SeaGlide_TEAM	Chloride & Salinity	Lesson # 6 (60 minutes)

Description:

For this lesson, you will assume the role of an engineer working at Vernier. Your job primarily involves sensor design and improvement. Currently, Vernier produces three different probes that measure the same quantity - salinity. Salinity in water, generally, means the density of chloride ions in the water. Your task today is to test three samples of water from the same source to determine the amount of chloride ions they contain and to use that amount to measure the salinity of the samples. You are then to compare the results for the three sensors and determine which is the most effective. Your company will advertise and advocate for the sensor of your choosing based on your experimental data.

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
- Compare the data derived using three different methods and determine which is the best method

Students will understand:

In this lesson, students will record several data, and 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 is excellent is introducing three different methods to measure the same sample quantity, and then using the findings to determine the best method. This is an essential part of engineering since comparison and trial and error can help in achieving the most accurate methods of obtaining data.

Key Definitions & Concepts: [1]

- **Salinity:** the
- **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
- **Chloride ISE:** an Ion Selective Electrode (ISE) is a special electrode that is used to determine the concentration of one particular ion from a solution. Chloride ISE measure the chloride ions only
- **Salinity Probe:** a sensor that measure the salinity of a sample of water by detecting the amount of chloride ions in the sample

- **Conductivity Probe:** a sensor that measures how well a sample conducts electricity. This is used to determine the salinity since the more the more the conductivity, the more the ions, and hence more the salinity
- **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.

Background Information

Prior Knowledge:

- Basic arithmetic and algebraic knowledge to solve mathematical equations
- Familiarity with computers tools, to use Logger Pro, and connect the Vernier Computer Interface
- Familiarity with sensor functions and usage
- Ability to create graphs from a table of data and then find trends after studying the graph
- Ability to read and compare data and determine the best figures

Science Practices: [Copied from: 3]

- Asking questions and defining problems
- 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
- Biogeology
- Natural Resources
- Human Impact on Earth Systems

Cross Cutting Concepts: [Copied from: 5]

- Patterns
- Cause and effect
- Scale, Proportion and Quantity

Possible Preconceptions/Misconceptions:

Salinity is generally measured in terms of the concentration of chloride ions present in a solution. This is only because, in brackish and ocean waters, chloride ions are prevalent is significantly larger quantity than any other ions. This is an important to know for this experiment since we are measuring the Chloride ion concentration only to determine salinity.

	Lesson Plan - 5E(+) Model	

Engage: [6]

This lesson is based on salinity tests and water quality. This section of the lesson is designed to ask students to calculate the salinity from the derived Chloride ion concentration - a method that they will have to use again in the *Analysis Questions* worksheet. The *Salinity* worksheet for this section asks a conceptual question that is intended to help students understand the significance of salinity, and how it relates to density. Students will have about 5 minutes to answer the questions individually. Once completed, 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], [7], [8]

Part I: Introduction

The instructor will give a brief overview of the *Chloride and Salinity* 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 *Chloride and Salinity* Vernier Experiment in pairs or small groups of three. The test can easily be done individually but pairs or groups are recommended since the test incorporates three different testing methods. This activity is designed for students to gain first-hand experience in determining salinity and chloride concentration in samples. During this activity, students will be actively engaged in the learning process. Students are expected to follow the procedure listed in the *Chloride and Salinity* 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. While providing the samples of water for the students, it is imperative that the actual salinity of the source is provided. Otherwise, students will not have any control value to compare their salinity values to. The Vernier lab manual does not specify where to get the sample of water to be tested from. Since students are expected to determine the accuracy of the three sensors, the instructor is should provide the students with samples of known concentration. The sample should have a salinity of 25 ppt. The instructor could either make the solution before the class, or purchase a solution of 25 ppt salinity. This activity should take about 30 minutes to complete.

Part III: *Investigation Lesson*: Analysis

After the *Chloride and Salinity* 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. 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 the water salinity 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 chloride concentration and salinity

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 expected amount of chloride found in water bodies would not affect the movements of a SeaGlide. The SeaGlide would, in fact, be equipped with salinity and chloride sensors to collect data. Unusually high chloride counts, and therefore very saline waters, would affect the SeaGlide. The more saline a water body is, the more dense it becomes. This means, the SeaGlide would not be able to submerge as deeply under the water when compared to a minimal to normal salinity range. Although very unlikely, an example of this can be seen in the Dead Sea. The salinity is so high that anyone swimming in the Dead Sea floats. Therefore, the students must be aware of the salinity of the water they are planning on sailing their SeaGlides.

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 *Chloride and Salinity* Vernier Experiment, and the *Analysis Questions* worksheet.

