Remote Sensing

Middle Level Lesson Plan

Overview

QUEST Remote Sensing provides a "birds-eye view" of the latest ways in which scientists are exploring the systems that make up our planet. Using satellite imagery, aerial photography, ocean data gathered at remote buoys, and other high-tech tools, humans can now literally see the "big picture" of how our planet works. This knowledge can be used in a variety of ways to improve human life and the life of planet Earth. This teaching unit focuses on two specific examples of New England based projects: The Ice Storm of 1998, and the GoMOOS (Gulf of Maine Ocean Observing System) initiative, which is providing a wealth of data about our ocean systems

Introduction

Middle-level students who participate in this teaching unit will have an opportunity to learn about the impact of technology on society through a variety of examples that are locally based. Often when students think of scientists, they imagine people who have all the answers. This lesson, in contrast, will introduce them to some of the many areas of scientific endeavor that have just recently begun to be explored. Students will also begin to understand the relationship between the value that society places on various subjects or concepts and what ends up being selected – and funded – for scientific study. The culminating task has students (either individually or with partners) researching various projects that have been made possible by developments in the world of remote sensing. This offers teachers a perfect opportunity to combine learning goals from the fields of science, technology, and media literacy and address them in one integrated activity.

Time Allotment

This unit requires approximately five 45-minute class sessions or more, depending on the amount of time spent on the final research project.

Accessing Prior Knowledge

Portions of this teaching unit include information about the earth's ocean systems that has come from recent research. These recent findings have an impact on our understanding of global climate change. It is helpful (but not necessary) for students to have some knowledge about the possible causes of global climate change as well as some of the key issues associated with this phenomenon.

Maine MATHEMATICS and SCIENCE Alliance

QUEST lessons are developed in partnership with Maine Mathematics and Science Alliance

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Concepts to Clarify

Students sometimes believe that scientists and engineers are more capable of making decisions about science- and technology-related public issues than the general public. They tend to think that scientists and engineers know all of the "facts" and thus are not influenced by personal motives or interests.

CONNECTIONS TO THE STANDARDS

National Science Education Standards	Benchmarks for Science Literacy	Maine Learning Results	New Hampshire Curriculum Framework	Vermont Learning Standards
Content Standards (5-8) Science in Personal and Social Perspectives F. Science and Technology in Society – Societal challenges often inspire questions for scientific research, and social priorities often influence research priorities through the availability of funding for research. – Science influences society through its knowledge and worldview. Scientific knowledge and the procedures used by scientists influence the way many individuals in society think about themselves, others and the environment. The effect of science on society is neither entirely beneficial nor entirely detrimental.	**Chapter 1C: Issues in Technology** D. Technology has strongly influenced the course of history and continues to do so. It is largely responsible for the great revolutions… that have radically changed how people live.	**Science and Technology** M. Implications of Science and Technology – Research and evaluate the social and environmental impacts of scientific and technological developments.	**Unifying Themes and Concepts** Illustrate how models allow scientists to better understand the natural world.	**The Universe, Earth, and The Environment** Theories, Systems, and Forces 7.15.f. Explain how modern views of the universe emerged (e.g., … improved instrumentation).

Materials Needed

- TV with VCR
- QUEST *Remote Sensing* video
- Atlas of your state
- Chart paper and markers
- Overhead transparencies (described in individual activities)
- Computers with Internet access for student use
- Student Handout 1: How Have Maps Changed the World?
- Student Handout 2: GoMOOS – What Can the Ocean Tell Us?
- Student Handout 3: A QUEST into the World of Scientific Research
- Student Handout 4: Quest At Home: Investigating Our World Through Remote Sensing

1. Introducing the Concepts

Activity 1

This initial activity will help elicit students' ideas so that you can determine the extent to which they recognize one common tool – a map – as a model of the world. It will also help you determine the extent to which they understand how the information on the map was gathered (by remote sensing).

The activity will also lead students to understand how a commonplace tool like a map can have a significant impact on how people live – and, in turn, on how people then affect the environment.

Step 1

Show the class an atlas for your state. Ask students to brainstorm individually a list of all of the kinds of people who would benefit from using this resource. Have students describe specifically how each one of these people would use the atlas and gazetteer.

