually. This activity is designed for students to gain first-hand experience in collecting data from a water body, and then use these values to answer conceptual questions. The experiment will be carried out in a lab, with the samples provided by the instructor. Students are expected to follow the procedure listed in the *Turbidity* test in the Vernier book to complete the lesson. The instructor should circulate throughout 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 completion of the *Turbidity* 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 understanding how turbidity 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 turbidity determination. 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 turbidity of sampled of water. This is one of the most important aspects that students should consider when operating a SeaGlide because the device is operated underwater, and the difficulty to maneuver a SeaGlide depends on both the stream flow as well as the clarity of the water. Depending on the state of the water body, students may have to add a thermal sensor to be able to navigate through the unclear water. Knowing how to measure the turbidity of the water is necessary, and being able to use the Vernier equipment is imperative as a result.

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 *Turbidity* Vernier Experiment, and the *Analysis Questions* worksheet.

Enrich:

This lesson can be extended to an aquatic ecology course because of the *Turbidity* Vernier Experiment activity. In aquatic ecology, field work involving stream water sampling and aquatic environmental factor data collection is heavily emphasized and required for coursework. This lesson and its associated activity can be further extended by including water purification examples where turbidity tests could be used to measure the water clarity after different stages of water treatment. Turbidy can also be used in the medical field to test blood or urine.

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 3: Turbidity) used during the exploration can be found in the Water Quality with vernier lab manual, starting on page 3-1.

Name:_____ Date:_____

Turbidity [6]

1. What are two factors that increase the turbidity of water?

2. If a sample of water is cloudy solely because of dirt and dust, what is the best way to clean the sample?
    a. Filtration
    b. Sedimentation
    c. Boiling
    d. Adding Chlorine

3. How would turbid water affect the aquatic plant life in that water body?

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. Turbidity tubes are cleaned with distilled after each experiment. Why?

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

4. Suppose you determine the turbidity of a body of water that you are going to place your SeaGlide in. Describe how the turbidity would affect its movement in the water.

Name:_____ANSWER KEY_____ Date:_____

Turbidity [6]

1. What are two factors that increase the turbidity of water?

   Students' answers may vary, but some examples are as follows: sediments, fertilizers, finely divided organic and inorganic matter

2. If a sample of water is cloudy solely because of dirt and dust, what is the best way to clean the sample?

   a. Filtration
   b. Sedimentation
   c. Boiling
   d. Adding Chlorine

3. How would turbid water affect the aquatic plant life in that water body?

   Turbid water would prevent sunlight from penetrating far into the water body. The plants underwater would, therefore, not be able to photosynthesize. Hence, aquatic plant life would die.

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 activity was to determine the turbidity of a body of water using measurements obtained from two sites along the stream.

2. Turbidity tubes are cleaned with distilled after each experiment. Why?

   To clean out all the impurities that might be clinging to the walls of the tube.

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 example is as follows: the walls of the turbidity tube might be scratched. This would result in a higher turbidity value than the actual values.

4. Suppose you determine the turbidity of a body of water that you are going to place your SeaGlide in. Describe how the turbidity would affect its movement in the water.

   Turbidity affects the clarity underwater. Water would be too cloudy if the turbidity is high and vice versa. So, turbidity would change the visibility underwater and this would make it difficult for the SeaGlide to be maneuvered.

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 Turbidity lesson plan. The reference aided in the completion of the Explore. Test 3 in the book, the Turbidity test, was excepted for the students. Pages 3-1 through 3-4 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 Vernier 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.

[6] Water Purification. (n.d.). Retrieved April 15, 2019, from https://www.tyndale.edu.au/library/Senior/Science/Chemistry/Water_Quality/waterquality/lo/inv_03/inv_03_ap03_text.htm

This website was used for excerption within the Turbidity lesson plan. The reference aided the students in getting a clearer understanding of turbidity and its effects on the water body. Questions were excerpted from the website to be used in the Engage section of the lesson. The questions were intended to give students preliminary knowledge about what is to come in the next sections.