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| **Water Dawgs Lesson Plan**  **Topic: Data Accuracy**  **Learning Module #9** | | | |
| **Lesson Objectives(s):** | | * SWBAT define Clean Water Act, TMDL, data accuracy. * SWBAT create a scatter plot. * SWBAT compare and contrast measurements from two procedures. * SWBAT describe qualifications necessary to pursue a career as an analytical lab technician. * SWBAT explain why collecting accurate water quality information is important to upholding standards of the Clean Water Act. | |
| **Associated NGSS Standard(s):** | | NA | |
| **Associated A.P. Environmental Science Standard(s):** | | N/A | |
| **Materials:** | | * PowerPoint * Printed materials:   + Lesson worksheets (WS) – 1 copy per student   + Transcript of Video (H1) – 1 copy per student * Online material:   + Graphing Activity (­Excel1) – Send out to students via email   + *NOTE -> There is a key to the graphing activity (Excel1\_Key) – this is for you, do NOT send to students* * Computer for each student for EXPLORE activity | |
| **Instructor to do before lesson:** | | * Take measurements of local streams for nutrient concentrations using Hach colorimeter method and Analytical lab methods. This would involve going to ~10 streams, collecting and running NO3 and PO4 samples in the Hach Colorimeter, and taking duplicate samples to submitting them to an analytical lab for analyzation. Then, you will need to entre these data into two excel files (sheets 3 and 4):   + WaterDawgs\_LM9\_ Excel1.xls   + WaterDawgs\_LM9\_Excel1\_Key.xls   + ***NOTE --> After the inaugural Water Dawgs Program is completed in 2023, this step will have been completed. You can use the data already collected, and you will not need to complete this step.*** * Set up field trip with Analytical lab (at UGA, this could either   be CAIS or the Agricultural Lab). This would include setting up tour with lab folks, setting up transportation, and getting field trip forms signed.   * Secure computer lab or laptop computers for students for EXPLORE activity * Print:   + Lesson worksheets (WS) – 1 copy per student   + Transcript of Video (H1) – 1 copy per student * Look over PPT/Lesson plan * Watch the video and decide if you want to run it at normal speed or 0.75 speed. * **OPTIONAL:** run though EXPLORE activity on provided computers. The instructions listed in the excel file to create the scatter plot, etc., might be slightly different on a PC vs. a Mac or a different version of excel. If this is the case, you may need to change the instructions within the excel file slightly before sending to students. * Send Graphing Activity (Excel1) to students via email. | |
| **Part of Lesson** | **Time** | **Duration** | **Lesson** |
| **ENGAGE** | 9:00 | 25 min | Video - Clean Water Act and TMDLs  \*\*Students will watch the following video about the Clean Water Act and TMDLs.  ***🡪 Note****: you may decide to play the video at 0.75 speed, as the video runs at quite a fast pace.*  <https://lawshelf.com/shortvideoscontentview/the-clean-water-act/>  ^^Allow 5-10 min for video.  \*\*Pass out Lesson Worksheets (WS)  \*\*Pass out a transcript of the video (H1). Allow students to work with a partner to answer the following questions   1. What is the purpose of the Clean Water Act? 2. Does the Clean Water Act regulate point source or non-point source pollution? 3. What is one example punishment for violating the Clean Water Act? 4. What does it mean for a water body to be “impaired”? 5. What is a TMDL (in other words, a Total Maximum Daily Load)? 6. What kind or kinds of water is not included in the Clean Water Act?   ^^Allow 10-15 min for answering questions.  \*\*Engage class in discussion about the Clean Water Act and punishments for violating the Clean Water Act. In the discussion, make sure to include these questions.   1. Do you think punishments for violating the Clean Water Act are fair? Why or why not? 2. Why is it important to accurately measure the amount or concentrations of pollutants in a water body?   ^^Allow 10 min for discussion |