Enrich:

This lesson can be extended to an aquatic ecology course because of the *Chloride and Salinity* 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 other data collection methods, such as: plant life collection, predator-prey interactions, and microenvironment analysis. The salinity of water affects all of these data. The lesson could also be extended to chemistry lessons were students are taught to use various chemicals to desalinate the sample.

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 15: Chloride and Salinity) used during the exploration can be found in the Water Quality with vernier lab manual, starting on page 15-1.

Name:_____ Date:_____

Salinity [6]

1. If there is 0.023 g of chloride ions in 100 liters of water, what is the concentration of chloride ions in the sample in mg/L?

2. Using this relationship: salinity(ppt) = 0.0018066 X Cl^- (mg/L), what is the salinity of the sample of water above.

3. Why does the ocean contain higher concentrations of chloride as opposed to freshwater environments?

Name:_____ Date:_____

Analysis Questions [7], [8]

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

2. For Method 1, calculate the salinity of the sample using the relationship provided in page 15-1.

3. Now that you have the salinity readings from three different methods, which method is the most accurate? Defend your choice with evidence.

4. The Dead Sea has one of the highest known measurements of salinity concentrations when compared to any other body of water around the globe. Discuss the differences in the sailing of your SeaGlide in the Dead Sea versus the Baltic Sea. Defend your assumptions. Hint: the Baltic Sea has a relatively low salinity concentration.

Name:_____ANSWER KEY_____ Date:_____

Salinity [6]

1. If there is 0.023 g of chloride ions in the 100 liters of water, what is the concentration of chloride ions in the sample in mg/L?

   0.023 g = 23 mg
   Concentration = mass/volume = 23mg/100L = 0.23mg/L

2. Using this relationship: salinity(ppt) = 0.0018066 X Cl^- (mg/L), what is the salinity of the sample of water above.

   Using the relationship, salinity = 0.0018066*0.23 = 0.00042 ppt

3. Why does the ocean contain higher concentrations of chloride as opposed to freshwater environments?

   Ocean water is contains more chlorine ions than river and other freshwater sources. This makes ocean and sea waters more saline. This happens because acid rain dissolves rocks on land that contain minerals like sodium chloride etc. These then seep down into ocean water, and years of deposition of such minerals makes ocean water saline.

Name:_____ANSWER KEY_____ Date:_____

Analysis Questions [7], [8]

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 salinity of three samples of water using three different methods, and determine which is the best of the three.

2. For Method 1, calculate the salinity of the sample using the relationship provided in page 15-1.

   Depends on the students findings

3. Now that you have the salinity readings from three different methods, which method is the most accurate? Defend your choice with evidence.

   Depends on the students findings.
   The sensors that shows a reading closest to the actual value of the sample is the most accurate sensor.

4. The Dead Sea has one of the highest known measurements of salinity concentrations when compared to any other body of water around the globe. Discuss the differences in the sailing of your SeaGlide in the Dead Sea versus the Baltic Sea. Defend your assumptions. Hint: the Baltic Sea has a relatively low salinity concentration.

   The Dead Sea has an unusually high salinity which means its water is denser than that of any other waterbody. Since the water is so dense, SeaGlides placed in it will float. They will not sink down as expected because the water is much denser than the devices themselves. Thus, the SeaGlide will not move at all.

   The Baltic Sea, which has normal salinity, would be a perfect medium for the SeaGlide, as the device would sink.

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 Chloride and Salinity lesson plan. The reference aided in the completion of the Explore. Test 15 in the book, the Chloride and Salinity test, was excepted for the students. Pages 15-1 through 15-11 contain information, required material, procedure and a data collection sheet for the students. The following five pages (15-1I to 15-5I) 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.

[6] US Department of Commerce, & National Oceanic and Atmospheric Administration. (2008, November 14). Why is the ocean salty? Retrieved from https://oceanservice.noaa.gov/facts/whysalty.html

This website was used for adaptation within the Chloride and Salinity lesson. The reference aided in the completion of the Engage. The students were asked why ocean water is saline while river water is not. The answer to that was found in this website, and it was adapted for the students.

[7] Pletcher, K. (2019, January 17). Dead Sea. Retrieved from https://www.britannica.com/place/Dead-Sea

The website was used as a reference within the Chloride and Salinity lesson. This was used as a resource to enable utilization of a high saline sea, to be compared to a lower saline sea. The reference was neither adapted nor excerpted.

[8] Baltic Sea. (n.d.). Retrieved from https://www.newworldencyclopedia.org/entry/Baltic_Sea

The website was used as a reference within the Chloride and Salinity lesson. This was used as a resource to enable utilization of a low saline sea, to be compared to a higher saline sea. The reference was neither adapted nor excerpted.