



Classroom Connections



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TEACHER'S GUIDE



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EMERGING SCIENCE

Classroom Connections TEACHER'S GUIDE

Classroom Connections is a companion to Vermont Public Television's Emerging Science, a locally produced television series featuring Vermonters at the frontiers of science. This guide has been assembled by Vermont science teachers and the Vermont Genetics Network at the University of Vermont for use in high school classrooms.

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Vermont Genetics Network (VGN), a NIH/NCRR grant funded program,
located at the University of Vermont



Emerging Science Classroom Connections is made possible by VT EPSCoR's award from the National Science Foundation on Complex Systems Modeling for Environmental Problem Solving, NSF EPS # 0701410.

● Nanotechnology

*Lesson plan resource list compiled by Gail Hall (Gail.Hall@state.vt.us),
Science Assessment Coordinator, Vermont Department of Education.*

This episode of **Emerging Science** examines the remarkable potential for creating scientific tools and models at nanoscale – that is, one billionth of a meter in size. Considering the ability of current technology to manipulate and engineer materials from the atomic level upward, scientists predict that nanotechnology will have a “greater impact on our lives than the industrial revolution or the great advances that have been made in genomics.” (Jones, M. et al 2007)

Nanoscale science uniquely ties together all the domains of science, because it focuses on the raw materials – atoms and molecules – that are the building blocks of physics, chemistry, biology, and earth and space sciences and is using these materials to approach solutions for complex, real-world problems.

Vermont students should be prepared for a future including nanotechnology. They will need an understanding of the basic science behind nanoscale research. A first step that educators can provide is an opportunity for students to investigate the importance of size, scale and models throughout their science learning experiences. Benchmarks for Science Literacy (1993), in describing recommended national science standards, notes, “[l]ooking at how things change with scale requires familiarity with the range of values and with how to express the range in numbers that make some sense. So children should start by noticing extremes of familiar variables and how things may be different at those extremes.”

The following annotated resources offer suggestions for classroom activities to support nanoscience learning.

American Association for Advancement of Science. 1993. Benchmarks for Science Literacy-Project 2061. Arlington, Va. NSTA Press

This publication is one of the national science literacy resources used in Vermont to derive the Vermont Framework and Standards and the Vermont Science Grade Expectations. Instructional content is organized for grade clusters K-2, 3-5, 6-8 and 9-12 in a developmentally appropriate sequence.

Bowles, Ken. 2004. Teaching Nanotechnology in the High School Curriculum: a Teacher’s Guide. Apopka High School. Apopka, Fl.

[http://www.bowlesphysics.com/nano/
TeachingNanotechnologyintheHighSchoolCurriculum.doc](http://www.bowlesphysics.com/nano/TeachingNanotechnologyintheHighSchoolCurriculum.doc)

This resource is a curriculum guide that contains an overview of nanotechnology in the high school classroom, as well as a variety of nanoscience student activities in measurement, reading, chemistry and physics. The resource also contains book reviews of fiction and nonfiction publications relating to nanoscience, including “Prey” by Michael Crichton and “Nano” by John Robert Marlow. Websites for additional educator resources are also included.

Molecular Expressions – Science, Optics and You – Secret Worlds: The Universe Within

<http://micro.magnet.fsu.edu/primer/java/scienceopticsu/powersof10/>

This website offers a tutorial program that allows a student to move through space (one click at a time) towards the earth in successive orders of magnitude until the observer reaches a tall oak tree just outside the buildings of the National High Magnetic Field Laboratory in Tallahassee, Fl. After that, the image begins to move from the actual size of a leaf into a microscopic world that reveals leaf cell walls, the cell nucleus, chromatin, DNA and finally, into the subatomic universe of electrons and protons.

How Much Information – Data Powers of Ten

<http://www2.sims.berkeley.edu/research/projects/how-much-info/datapowers.html>

This website provides a glossary of the powers of computer data storage capacities in which meaningful computation or data can be stored. This listing could be used as a ready reference for students during classroom discussion around scale.

Jones, M.G., Falvo, M., Taylor, A., Broadwell, B. 2007. Nanoscale Science: Activities for Grades 6-12. Arlington, Va. NSTA Press

<http://www.nsta.org/store/search.aspx?action=quicksearch&text=Nanoscalescience%20&gl=0&sid=0>

This excellent resource includes 20 nanoscience classroom investigations designed to teach students about the unique properties and behaviors of materials at the nanoscale. The investigations are designed as guided inquiries with open-ended exploration where possible. The book is organized around five themes: scale, tools and techniques, unique properties and behaviors, nanotechnology applications, and societal implications. The following website from the National Science Teachers Association provides purchase information for this and several other publications dealing with nanoscience in the classroom.

NanoScale Science Education – The NanoScale Science Education Research Group: Working Small ... Thinking Big – K-12 Educational Materials

<http://ced.ncsu.edu/nanoscale/materials.htm>

This website from the University of North Carolina at Chapel Hill and the University of Louisville contains several K-12 science presentations, activities and additional websites to support nanoscience discussion in the science classroom.