Step 2

Ask each student to provide at least one example of how people might use this book of maps. Record their ideas on chart paper or on the board. After completing one or two rounds of examples, prompt students to consider some of the following if they haven't been mentioned yet:

- People who fish – to find remote ponds or access to coastal waters
- Real estate salespeople – to locate home sites that they are going to sell
- Bicyclists and ATV riders – to find back roads or trails with good topography for riding
- Boaters – to locate public boat launches on lakes or on the ocean
- Hikers – to identify hiking trails
- Delivery drivers and salespeople – to find towns and streets
- Working commuters – to find the shortest/fastest route to work

- Travelers – to find the most scenic (or efficient) routes
- International travelers – to locate border crossings or ferry routes into Canada
- Foresters and loggers – to locate back country roads in areas where they will be growing or cutting wood
- Bird watchers – to locate areas where they can see certain kinds of birds (e.g., in marshes, bogs, hillsides, etc.)

Have students explain how each kind of user would know where to find the places where it would be possible to "do his/her thing" (various symbols and markings indicate features on the land and water).

Step 3

Project an overhead transparency from an interesting page in your state atlas and gazetteer (one that illustrates many land features, for example). Discuss the various symbols that are on the page with the class.

Step 4

Arrange students into groups of four. Distribute a good photocopy of a different atlas page to each group. Have each team then work to find symbols on their map that might be helpful to some of the people mentioned during the brainstorming session.

Step 5

Have teams discuss the following question: In what ways is this map, this model of the world, *like* the real world? In what ways is it *not like* the real world?

Ask students how they think the information was gathered that was used to make their maps. (Some may suggest that people walked or drove across the land to record various features. Others may say that pictures or images from airplanes or from satellites were used. If no one mentions the latter, be sure to bring it up.)

Step 6

Distribute copies of Student Handout 1 (How Have Maps Changed the World?). Read the directions together. Give students about five minutes to consider and to record their ideas. If they do not clearly understand the task, try offering the following as an example:

- Kind of use: locating good remote fishing holes
- How the atlas has changed peoples' lives – more people are going fishing in the ponds that once were unknown
- How this change may affect the environment
- Fish population may drop in some of the areas that are now overfished.

Another example might be that more commuters are finding back roads to use as shortcuts to work; this creates more and faster traffic on smaller back roads, which then creates more noise and road kill on what once were quiet country roads.

After everyone has had time to complete the chart, discuss students' responses together.

Step 7
Ask the class, what other kinds of information do people collect and map? Discuss all logical responses. If necessary, prompt students for responses including such things as weather; ocean features and navigation markers; kinds of soils; minerals; hurricane, flood, or ice storm damage; power lines, and so on.

2. Exploring the Concepts

Activity 2

This activity will familiarize students with the different kinds of information that are collected through remote sensing. It will also lead students to consider why such information has been deemed important enough to be collected in this way.

Step 1
Introduce the activity by reviewing together all of the ways in which students thought that people could use the state atlas maps (Steps 1 and 2 of Activity 1).

Now ask students to think individually about the kinds of scientists and scientific projects that would benefit from the kinds of information gathering and mapping that could be done from an airplane or satellite. Have them discuss their thoughts with partners. Then ask partners to share a few of their ideas with the class.

Step 2
Tell students that they will be watching the first part of a videotape showing many of the kinds of data that are now being collected and connected to give us a better picture of our world and how it works. Ask them to take notes on the kinds of information being gathered, how this information is gathered, and ways in which it is used.

Step 3
Show the first part of the QUEST *Remote Sensing* video, stopping at the end of the section on the 1998 ice storm.

Step 4
Ask the class the following question: As you watched this video, what kinds of information did you learn about that were being gathered by remote sensing? Some responses might include:

- ocean currents
- weather (temperature and moisture)
- location of schools of fish
- geologic features
- vegetation
- sea height

Now ask: How was the different information gathered? Possible responses might include:

- satellite imaging
- aircraft photos
- sketch mapping

Point out that about 90 percent of the data is collected by the first two methods (satellite imaging and aircraft photos).

Ask studentS: What happens to this information after it is gathered? Responses might include:

- Computers process it – People feed data they have gathered in the past into computers to create mathematical models of how they think the world works. They then check any new information against those models. The new information is incorporated into the models to improve them so that they are even more accurate at showing and predicting how the world works.

