Comparing Water Quality Data

Virginia SOL

- *Science* ES.2
- *Social studies* WG.12, GOVT.1
- *Language arts* 9.2, 9.4, 9.9
- *Technology* C/T12.2, C/T12.3, C/T12.4

Objectives

- Use a computer with Internet access to obtain water quality data
- Interpret graphs of water quality data measured at different times
- Observe how water characteristics can vary with location
- Use water quality data to reach reasoned conclusions
- Analyze water quality data relative to water quality standards
- Use tables and graphs and presentation software to communicate conclusions

Materials

- Computer with Internet access
- Computer tools
- Graph paper, pencils, etc

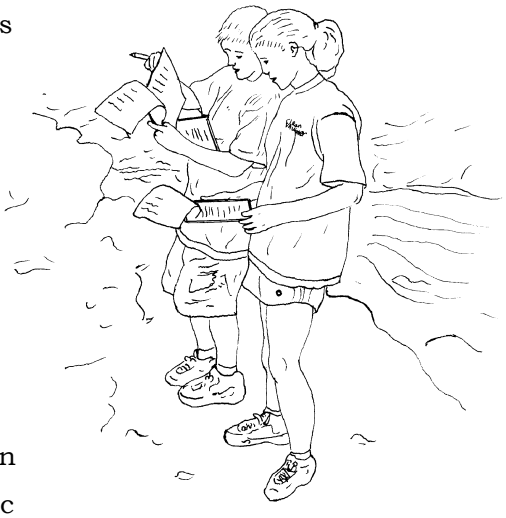
Time Needed

Two class periods

What conclusions can we make by comparing different sets of water quality data?

This lesson is intended for ninth-grade Earth Science students. The lesson combines data analysis with use of computer data sources and analysis tools. The ninth-grade Virginia Science SOL focus on development of scientific investigation skills. SOL ES.2 emphasizes students should "recognize evidence is required to evaluate hypotheses and explanations." The ninth-graders are expected to be actively involved in systematic investigation, and also various technologies should be used "to collect, analyze, and report data." The students should also be able to "interpret maps, charts, tables, and profiles."

Bodzin and Cates, from Lehigh University, wrote in The Science Teacher magazine about using Web-based activities to promote scientific inquiry learning (December, 2002). Such Web-based inquiries (WBI) can give students good practice in examining real data and forming conclusions based on data. Online data sets and supporting resources available on the Web can exceed equivalent information available in text-books or other print media. Students can experience working on larger, more authentic



scientific problems using the type of data available to scientists in their investigations. Bodzin and Cates suggest six criteria that should be satisfied by a Web-based inquiry.

- Students should be working to answer a question, they should give priority to evidence, and they should develop sound conclusions based on evidence.
- The activity should be student-centered.
- Students should be learning some science content.
- The activity should take advantage of features of the Web.
- Evidence used by students should be of the same type an actual scientist would use.
- Students' conclusions should involve reasoning beyond simple data analysis.

In this lesson, students will examine water quality data that is available on the Internet. Numerous sources of water quality data are available online for student use. One excellent source of data, measured by other students, is the Global Learning and Observations to Benefit the Environment (GLOBE) program. The GLOBE data set is available at *www.globe.gov*. A variety of other online water quality data can be obtained through the web site of the Virginia Institute of Marine Science (VIMS) at *www.vims.edu*, the Global Rivers Environmental Education Network (GREEN) at *www.green.org*, the Virginia Water Monitoring Council at *www.vwrrc.vt.edu/vwmc* and the Virginia Department of Environmental Quality at *www.deq.state.va.us/water/monitoring.html*. Students in the classroom can explore and analyze the online water quality data, either in a computer lab setting or in a "one-computer classroom." They can practice drawing reasonable conclusions from the data. The students can see how water quality characteristics vary at different times and at different locations. Hopefully, after analyzing water data collected by others, the students will be encouraged to go on and investigate a local water site of their own. See the lesson plan Evaluating a Stream in this packet for information on how students can gather water quality data.

The GLOBE program is described in a later section of this curriculum packet under the heading Curriculum Materials Available for Teaching About Water Resources. Briefly, the program involves students worldwide collecting high quality data, and then posting it on the Web for use by other students as well as by practicing scientists. Educational support materials are available at the GLOBE web site to help teachers use the GLOBE resources. One GLOBE lesson at the web site (*www.globe.gov*), "Water, Water Everywhere! How Does It Compare?" involves students in comparing water quality data from the web site. This lesson is based in part on that GLOBE activity.