Birch, Hayley. “Learn about ... Nanotech” in *Null Hypothesis, the Journal of Unlikely Science*, June 28, 2008

http://www.null-hypothesis.co.uk/science/teaching/item/learn_more_about_nanotechnology_teaching

This website contains a resource article from the Journal of Unlikely Science addressing the concept of nanoscience in very readable, everyday language. Additional website resources are cited.

Powers of 10 – For Educators

<http://www.powersof10.com/index.php?mod=education>

This website provides a variety of opportunities to explore the classic concept for 40 powers of 10 developed by Charles and Ray Eames. The educator's section offers Powers of 10 activities, information about Powers of 10 exhibitions, sources for Powers of 10 products and information about the annual Powers of 10 Day celebrations (October 10th each year!).

Powers of 10 – The Video

http://www.powersof10.com/index.php?mod=watch_powersof10

This is a site where students can view the classic video Powers of 10, which takes the observer from a park in Chicago by increasing powers of 10 to a location 100 million light years from Earth at 10^{24} power and then back again to the sub-atomic level of a carbon proton at a power of 10^{-16} .

GEs (Grade Expectations for Vermont's Framework of Standards and Learning Opportunities)

Grades 7-8

- S7-8:5 Inquiry – Representing Data
- S7-8:7 Inquiry – Explaining Results
- S7-8:12 Physical Science – Molecular Motion
- S7-8:14 Physical Science – States of Matter
- S7-8:23 Physical Science – Energy Transfer
- S7-8:28 Physical Science – Light Energy
- S7-8:45 Earth/Space Science – Solar System
- S7-8:48 Earth/Space Science – Seasons

Grades 9-12

- S9-12:8 Inquiry – Applying Results
- S9-12:19 Physical Science – Motion and Velocity
- S9-12:21 Physical Science – Force and Acceleration
- S9-12:24 Physical Science – Electrical Energy
- S9-12:26-27 Physical Science – Electromagnetic Forces
- S9-12:30 Life Science – Molecular Structure/Cells
- S9-12:31 Life Science – DNA Structure
- S9-12:34 Life Science – Energy in an Ecosystem
- S9-12:37 Life Science – Recycling in an Ecosystem
- S9-12:40 Human Body – Genetic Structure
- S9-12:42 Human Body – Human Health/Disease
- S9-12:47 Earth/Space Science – Plate Tectonic Movement
- S9-12:48 Earth/Space Science – Weather Systems

● Weather and Climate Change

*Lesson prepared by Emily J. Dehoff (emilydehoff@ncuhs.org),
North Country Union High School, Newport, Vt.*

This episode of **Emerging Science** explains how the earth's climate system works and explores the impact of human activity on this system. In the following lesson, students will investigate global warming and the greenhouse effect, using the Internet as a research tool and building on the material covered in **Emerging Science: Weather and Climate Change**.

Learning Outcomes

Students will be able to:

- Access the Internet and search for information on a given topic
- Read and summarize a technical article
- Define the key terms listed on the student worksheet
- Explain the greenhouse effect and be able to draw a picture showing the key points
- List some impacts of global warming in the world

Materials Needed:

A computer with Internet for every two or three students

Time Requirements:

Approximately 90 minutes

- Post-Viewing Activity -

- 1) **Have students go to the website www.epa.gov/globalwarming/**
Click the Kids and Educators button.
Click the Global Warming option.
- 2) **Have students read the information provided on the next three website pages.** (If there is time remaining, go back and read pages 3-10.)
- 3) **Have students complete the following worksheet with the help of the website information, referring back to the reading and using the built-in dictionary and aids provided.**

If students have computer time remaining, have them try finding other information on global warming by typing the term into the search box. List any other sites and information found.

Recommended rubrics: Rating out of 4

1pt = clearly, mostly finished worksheet

1pt = accurate information

1pt = good use of computer time, active participation

1pt = picture provided at the end of the worksheet or any extra websites found and recorded

- Student Worksheet -

Part I

Directions: Please define each of the following terms. To use the dictionary included on the website, click on the highlighted red term that you want defined.

- 1) Greenhouse effect
- 2) Name three greenhouse gases
- 3) Atmosphere
- 4) Weather
- 5) Global warming
- 6) Climate

Directions: Answer the following questions in your own words.

- 1) How much has Earth warmed up over the past 100 years?
- 2) Why has Earth warmed?
- 3) Are scientists sure that the greenhouse effect causes warming of air?
- 4) What factors are likely to change on Earth due to a warming atmosphere?
- 5) How is our atmosphere like a greenhouse?

Part II

- 1) List three more points that you learned from this reading.
- 2) List at least one question prompted by this reading.
- 3) Draw a picture of what happens to the sun's energy as it enters our atmosphere. Include the terms atmosphere, absorption, reflection, transmission and re-emitted. Use the computer-drawing program or sketch this in the space provided. Be sure to print out a copy of your sketch if you are using the computer drawing program.