Step 5

Discuss the following questions with students:

- In the video, what did Neil Lamson (Ice Storm Recovery Coordinator from Vermont) mean when he said, "We actually put information together, packaged in such a way that it actually made a difference"?

- How did the information referred to by Mr. Lamson make a difference? (Answers might include the following: They were able to map out and see the extent of the ice storm damage; they were then able to use those maps and data to get money from the federal government to clean up the damage.)

3. Developing the Concepts

In performing this activity, students will develop a deeper understanding of how data that are collected by scientists through remote sensing can be used to increase our understanding of the systems of the natural world.

Activity 3

Step 1

Introduce the lesson by telling students about a project that has been ordered by the United States Congress; it involves the development of a system that can observe the ocean.

Ask students: Why do you think the U.S. congress wants to observe the ocean? In what ways could this information be used? Discuss all responses.

Tell students about GoMOOS (The Gulf of Maine Ocean Observing System). This project includes the American and Canadian provinces that border the Gulf of Maine (Massachusetts, New Hampshire, Maine, New Brunswick, and Nova Scotia). The project is providing a model that can be used by the other areas of the country to conduct ocean observations.

Step 2

Direct students to the GoMOOS Web site that describes the national ocean observing system *(http://www.gomoos.org/oceanobsvnatl/)*. Discuss with students the section at this site that is titled The Need, in which the purposes for the project are explained.

Step 3

Tell students that the second part of the QUEST *Remote Sensing* video focuses on some of the studies and information from GoMOOS. Then distribute copies of Student Handout 2 (GoMOOS: How Can We Study the Ocean? What Can the Ocean Tell Us?). Review Part 1 of the handout with the class, instructing them to fill in the chart as thoroughly as possible while they watch the second half of the video.

Step 4

Play the remainder of the video. When it is done, move on to Part 2 of the handout and read the final questions together with students. Allow students enough time to answer the questions individually; then have them discuss their responses in the small group arrangement that was used in Activity 1.

Step 5

To summarize, have a whole-class discussion in which groups can report their conclusions. Reinforce the importance of viewing the ocean and the surrounding environment as a connected system, including the earth's atmosphere. Point out to students the joy and fun that the scientists in the video seem to be having with their work on phytoplankton; however, also stress the more serious implications of the knowledge these scientists have gained, altering our views on climate change and the rise in carbon dioxide in the atmosphere. Prompt students to consider this when they are discussing the issue of funding for research.

4. Synthesizing the Concepts

Students will now have an opportunity to use their new knowledge about the technology of remote sensing and its applications. By researching the variety of ways in which scientists employ remote sensing to model and understand earth systems, students can synthesize their thinking about the impact these technological developments have on people's lives.

Note: This activity involves student use of the Internet to locate and select remote sensing research projects to investigate. Decide whether you will provide students with a list of sample Web sites or whether you will have them use a search engine to find such sites themselves. If you choose the former option, prepare a list of reliable sites from which students can choose; see the Resources section at the end of this teaching unit for suggestions.

Before beginning Step 1 below, you should also decide whether you prefer to have students complete this activity individually or with partners.

Activity 4

Step 1

Explain to students that (either individually or with partners) they will be researching a remote sensing project that they find interesting. After conducting their research to learn more about the project, they will be sharing this information with their classmates.

Step 2

Provide each student with a copy of Student Handout 3 (A QUEST into the World of Scientific Research). Read the directions together and clarify any questions or concerns students may have about the project.

Step 3

Provide students with enough class time (and additional research time, such as a library period or study hall, if necessary) to complete their work. Offer assistance as needed.

Step 4

Upon completion, have students share their results with the class. As you listen to each presentation, pay particular attention to the conclusions and opinions of the presenting students. Students who are proficient in this activity will be able to identify important ways in which their chosen remote-sensing study is contributing data and results to the world. They will also be able to provide evidence from their chosen Web site to back up their opinions about the ramifications of that particular remote-sensing project.

5. Applying the Concepts

Activity 5

This activity is designed to help students and their families become more aware of all of the ways in which the world has benefited from knowledge that has been (and is being) gathered through remote sensing.

Step 1

Distribute a copy of Student Handout 4 (Quest At Home Investigating Our World through Remote Sensing) to each student. Review the directions together and explain that students will need to find at least one kind of map at home (or download one from the Internet) to discuss with family members. If one or more students do not have maps at home (or access to the Internet), have a variety of maps on hand at school for them to borrow.