LESSON INTRODUCTION

Begin this activity by discussing with students how scientists approach the task of answering questions. Stress with students the importance of using evidence to find an answer to the question. Also, emphasize that reasoning is needed to go beyond simple data analysis and develop a logical argument in support of the answer. The final stages of scientific inquiry involve connecting the new information in a meaningful way to existing prior knowledge, and summarizing and communicating the new information.

ACTIVITY PROCEDURES

Interpreting graphs of water quality data measured at different times...

Demonstrate for students how to obtain comparative water quality data from the GLOBE web site (*www.globe.gov*). Students can create and view on a computer graphs of data collected by any of the schools that participate in the GLOBE program. One way to select data is to enter the GLOBE site, then choose "GLOBE Data" and "Maps and Graphs." One of the choices presented within "Maps and Graphs" is "GLOBE Graphs (Time Plots of Student Data)." Carrying out a "Simple Search" under this heading, students can zoom in using the maps that are presented, to select a local school. For example, one participating school in Virginia that can be selected is the New Horizons Governor's School for Science and Technology in Hampton. After selecting a

Using Web-Based Inquiries in the Classroom

(From Bodzin & Cates, The Science Teacher, December 2002)

Computer requirements

- Network connection speed should be 56k
- Some web sites require plug-ins to be installed in the Web browser, such as QuickTime, Flash, or RealPlayer
- Browser should be Internet Explorer 4.0 or higher, or Netscape Communicator 4.7 or higher

Implementation suggestions

- Test the web site on the school computer before using with your students
- Students should work in pairs to allow for discussion of ideas
- If you have one computer, use this in the classroom with a projection device
- Alternatively, one computer can be set up as a learning center and student groups can be rotated to the computer alongside different class activities

school site, students can create comparative graphs plotting up to six different water quality measurements against time. For example, students can select for the computer to plot dissolved oxygen and water temperature versus time, or pH and water temperature versus time. Students can then analyze the patterns shown by the graph to determine relationships between the parameters that are plotted.

Students should use their graphs to try to answer science questions relating to water quality. Ask students to make a hypothesis for the answer to their question before reviewing the computer data. For example, it is a meaningful question for students to ask the relationship of dissolved oxygen to water temperature. How does the dissolved oxygen content change when the water temperature undergoes seasonal changes? In coastal areas, students can examine how salinity relates to the amount of dissolved oxygen in the water.

Help the students to identify trends in data and also outliers in the data. Before trying to discern trends, students should go through the data carefully looking for outliers. Outliers are measurements that are greatly different from the pattern suggested by other measurements. Outlier measurements should be questioned. For example, students should question a very low temperature measurement among other temperature measurements that are a lot warmer.

Help students to form and write a reasonable conclusion in answer to their question. They should use the six-step method described in the earlier chapter, Analyzing Experimental Data, as a writing framework for their conclusion. Using this framework, students create a conclusion statement by addressing six questions in order. What was the purpose or question? What were the findings? Did this support an original hypothesis? How do the findings from the data compare with text-book information? How can you explain the findings? How can the question or investigation be extended further?

Students should attempt to analyze observed trends in water quality data in relation to water quality standards. Water quality standards are available online through the U.S. Environmental Protection Agency web site (*www.epa.gov/ebtpages/watewaterpollutionlegalaspects.html*) and the Virginia Department of Environmental Quality's web site at *www.deq.state.va.us/wqs*. Students should try to relate trends that they observe in data to both expected seasonal changes and changes due to disturbances. For example, pH measurements are usually fairly steady unless there is a major disturbance to a stream or lake, such as periodic waste discharge, large rainfall, a large algae bloom, or a change in flow rate due to snowmelt or reservoir discharge upstream.

Comparing water quality data from different sites...

Students need to learn to review data measured at different times, to draw conclusions about trends across time. They should also have as much practice as possible comparing and analyzing scientific data measured at different locations. Using this type of activity, students can create summary data tables of the type described earlier in the Analyzing Experimental Data chapter. Once again, students should consider this type of evidence in the context of answering meaningful questions by using the evidence to formulate reasoned conclusions.