Part III

Directions: answer the following key greenhouse questions.

- 1) Which has the longer wavelength, infrared or ultraviolet radiation?
- 2) Which has more energy, infrared or ultraviolet radiation?
- 3) Which passes through glass without a problem, infrared or ultraviolet radiation?
- 4) Which is the wavelength that is nicknamed the “heat wave,” infrared or ultraviolet radiation?

Key points to remember:

- The shorter the wavelength, the greater the energy level
- Good absorbers of energy are good radiators
- Specific gases absorb certain wavelengths of light
- CO₂ and methane are called greenhouse gases because they are good absorbers of infrared radiation and tend to warm the atmosphere
- It is believed that the more greenhouse gases there are, the greater the atmospheric warming will be

GEs (Grade Expectations for Vermont’s Framework of Standards and Learning Opportunities)

S9-12:49 Students demonstrate their understanding of processes and change within natural resources by explaining a natural chemical cycle that has been disrupted by human activity and predicting what the long term effect on organisms will be (e.g., acid precipitation, global warming, ozone depletion, pollution of water by phosphates, mercury, PCBs, etc.).

● Water and the Landscape

*Lesson prepared by Jeff Rouleau (jrouleau@bfasta.net),
BFA-St Albans, St. Albans, Vt.*

This episode of **Emerging Science** explores the complex system of the Lake Champlain watershed. Experts from the fields of geology, hydrology, ecology, computer science and other disciplines collaborate to develop a model of the watershed that will help to quantify human impacts on Vermont's water systems. In this lesson, students get hands-on experience studying the watershed in which they go to school from the point of view of geology, hydrology, ecology, social science and land use planning, revealing how all these disciplines integrate to create a complete picture of the watershed and their impact on it.

- Pre-Viewing Activities -

The following are intended as options for pre-viewing activities and for getting the thought processes going on water. It is not recommended that all the activities be done before watching the video, however they are all valuable and could be done at a later time.

- 1) **Take a walk to a local river, stream, pond or lake and have students generate a set of questions about the water.**

Have them share the questions with each other in a discussion that narrows down their questions to the most important question they have generated. They should be prepared to share why it is the most important question.

- 2) **Define what a watershed is and determine what watershed your school grounds are in.**

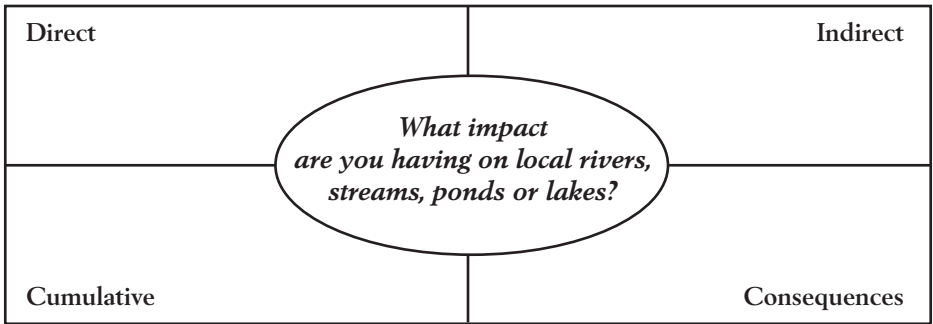
Many Vermont schools are likely part of the greater Lake Champlain watershed or the Connecticut River watershed, but investigate further to determine if there is a local stream, river, pond or lake watershed that the school is part of. Google "Vermont Watersheds" for a list of available resources.

- 3) **Discuss what shared responsibility means.**

Have students give examples and then ask how they pertain to Vermont's clean water supply.

- 4) **Discuss what forces shaped the Champlain Valley?**

This should be a review of earth science. Answers might include: plate tectonics, plate boundaries, gravity, climate, wind, glaciers, rivers, humans, etc. Be sure to include glaciers in the discussion as it is an important part of the video.



- 5) Have students complete the graphic organizer, above, then have them pair up and share their results.
- 6) Have students divide up into groups. Each group will write the following concepts on a sheet of chart paper and attempt to define the terms or give examples of the concept using past experience and knowledge.

Natural resources, urban development, nonlinear interaction, hydrologic cycle, dynamic forces, feedback loop, closed system

- Viewing Activities/Questions -

Chapter 1 – The Lake Champlain watershed

1. What is a watershed?
2. What are the boundaries of the Lake Champlain watershed?
3. How old is the bedrock in the Champlain Valley?
4. How deep was the ice that covered Vermont?
5. Why does it take so long for the water to drain out of the land in the Champlain Valley?