Step 2
Set a deadline for students to turn in their results. When they bring their completed activity sheets in to school, lead a class discussion so that students can share the many ways they have discovered families use data gathered from remote sensing.

5. Extending the Concepts

Community Connections

Ask students where they think maps are actually developed, designed, and printed. Encourage them to investigate whether there are map developers in your state (for example, DeLorme in Yarmouth, Maine). Students can also research how maps are created in their local communities (one example might be professionals who survey tracts of land, then create maps from these surveys.) Prompt students to consider how all these kinds of maps are used.

Another option might be for students to explore how maps might be of use in various official agencies such as the department of transportation, the department of tourism, the military, and so on. If time permits, you could invite adult professionals from these career areas to come in to the school as guest speakers.

Career Opportunities

Ask several community members related to forestry, hdrology, geology, or geography to come in to the school to talk about their jobs, where they work, what the working conditions and occupational hazards are, what training and skills are needed. Or, assign students to interview someone in the community about his or her job and create a brochure about it. Post the brochure in that person's place of work – with permission, of course – for the community to see.

Resources

Print Publications

The Gaia Crossroads Project: Using Satellite Imagery in the Classroom and Community; An Education Initiative of Bigelow Laboratory for Ocean Sciences
(Book of lessons and activities edited by Cynthia B. Erickson and Janet W. Campbell and published by Bigelow Laboratory)
http://www.bigelow.org

Project IMAGE (Investigating Materials about Global Environments)
(Book of activities and images by the Harvard-Smithsonian Center for Astrophysics, published by Kendall Hunt Publishing Company)
ISBN: 0-7872-1708-5

From Cape Cod to the Bay of Fundy: An Environmental Atlas of the Gulf of Maine
(A collection of articles and images involving natural landforms, earth systems, and land use, edited by Philip Conkling of the Island Institute and published by MIT Press)
ISBN: 0-2625-3127-5

Web Sites

Gulf of Maine Ocean Observing System (GoMOOS)
http://www.GoMoos.org/

Maine GIS
(An excellent Web site for Activity 4 Synthesizing the Concepts)
http://apollo.ogis.state.me.us/projects/projects.asp

VGIS (Vermont GIS)
An excellent resource with links to all major state and federal organizations that use remote sensing data and images. Very helpful for people in all New England states.
http://www.vcgi.org/cfdev2/links/links.cfm

NAUTILUS
This Web site's goal is to make the power of remote sensing technology available, accessible, and usable for land-use planners, especially as they deal with issues of sprawl.
(This is another appropriate Web site for Activity 4 Synthesizing the Concepts.)
http://resac.uconn.edu/welcome/index.html

How Have Maps Changed the Word?

Think about all of the different ways in which people use maps. For example, does your family use maps when you drive somewhere new, plan a vacation, or choose a trail to follow at a state park or ski area?

Now try to picture what your town – and all areas of your state – were like a hundred years ago, before maps were so readily available and before they included so much information. How might the lack of good maps have affected life back then?

Refer back to the list that your class brainstormed earlier. From this list, pick a few examples of how people use maps. Then, using these examples, fill in the chart below. Be sure to explain how people's lives have changed as a result of these maps being available. Also explain how the environment may have been changed as a result of the increased land use that the maps make possible.

Type of Use For the Atlas Maps	How the Atlas Has Changed People's Lives	How This Change May Affect the Environment

GoMOOS: How Can We Study the Ocean? What Can the Ocean Tell Us?

Part 1 Record information about ocean observing as you watch the videotape. Use the chart headings below to help your organize your information.

Kinds of Ocean Data That Can Be Gathered	How Are These Data Collected?	How Are These Data Used?

Part 2 After watching the video, please record your responses to the questions below.

1. What are some of the kinds of ocean data that humans can now put together in order to get a better sense of how the natural systems of the ocean work?

2. Why are the scientists at Bigelow Laboratory so excited about studying phytoplankton?

3. Do you think that the Bigelow scientists should receive more money to continue studying the phytoplankton? Why or why not?

A QUEST into the World of Scientific Research

The northern New England region is positively rich with examples of research projects that involve the use of remote sensing to learn more about our world.