The Virginia Institute of Marine Science (VIMS) has collected a variety of comparative water quality data for teachers at their web site (*www.vims.edu*). Under "Education" at the VIMS site, teachers can find the "Bridge – Ocean Sciences Education Teacher Resource Center" (*www.vims.edu/bridge*). One of the Bridge features is "On-Line Data (Links to classroom-friendly scientific data sets)," a variety of data sets for teachers, which includes some real-time data. The VIMS data can be used to make comparisons across time at one site and also to make comparisons between different sites.

The VIMS online data includes both local Virginia data and data from other locations around the country. The Virginia data can be used to answer questions comparing different locations within Virginia, and the wider data set can be used to answer other questions comparing locations around the country. The following different types of Virginia data are available for teachers and students to work with. The "VIMS Scientific Data Archive" link provides salinity and temperature data for the York River and submerged aquatic vegetation (SAV) data for the Chesapeake Bay. The "Chesapeake Bay Observing System" link provides real-time data from two stations on the Bay (Horn Point and Mid Bay). The "NERR System-Wide Monitoring Program" link prvides extensive data collections from National Estuarine Research Reserve sites in different parts of the United States. For the Virginia Chesapeake Bay, data are available from Goodwin Island and Taskinas Creek, including temperature, conductivity, salinity, dissolved oxygen, water level, and pH measurements. Finally, the "Tidal Wetlands Impacts

Data Home Page" link provides data on tidal wetland impacts and shoreline alterations due to human activities. Yearly data is provided for different localities and also for different watersheds.

Using tables and graphs and presentation software to communicate conclusions...

To practice the final stage of scientific inquiry, summarizing and communicating their investigations, students should complete this data analysis activity by preparing short summaries for classmates of their original questions, their data, and their conclusions. Students can include tables and graphs of the data measurements they have studied. GLOBE graph data can be recreated using computer software or it can be plotted by hand on graph paper. If recreating GLOBE graphs by computer, the data can be imported from GLOBE into spreadsheet software. In general, students should be encouraged to use technology, including presentation software such as PowerPoint, to compose and deliver their class presentations.

It is important that ninth grade students should have opportunities to give small-group oral presentations in front of the class. Every student should be responsible for some part of the presentation. This oral presentation supports the Virginia English SOL 9.2, and the instructions and grading rubric for the students' presentations can be drawn from the English SOL.

QUESTIONS

- How would you describe the trend observed for the dissolved oxygen content of water measured in different months?
- How does the dissolved oxygen content of the water relate to the temperature of the water?
- Since dissolved oxygen levels are correlated with water temperature, what other measurements do you think might also be correlated to temperature?
- How do you think the pH data measurements would differ if data were collected using pH paper versus a pH meter?
- How could you explain any large changes in water pH?
- What differences do you notice in water quality data collected from different locations?
- How would you explain the differences in water quality data from different locations?
- How would you predict the data trends to continue in future months?

ASSESSMENTS

- Students should be able to identify trends, anomalies, and problems with data sets. As students work, you can observe them and ask questions to informally assess their understanding.

- Journal writing to summarize comparisons of water quality data. Students should include a question that was investigated, a summary of data evidence that was collected to answer the question, and a conclusion that answers the original question. Assessment of journal writing should include some assessment of science content learned by students as well as their abilities to compare data.
- Students should be graded on their contribution to small-group oral presentations. Instructions and grading rubric for the oral presentations can be drawn from Virginia English SOL 9.2.

EXTENSIONS

- Use topographic maps to identify a watershed area. Use the GLOBE web site to create graphs comparing water quality data from different sites within the watershed to try and identify variations. To compare multiple school sites using the GLOBE web site, select one school site first, and then "Add or Change Schools" under "Other Options."
- As a long-term goal, the school might consider joining the GLOBE project as a participating school. The school could then measure water quality data for a local site and add these to the GLOBE database, in addition to using GLOBE data from other sites.

RESOURCES

- Global Rivers Environmental Education Network (GREEN). *www.green.org*
- GLOBE. *www.globe.gov*
- Inquiry dot Com. Bodzin, A. M., & Cates, W. M. (2002). *The Science Teacher, 69*(9), 48–5 2.
- Virginia Department of Environmental Quality. *www.deq.state.va.us/water/monitoring.html*
- Virginia Institute of Marine Science. P.O. Box 1346, Gloucester Point, VA 23062. 804-684-7000 or *www.vims.edu*
- Virginia Water Monitoring Council. *www.vwrrc.vt.edu/vwmc*
- Water, Water Everywhere! How Does It Compare? *GLOBE.*

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