Chapter 2 – Understanding how water on and in the ground works

1. When was Vermont's last big flood?
2. What is an aquifer?
3. What functions do wetlands perform? (Give at least 3)

Chapter 3 – The human impact on watersheds in Vermont

1. How did the European settlers change the Lake Champlain watershed?
2. What are three other human activities that have impacted the Lake Champlain watershed?
3. What is an impervious surface?

4. What are three techniques that can be used in developed areas to reduce human impact on watersheds?
5. What concern do scientists have about the impact of ski areas on watersheds?

Chapter 4 – Creating solutions to our watershed problems

1. What is a complex systems model?
2. What are some of the parts of a complex systems model of a watershed? (Give at least five)
3. What is an ecologically-designed solution?
4. How is market value different from ecological value?

- Post-Viewing Activities -

1) River Discharge Activity

A river gauge is able to measure the discharge of a particular river. Data for a 12-hour sampling was collected and recorded below. The two sets of data indicate the river discharge before development and after development with the same amount of rainfall. The student’s job is to graph the data and use the graph to determine what the relationship is between development and discharge in the river.

Hypothesize:

- How do you think development influences the discharge of a river?

The Data		
Time (hours)	Discharge (m ³ /sec) before development	Discharge (m ³ /sec) after development
12:00 noon.....	220	220
1:00 pm.....	260	310
2:00 pm.....	410	460
3:00 pm.....	810	940
4:00 pm.....	1270	2100
5:00 pm	1850	3600
6:00 pm.....	2750	2150
7:00 pm.....	2050	1300
8:00 pm	1390	900
9:00 pm	1000	750
10:00 pm.....	840	730
11:00 pm.....	800	720

Procedure:

- On the same graph, create a graph for each data set in the above table.

Analyze: Answer the following questions.

- Make four statements about the data on the graph.
- Why do you think there is a difference in the time between the peaks?
- What do you notice about the slopes of the curves before and after the peaks?
- How would the discharge graph change if water retention/detention devices were added to the watershed of this river?
- How does rainfall affect the discharge of a river or stream?

Going further:

- How do you think the change in the peaks affects the river channel?
- How do you think the change in the peaks affects the organisms living in the river?
- What is the impact on the lake receiving the water from this river?

- 2) **Perform a macroinvertebrate survey of a local stream to determine the health of the water. Teachers will be very pleased with the overall outcome of this activity. It is well worth the prep time. Do not shy away from this activity because you don't know what the macroinvertebrates are. Learn them with your students.**

This is a fantastic hands-on activity that students will enjoy tremendously. It involves going to the stream, turning over rocks, collecting and identifying the bugs that are living under the rocks. The bugs that are present or not present reveal a lot about the water in that stream. This can lead to quality conversations about what students learned in the video. There are a number of different sources for identifying and scoring the bugs that are found, including the following.

Lessons and explanations on how to do the activity:

<http://www.ncsu.edu/sciencejunction/depot/experiments/water/lessons/macro/>

<http://sftrc.cas.psu.edu/LessonPlans/Water/Macroinvertebrates.html>

<http://www.dep.state.fl.us/water/bioassess/bugind.htm>

Pictures for identifying the macroinvertebrates:

http://www.wvdep.org/Docs/14270_Macroinvertebrate_Identification.htm

<http://people.virginia.edu/~sos-iwla/Stream-Study/StreamStudyHomePage/StreamStudy.html>

- 3) **Have students complete the graphic organizer from the Pre-Viewing Activities again, using new pieces of information gained from the video.**
- 4) **Do an agree, disagree or neutral debate with the students on currently controversial water-related topics being debated in the Vermont legislature.**

The teacher reads a statement aloud to the class. The students individually decide if they agree, disagree or are unsure about the statement and then move to areas in the room designated as the agree, disagree and neutral areas. Once students have moved, the teacher then asks them to explain why they moved to their chosen area. As the discussion goes on, students may change their mind and move to new area. Allow this to happen and ask for an explanation on the change of mind.

The following are suggestions for statements to read aloud.

- Underground water belongs to those who own the land above it.
- All Vermonters should be free to do as they please with their land.
- Market value is more important than ecological value.
- Clean water is the single most important resource on the planet.
- Wetlands are vital to the health of all Vermonters and should be protected.
- All waterways in the State of Vermont should have a 50 foot buffer zone along their banks.

5) Have students write a persuasive essay on the statements made in #4.

- Extensions -

- 1) Obtain a copy of the city/town's zoning ordinance and identify those sections that pertain to water. If they do not meet the students' standards, organize a meeting with the zoning board or planning staff to investigate the issue.
- 2) Locate your local watershed group and learn how the class can be of assistance in improving the local watershed.
- 3) Organize a tree planting on a local river or stream.
- 4) Visit the Lake Champlain Basin Program website (www.lcbp.org) for more ideas on how to get the students involved, identify potential guest speakers and identify lots of data on Vermont's water for student analysis.
- 5) Plan a field trip to ECHO at the Leahy Center for Lake Champlain in Burlington.
- 6) Visit Vermont's Agency of Natural Resources website for information and updates on the Governor's Clean and Clear Action plan (www.anr.state.vt.us/cleanandclear/).