Your task is to go on an Internet QUEST to find and learn more about **one remote sensing project that you find interesting.**

To locate an appropriate Web site, you will either visit the Web addresses provided by your teacher or you will visit a search engine to find sites on your own.

From the sites that you review, work to select one that you (or you and your partner) find interesting and that you want to learn more about. You will be sharing your findings with your fellow classmates.

Once you've decided on a promising site, you may wish to print out the Web pages that appear to be the most useful to your research. You will use this information, along with your own thoughts and reactions, to respond to the following prompts. You may respond on a separate piece (or pieces) of paper or in your science journal.

1. Web site Title and URL: List the title and the address of the Web site for the remote sensing study that you have selected.

2. Problem(s) or Issue(s): Read about the research study that you have selected. Try to talk (by phone, e-mail, or other means) with someone about why this study was done, why this information was collected, and what specific problem(s) the scientists involved were hoping to address. Record the problem(s) or issue(s) that provided the focus of the study and data collection.

3. Evidence and Data: Look at the actual study to see what kinds of data or information (evidence) were/are being collected.

(a) Describe the kinds of evidence being collected: Write a sentence or two describing the kinds of measurements and/or information that are being collected.

(b) Explain where, how, and by whom the study was/is being carried out

4. Real Life Applications: Read and talk with someone, then record the following:

(a) Who uses the results of this study, of this data collection?

(b) Who might have paid for the work to be done and for the instruments and materials that were

needed to do it? (Some Web sites will list the sponsors of the studies and research at the beginning or at the end, or in a sidebar. Others may mention it in the actual report about the studies.) You might find it interesting to do a Web search and find more information about these sponsors.

Why do you think that this person or organization was willing to provide money and/or support for the work?

5. Your Opinions: Based on your research and your conversations, record your own opinions and responses to the following questions. Be sure to list evidence from the article to back up your opinions.

(a) What do you think about this study or research?
– Is it important?

– In what ways do you think it could be helpful to people's lives or to the health of our planet?

(b) Are there any problems with the research?

(c) What new ideas or problems might be discovered through this project?

REMEMBER: Please list evidence from the study and the Web site articles to support each of your ideas.

Investigating Our World Through Remote Sensing

You're on a QUEST!

Think about what it's like to see from a "birds' eye view." Imagine looking at your yard, neighborhood, and town from up above. How different do you think things would look if you could see them from the clouds? Remote sensing involves collecting and processing information from a distance, like from satellites or airplanes. This activity will give you an idea of what life is like with – and without – remote sensing technology!

Materials needed
- Computer with Internet access
- Pen and paper for notes
- Map of your town or city

Investigate with your family!

Discuss these questions with family members:

- How do we use maps?
- How would we be able to drive to an unfamiliar location without using a map?
- What geographic features or other information do you look for on maps when you're going to an unfamiliar location?

Make a map with your family!

Imagine having an aerial view of your neighborhood. Keeping this "bird's-eye view" in your mind, **create an aerial map of the neighborhood** with family members. Remember that many individuals reading your map may not be familiar with your area. What will you be sure to include on your map so that it will be as clear and complete as possible? Be sure to add a legend or key that can guide people who are reading your map.

Here are two helpful Web sites that will give you an idea of the different types of maps that exist today. You'll find political maps, street maps, historic maps, satellite maps, and more!

National Geographic Society Map Machine *http://plasma.nationalgeographic.com/mapmachine/*

U.S. Department of the Interior, U.S. Geological Survey *http://mapping.usgs.gov/*

Compare your results!

Visit your city hall to find out whether there is a map of your neighborhood on record. How is this map different from the map you and your family have created? What elements are used on the official maps that are different the ones you created?

Electronic Quest!

Visit one or more of the following Web sites to discover a wide variety of information that comes from maps and other models of the world!

NH GRANIT
http://www.granit.sr.unh.edu/

National Aeronautics and Space Administration (NASA)
http://www.gsfc.nasa.gov/NASA_homepage.html

National Oceanic and Atmospheric Administration (NOAA)
http://www.noaa.gov

University of Vermont
Bailey/Howe Library http://bailey.uvm.edu/govdocs/map.html

Maps.com
http://www.maps.com

The University of Texas at Austin (This site features maps of the United States national parks and monuments.)
http://www.lib.utexas.edu/maps/national_parks.html

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