| **EXPLORE** | 9:25 | 55 min | Procedure comparison  \*\*Explain:   * We have learned that there is usually more than one way/method/procedure to measure a water quality parameter (nutrients, dissolved oxygen, pH, etc.). * Today, we are going to compare for nitrate and phosphorus concentrations measured by two different procedures – the Hach Colorimeter (Adopt-A-Stream methods; non-professional) and by an Analytical Laboratory (a professional laboratory).   \*\*Use the PowerPoint to go over:   * Ways to compare procedures * Trendline/Line of Best Fit * R2   *🡪 NOTE: SEE PPT!! We did not re-copy slides from PPT into this lesson plan.*  \*\*Open up the Graphing Activity (Excel1), and have the students do the same on their computers.  \*\*Start off on Sheet 1, Example 1 (Dissolved Oxygen). Using the instructions in column K, walk through students how to create a scatter plot and adding a trendline, R2, and axes labels. Work together to answer the associated questions on the lesson worksheet (WS).  1) Visually comparing measurements from the two procedures, do you see any trend? (It’s ok if the answer is no!)  2) What is the R2 of the relationship between the two analytical methods?  *🡪 NOTE: you might also want to show students how to find the average of each column.*  **\*\*Optional:** If needed, run through second example (Sheet 2/Example 2: pH)  \*Students will then work through Sheets 3 and 4 (nitrate and phosphorus), the associated questions, and final wrap up questions on their own (or with a partner).  Final questions  In your own words, how did the Hach Colorimeter measurements compare to the Analytical Lab measurements for nitrate? What about for phosphorus?  If you owned a paper mill and the stream by your factor was being tested for water quality, would you want the EPA to use the Hach Colorimeter test or the Analytical Lab to test for nutrient concentrations? Why?  \*\*Once students are done with the activity, review graphs and question responses for nitrate and phosphorus, as well as the final question responses, with students.  ^^Allow ~55 min for activity |
| **EXPLAIN** | 10:20 | 15 min | Analytical Labs  \*\*Go through the PPT slides explaining Analytical Labs and the importance of data accuracy.  \*\*Let students know that they do not have any guided notes, but they are welcome to take notes on their own in their notebooks.  **Slide 1**  What are analytical laboratories?  Analytical laboratories offer professional services that classify, assay and/or analyze chemical, material, biological, geological and environmental samples.  **Slide 2/3/4**  What are the different types of analytical laboratories?   * Bioanalytical (Assays, Drug Discovery) * Food and Beverage Testing * Cleanliness Monitoring/Testing * Environmental Testing and Analysis Services * Failure Analysis * Industrial Hygiene Services * Stack Emissions/Opacity Testing * Water Quality Monitoring Standards Testing/Certification * Toxicity/ Reactivity Testing   *🡪 NOTE: See PPT notes for a brief explanation of each. Connect different labs to things students might know – i.e., food and drug*  *🡪 NOTE: Highlight that freshwater ecologists mostly utilize Environmental Testing labs and Water Quality Monitoring labs*  Slide  **Slide 5**  Why do we need analytical laboratories?    \*\*Have students try to come up with a few ideas on their own. Then, go over the following reasons, as well as the definitions of precision and accuracy:  **Slide 6**   * Many different people, scientists, and companies require accurate measurements of substances to ensure samples (food, drug, water, environmental etc.) meet certain standards.   **Slide 7**   * Accuracy: how close the measurements are to *the truth* * Precision: how close the measurements are *to each other*   **Slide 8**   * Testing equipment is often very expensive. Sometimes, it makes sense for scientists to “send off” samples to a laboratory, rather than try to conduct the analyses on their own. |
| BREAK | 10:35 | 15 min | 15 min break |
| **ELABORATE** | 10:50 | 1:30 | Field Trip to Analytical Lab  15 min – travel to Analytical Lab  45 min- 1 hour – tour of Analytical Lab  15 min – travel back to campus from Analytical Lab |
| **EVALUATE** | 12:20 | 10 min | Exit Slip  \*\*Have students answer the question on their lesson worksheets (WS).  Question 1: In your own words, why is taking accurate measurements of water pollution (like nutrient concentrations) important?  ^^Allow 5 min. Collect responses and review after the lesson. |