GEs (Grade Expectations for Vermont’s Framework of Standards and Learning Opportunities)

Enduring Knowledge (Scientific Questioning): Students raise scientifically oriented questions that can be answered through observations, experimentation and/or research. At later stages, students connect their questions to scientific ideas, concepts and quantitative relationships that inform investigations.

S9-12:1 Students demonstrate their understanding of scientific questioning by framing testable questions showing evidence of observations and prior knowledge to illustrate cause and effect.

Enduring Knowledge (Representing Data and Analysis): Students represent data using text, charts, tables and graphs.

S9-12:7 Students demonstrate their ability to explain data by proposing, synthesizing and evaluating alternative explanations for experimental results.

S9-12:7 Students demonstrate their ability to explain data by including logically consistent positions to explain observed phenomena.

Enduring Knowledge: The universe, earth and all earth systems have undergone change in the past, continue to change in the present and are predicted to continue changing in the future.

S9-12:47 Students demonstrate their understanding of processes and change over time within earth systems by identifying interactions among solid earth, atmosphere, oceans and organisms that have resulted in ongoing change of earth’s systems (e.g. effects of glacial activity).

S9-12:49 Students demonstrate their understanding of processes and change within natural resources by explaining a natural chemical cycle that has been disrupted by human activity and predicting what the long term effect will be on organisms (e.g. pollution of water by phosphates).

S9-12:49 Students demonstrate their understanding of processes and change within natural resources by identifying how materials and habits from human societies affect both physical and chemical cycles on earth, and how human alteration of these cycles can be detrimental to all organisms.

S9-12:49 Students demonstrate their understanding of processes and change within natural resources by identifying how natural ecosystems provide many basic processes that affect humans – control of the water cycle and recycling of nutrients.

Standard 1.11: Persuasive Writing

WHS: 16 In persuasive writing, students present and coherently support judgments or solutions by ...

- Providing a hook

- Arranging supporting evidence persuasively with effective use of transitional words and phrases
- Providing convincing and relevant arguments and/or reasons
- Using a range of strategies to elaborate and persuade (eg. statistics, appeals to logic, appeals to emotion, experience, case studies, expert opinion)
- Addressing the reader's potential concerns or counterarguments
- Writing an effective conclusion

● Remote Wireless Sensing

*Lesson prepared by Dan Rosenthal (drosenthal@svsu.org),
Mount Anthony Union High School, Bennington, Vt.*

This episode of **Emerging Science** examines remote wireless sensing, a technology that gives one the ability to monitor data without actually being on site. Remote sensing is becoming an important tool for scientists and professionals to study the natural environment and urban areas. There are many useful applications for remote wireless sensing including monitoring the water content of snow in Vermont or California to predict the quantity of spring runoff that will occur, simultaneously monitoring the stress on a bridge and viewing real time images of the traffic that is crossing it, and continuously monitoring volcanoes for seismic activity.

For students, a nice introduction to the world of remote sensing can come through an experience with geographic information system (GIS) and global positioning system (GPS). Students can use this technology to engage in a real scientific research project where the data is meaningful. In this lesson, the focus will be on GPS. For additional lessons that include GIS, visit www.vpt.org/programs/emergingscience.html.

Teacher Preparation:

Before class begins, use Arc View to create a grid of your school campus. The VINS Community Mapping website has a tutorial on making grids. You will need to have Arc View and your local orthophoto (aerial photograph). You can download Vermont GIS data like orthophotos and other data layers from VCGI (Vermont Center for Geographic Information). You may need to purchase some layers like orthophotos. In the field, each group of students should have a clipboard, the school campus grid on a clipboard, a GPS unit and a pencil. Have students plot their waypoints on the grid manually. (See pg. 19 for example of grid.)

Required Technology:

G.P.S. units – ideally one per student

Garmin Interface Cable – connects the Garmin GPS to a computer's serial port

The Basics of GPS

1) What does GPS stand for?

Global Positioning System

2) How many of you have used a GPS receiver before? For what purpose?

3) How does a GPS work?

Through 3D trilateration. There is an excellent summary of 3D trilateration on the following website.

http://download.intel.com/corporate/education/emea/eng/za/elem_sec/tools_resources/plans/gps/lessonplans/unit_support/educator_support/How_GPS_works.pdf

You can demonstrate 3D trilateration by having students hold meter sticks and form a circle. The students are satellites and the meter sticks are radio waves. Have your students point their meter sticks towards the center of the circle. Where the sticks overlap would be your location on the surface of the earth. (Note: instead of lines intersecting it would actually be spheres intersecting.)

- 4) **From how many satellites should a GPS receive a signal in order to be accurate?**

At least three. It is better if your unit receives a signal from more satellites.

