SeaGlide_TEAM	Stream Flow	Lesson # 1 (60 minutes)

Description:

For this lesson, you will assume the role of a hydrologist - a scientist who researches the distribution, the circulation and the physical properties of underground waters and of surface waters. Part of your job entails going into forests or wooded areas and studying the water bodies present. Here, you will be travelling with some of your colleagues to a nearby park to measure the flow rate of a creek. You will have to prepare a report based on your findings and include your interpretations of what the values mean. In order to do this, you must have a good understanding of how sensors work.

Students will be able to:

- Understand the necessity for sensors
- Properly utilize sensors to collect data
- Solve mathematical equations using the data they found
- 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 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. This lesson serves as an introduction to sensor technology.

Key Definitions & Concepts: [1]

- **Stream Flow/Discharge:** the volume of water that moves through a specific point in a stream during a given period of time. This is calculated by multiplying the velocity of the water with the cross sectional area of the stream
- **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 Flow Rate Sensor:** a device that consists of a propeller attached to one end of a rod. This device measures the velocity of the water flowing through
- **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

- **Cross Section:** a view into the inside of something made by cutting through it. For example, the cross section of a cylinder is a circle. **Cross-sectional Area** is the area of this view
- **Correction Factor:** a value used to make the flow rate value more accurate, since surface flow rate always differs from the flow rate under water

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.

Background Information

Prior Knowledge:
- Basic arithmetic and algebraic knowledge to solve mathematical equations
- Familiarity with computers tools to use Logger Pro and to connect the Vernier Computer Interface
- Ability to create graphs from a table of data and then find trends after studying the graph

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:
Students may be given values that are either in the incorrect units or not similar to other students' results. This could be the result of a sensor error or incorrect input values. The instructor should consult the Stream Flow Experiment in the Vernier book for guides to alleviate these misconceptions.

	Lesson Plan - 5E(+) Model	

Engage: [6]
The Sensor Technology and Programming module introduces students to the idea of sensors, how they are used to collect data, and how these data are interpreted. This lesson deals with utilizing a sensor to measure the flow rate of a stream. The instructor will begin by giving a brief description of what a sensors are and why they are necessary. The definition of sensor is provided in the Key Definitions and Concepts section. Sensors are necessary since they are used to collect data about any aspect of a system, and this data is then studied and determine if the system's specifications are within the normal range. For example, temperature sensors are used extensively in manufacturing plants. These sensors continuously provide temperature readings, and drastic fluctuations would mean that something is wrong and has to be fixed. The instructor will then show the Measuring flow of a stream video, and hand out the *Float Method* half sheet for the students to complete individually. Students will have 5 minutes to complete this half sheet while watching the video. Then, 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 give a brief overview of the *Stream Flow* 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 *Stream Flow* Vernier Experiment in pairs or small groups of three. This activity is designed for students to gain first-hand experience by collecting data from a stream. During this activity, students will be actively engaged in the learning process by collecting data in the field. Students will following along with the *Stream Flow* Vernier Experiment worksheet procedure. If a stream is not readily available for the instructor, two pipes of differing diameters may also be used by having one student can pour the water into the pipe while another holds the sensor to collect the data. This activity should up to 20 minutes to complete.

Part III: *Investigation Lesson*: Analysis
After the *Stream Flow* 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 how streamflow 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 stream flow determination. Instructors should informally ask questions to promote thoughtful discussion that is designed to aid in

addressing any questions or concerns that the students may have. Students are expected to formalize their answers throughout the entirety of the lesson via the worksheets, the analysis questions, and the open class discussions.
<u>Elaborate:</u> The experiment has the students measure the width and average depth of a creek which they then use to determine the flow rate. This is one of the most important aspects that the students should consider when operating a SeaGlide because the device is operated underwater and because the difficulty to maneuver a SeaGlide depends almost completely on the flow rate of the medium. The faster the current is, the more difficult it is to operate the SeaGlide. Therefore, students must be familiar with stream flow rates of water bodies that they want to navigate and must modify/design their SeaGlides accordingly.
<u>Evaluate:</u> 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 unit are the *Stream Flow* Vernier Experiment and the *Analysis Questions* worksheet.
<u>Enrich:</u> This lesson can be extended to an aquatic ecology course because of the *Stream Flow* Vernier Experiment activity. In aquatic ecology, field work involving stream water sampling and aquatic environmental factor data collection is heavily emphasized and is required for coursework. This lesson and its associated activity can be further extended by including other data collection methods, such as: plant life collection, predator-prey interactions, and microenvironment analysis.

All associated documents are attached below
Reference *Annotated Bibliography* on the very last page of this packet

<u>NOTE</u>:
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 16: Stream Flow) used during the exploration can be found in the Water Quality with vernier lab manual, starting on page 16-1.

Name:______________________________ Date:________________

Float Method [6]

You and two of your friends decide to carry out the experiment shown in the video at a nearby creek. Once you completed and recorded all the necessary data, you need to calculate the Flow Rate. You measured the width of the creek to be 3 m, the average depth was determined as 1.5 m. The bottle that floated covered a distance for 2 m in the span of 1.8 minutes. Given that the correction factor is 0.85, what is the flow rate of flow of the stream?

Name:______________________________ Date:________________

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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 Step 6a, data collecting for Points 1 and 7 are skipped. Why was this done?

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 Stream Flow of a body of water that you are going to place your SeaGlide in. Describe how stream flow will affect its movement in the water.

Name:____________________ANSWER KEY__________________ Date:_______________________

Float Method [6]

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<u>The formula showed in the video was:</u>
<u>Stream Flow = Width X avg Depth X (Velocity of water) X Correction factor</u>

<u>Velocity = Distance X time</u>

<u>Therefore, V = 2m*1.8*60 s = 216 m/s</u>

<u>Stream flow = 3m * 1.5m * 216m/s * 0.85 = 826.2 m^3/s</u>

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 stream flow of a body of water using measurements obtained from two sites along the stream.

2. In Step 6a, data collecting for Points 1 and 7 are skipped. Why was this done?

   Points 1 and 7 were skipped in Step 6a because they are near the water's edge and, therefore, have little to no water flow at those points.

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 in this experiment could be the disuse of plastic risers. The plastic risers allow for the sensor to be supported, which allows for greater control on the location and direction orientation of the sensor.

4. Suppose you determine the Stream Flow of a body of water that you are going to place your SeaGlide in. Describe how stream flow will affect its movement in the water.

   If the SeaGlide is travelling in the same direction as the stream flow, then the SeaGlide will be provided additional thrust. This would increase the speed of the SeaGlide. However, if the SeaGlide is travelling in the opposite direction of the stream flow, then additional drag will be provided. This would decrease the speed of the SeaGlide. If the stream flow is moving perpendicular (or at any side angle) to the SeaGlide, then the SeaGlide would be pushed in the direction of the stream flow. Hence, it would no longer glide in a straight line.

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 Stream Flow lesson plan. The reference aided in the completion of the Explore. Test 16 in the book, the Stream Flow test, was excepted for the students. Pages 16-1 through 16-6 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] Arizona Department of Environmental Quality (ADEQ). (2018, March 02). Measuring the Flow of a Stream | The Float Method. Retrieved from https://www.youtube.com/watch?v=W1IUdxE5BGU

This YouTube video was used for excerption within the Stream Flow lesson. The reference aided the students in realizing what data measured entails and how it is done. Only a segment of the video was excerpted, and it was used by the students to complete the Engage.