- 5) **How can a GPS unit determine your distance from a satellite?**

The GPS unit receives radio waves from satellites. Radio waves are in the electromagnetic spectrum and travel at the speed of light. The distance is determined by the speed (speed of light) times time (the time for radio waves to travel from a satellite to the GPS unit).

- 6) **The clock in a GPS has to be accurate to the fraction of a second. How can a GPS clock be so accurate?**

In order to be that precise an atomic clock is necessary. Atomic clocks cost thousands of dollars! GPS units get around this problem by having a quartz clock that constantly resets itself.

- Activity -

- 1) **Take students outside with a GPS, school campus grid superimposed on an orthophoto (aerial photo) – there are directions on how to create grids on the VINS Community Mapping website at http://www.vinsweb.org/education/cmp_resources.html – a clipboard and a pen or pencil.**
- 2) **Have your students turn on their GPS units.** After their units are ready to navigate have them find what the accuracy of their GPS is. The “accuracy” is actually the inaccuracy of the unit. For example, if the accuracy is 20 meters, that means your coordinates can be up to 20 meters away from your actual position on the earth.
- 3) **Show students how to navigate through the different pages until they get to the menu page.** Show them how to mark a waypoint and how to use the click stick to navigate to mark waypoint.
- 4) **Have students mark a waypoint and then use the coordinates of the waypoint to plot their position on the school campus grid map by hand.**
- 5) **Finally, have students walk a trail on campus and mark waypoints along the route.** Students should be careful to take frequent waypoints. When the trail curves it is good to mark waypoints at the beginning, middle and end of the curve.

Note: It is good to have all prior waypoints deleted from the GPS units.

GEs (Grade Expectations for Vermont's Framework of Standards and Learning Opportunities)

Note: These GEs are for the complete GPS/GIS lesson found at www.vpt.org/programs/emergingscience.html.

7.1 Scientific Method

Students use scientific methods to describe, investigate, explain phenomena and raise questions in order to:

- Generate alternative explanations – hypotheses – based on observations and prior knowledge
- Design inquiries that allow these explanations to be tested
- Deduce the expected results
- Gather and analyze data to compare the actual results to the expected outcomes
- Make and communicate conclusions, generating new questions raised by observations and readings

7.2 Investigation

Students design and conduct a variety of their own investigations and projects. These should include:

- Questions that can be studied using the resources available
- Procedures that are safe, humane and ethical
- Data that are collected and recorded in ways that others can verify
- Data and results that are represented in ways that address the question at hand
- Recommendations, decisions and conclusions that are based on evidence and that acknowledge references and contributions of others
- Results that are communicated appropriately to audiences
- Reflections and defense of conclusions and recommendations from other sources, and peer review.

This is evident when:

S9-12:49

Students demonstrate their understanding of processes and change within natural resources by:

- Comparing the availability of natural resources and the impact of different management plans (e.g. management of forests depends upon use, lumber production, sugarbush, deer habitat, mining, recreation) within the management area (forest, farmland, rivers, streams)
- Choosing a Vermont ecosystem and tracing its succession before and after a damaging event, showing how the ecosystem has been restored through

the maintenance of atmosphere quality, generation of soils, control of the water cycle, disposal of wastes and recycling of nutrients (e.g. flooding, former mining sites, glacial impact, deforestation, recovery of rivers from sewage/chemical dumping, burning of fossil fuels)

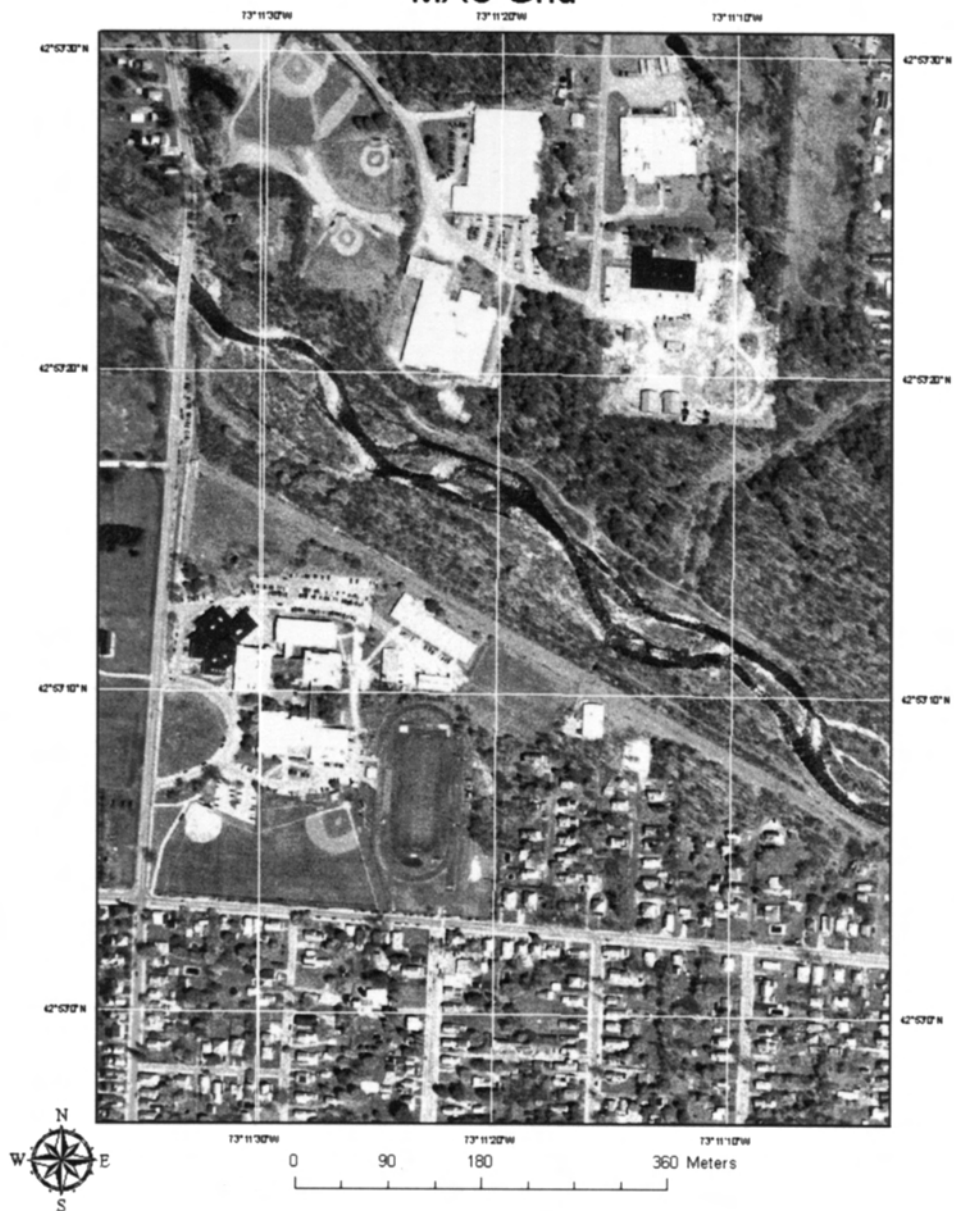
- Explaining a natural chemical cycle that has been disrupted by human activity and predicting what the long term effect will be on organisms (e.g. acid precipitation, global warming, ozone depletion, pollution of water by phosphates, mercury, PCBs, etc.)
- Tracing the processes that are necessary to produce a common, everyday object from the original raw materials to its final destination after human use, considering alternate routes including extraction of raw material, production and transportation, energy use and waste disposal throughout, packaging and recycling and/or disposal (e.g. aluminum can, steel)

S9-12:26

Students demonstrate their understanding of electromagnetic forces by:

- Comparing and contrasting the wave nature of electromagnetic energy to other forms of waves (water, sound, etc.)
- Relating the particle nature of electromagnetic waves to their frequencies and to discrete changes in energy levels within atoms (e.g. red shift, blue shift, line spectra)
- Giving examples and explaining the wave nature of electromagnetic energy (refraction, diffraction, etc.), and describing and explaining the particle nature of electromagnetic energy (photoelectric effect, Compton effect)

MAU Grid



– Science Career Opportunities –

Resource list compiled by Vermont Genetics Network (VGN), a NIH/NCRR grant funded program located at the University of Vermont.

National Resources

American Association for the Advancement of Science (AAAS)

AAAS is an international non-profit organization dedicated to advancing science around the world by serving as an educator, leader, spokesperson and professional association.

<http://www.aaas.org/careercenter/undergraduates.html> – AAAS Career Support

http://sciencecareers.sciencemag.org/career_development/previous_issues/articles/2007_07_06/carecredit_a0700094 – AAAS Advice filled Articles

Association for Women in Science (AWIS)

The Association for Women in Science is dedicated to achieving equity and full participation for women in science, mathematics, engineering and technology.

<http://www.awis.org/>

Biomedical Sciences

Listing of opportunities for undergraduates and recent college graduates

<http://people.clarkson.edu/~woodwort/opportunities.htm>

BNET Business Network

Information for undergraduates leaving the classroom for research

http://findarticles.com/p/articles/mi_qn4188/is_20070213/ai_n17221038

Brigham and Women's Hospital (BWH)

BWH is a teaching affiliate of Harvard Medical School.

<http://www.brighamandwomens.org/>

Bristol-Myers Squibb Pharmaceutical Company

Listing of career opportunities

<http://www.bms.com/career/data/>

Careers.md

Information on various healthcare careers

<http://www.careers.md/>

Dartmouth-Hitchcock Medical Center

Dartmouth-Hitchcock is New Hampshire's only academic medical center and is affiliated with Dartmouth College.

<http://www.dhmc.org/>

Duke University Career Center

Duke Career Center provides career services to undergraduates and graduate students.

http://career.studentaffairs.duke.edu/undergrad/get_advice/career_staff/industry_insights/engin_tech.html

Environmental Protection Agency (EPA) Careers

Information about student opportunities and programs

<http://www.epa.gov/careers/stuopp.html>

Forensic Science Service

Listing of forensic science courses offered at universities

http://www.forensic.gov.uk/forensic_t/inside/career/c_faq.htm

Howard Hughes Medical Institute (HHMI)

HHMI is a non-profit medical research organization whose mission is to advance biomedical research and science education in the U.S.

<http://www.hhmi.org/>

Johns Hopkins University

Part of the mission of Johns Hopkins University is to foster independent and original research.

<http://www.jhu.edu/>

Mathematical Association of America (MAA)

MAA is the largest mathematical society in the world that focuses on mathematics for students, faculty and all who are interested in the mathematical sciences.

<http://www.maa.org/students/undergrad/>

Mayo Clinic

The Mayo Clinic is the world's first and largest integrated non-profit group medical practice.

<http://www.mayo.edu/>

National Institutes of Health (NIH)

NIH is part of the U.S. Department of Health and Human Services and is the primary federal agency for conducting and supporting medical research.

<http://www.nih.gov/> – General information

<http://grants.nih.gov/training/resources.htm> – Listing of Career Opportunities

National Science Foundation (NSF)

NSF is an independent federal agency created by Congress in 1950 to promote the progress of science; to advance the national health, prosperity and welfare.

<http://nsf.gov/> – General information

http://www.nsf.gov/about/career_opps/ – Career Opportunities

New Scientist Jobs

Search for jobs in the field of science

<http://www.newscientistjobs.com/jobs/default.aspx>

PhDs.org

Lists jobs and advice on getting into graduate school

<http://www.phds.org/>

Pfizer Pharmaceutical Company

Listing of career opportunities

<http://www.pfizer.com/careers/>

Robert Wood Johnson Foundation

The mission of the Robert Wood Johnson Foundation is to improve the health and health care of all Americans.

<http://www.rwjf.org/>

Science Careers From the Journal *Science*

Search engine for science careers

<http://scjobs.sciencemag.org/search/jobs.aspx>

University Medical Center at Princeton

University Medical Center at Princeton, a unit of Princeton HealthCare System, has been a leading teaching hospital for more than 30 years.

<http://www.princetonhcs.org/page3942.aspx>

Weill Medical College of Cornell University

Weill Medical College of Cornell University is among the top-ranked clinical and medical research centers in the country.

<http://www.med.cornell.edu/>

Woods Hole Oceanographic Institution (WHOI)

WHOI is the largest non-profit oceanographic institution in the world.

<http://www.whoi.edu/>

Vermont Resources

Community Health Center of Burlington

Their mission is to improve the health of all within the communities they serve.

<http://www.communityhealthcenterburlington.org/>

DNA.gov:Vermont – President’s DNA Initiative

Advancing justice through DNA technology

http://www.dna.gov/state_profiles/Vermont

ECHO Lake Aquarium and Science Center

ECHO shares the stories of the ecology, culture, history and opportunities of the Lake Champlain Basin to foster stewardship of the basin and its precious resources.

<http://www.echovermont.org/>

Fletcher Allen Health Care

Fletcher Allen Health Care is both a community hospital and, in partnership with the University of Vermont, the state’s academic medical center.

<http://www.fahc.org/>

State of Vermont

<http://www.vermont.gov/portal/> – General Information

<http://www.vermont.gov/portal/employment/> – Career Opportunities

University of Vermont (UVM)

The University of Vermont combines faculty-student relationships most commonly found in a small liberal arts college with the resources of a major research institution.

<http://www.uvm.edu/> – General

<https://www.uvmjobs.com/applicants/jsp/shared/frameset/frameset.jsp?time=1214577054089> – Career Opportunities

Vermont Agency of Natural Resources

Information on Vermont’s natural resource divisions

<http://www.anr.state.vt.us/>

VT EPSCoR – Experimental Program to Stimulate Competitive Research

Partnership between the State of Vermont and its universities and colleges to develop science and technology infrastructure

<http://www.uvm.edu/EPSCoR/>

Vermont Fish and Wildlife Department

Their mission is to protect and conserve our fish, wildlife, plants and their habitats for the people of Vermont.

<http://www.vtfishandwildlife.com/>

Vermont Forensic Laboratory (VFL)

VFL provides services to the entire criminal justice system. Police officers representing local and state agencies, in addition to game wardens, state's attorneys' investigators and public defenders all bring evidence to the laboratory for examination.

<http://www.dps.state.vt.us/cjs/vfl/>

Vermont Genetics Network (VGN)

Their mission is to build biomedical research infrastructure throughout the state of Vermont.

<http://www.uvm.edu/~vgn/>

Vermont State Colleges

Information on all Vermont State Colleges

<http://www.vsc.edu/>