Northern Nevada Science Teachers Present: Climate Change Activities for the Classroom

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Table of Contents

Contributing Authors .............................................................. iii.
Introduction ............................................................................. v.

I. Elementary School Activities .............................................. 1
   Melting Ice and Rising Sea Levels ...................................... 3
   The Greenhouse Effect ......................................................... 15
   Global Climate Change for 3rd Grade ............................... 23
   Water and Global Climate Change .................................... 31

II. Middle School Activities ..................................................... 37
   Investigation of Water ......................................................... 39
   Climate Change and the Carbon Footprint ...................... 45
   Food Waste and Sustainability ......................................... 53
   Wetland Investigation ........................................................ 57
   Alternative Fuels Activity .................................................. 63
   What Is Sustainability? ....................................................... 69
   Wind Energy ................................................................. 71
   Meet the Creatures ........................................................... 73

III. High School Activities ....................................................... 77
   Oceans on Acid ................................................................. 79
   Ice Cores and Other Evidence .......................................... 85
   Climate, Climate Types and Global Climate Change ........ 93
   5E Water Wheel ............................................................ 99
   Wind Machine: 5 E Activity ............................................. 103
   Student Driven Research Into Green Technology ............ 107
What is a Biome? ............................................................... 117
Comparing Types of Gardening ........................................... 121
Dendochronology as a Tool for Teaching Climate Change .......... 125
Water, Climate Change and You (Water and the Radioisotopes) .... 131
Middle East Water Treaty Negotiations .................................. 141

IV. Appendices 163

Appendix A – The Socratic Method ........................................ 165
Contributing Authors


Chaney, Donna. Virginia Palmer Elementary School, Reno, Nevada. *Melting Ice and Rising Sea Levels as Part of the Unit Lesson on Weather and Climate; Water Barometers for Young Climatologists.* 2011.


Kaiser, Susan. Pine Middle School, Reno, Nevada.


This book was created to aid science teachers in bringing climate change science to their classrooms in an approachable and relevant way. The activities and lessons contained in this manual represent the best work of some of the Washoe County School District elementary, middle and high school teachers who participated in the EPSCoR climate change educational institutes held over four summers at the University of Nevada, Reno from 2009 to 2012.

Lessons were written for teacher use in Reno, Nevada but the authors believe that a wider application can be reached in other parts of the country and of the world. Lessons can be modified to fit specialized schools and programs that include units on climate change or environmental science. High school and middle school lessons can be modified to fit elementary programs. We believe that science teachers are very good at modifying lessons for their own unique circumstances!

The lessons that are included in this book are few, but have been implemented in public school science classes. We plan to expand this volume with a second edition within a year or two by inviting readers to submit their own inquiry-style science activities for publication. There is a deep need for effective climate change activities and lessons; the samples enclosed are a good start.

For comments or to submit lessons/activities, please contact us at:

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If you are interested in contacting the teachers who authored the lessons, you can Google their respective schools directly. A complete list of the contributing authors appears on page iii.
The 5E Method and Science Instruction

Presenting their lessons using the 5E Model, teachers have found their lessons to be more effective, easily comprehended by students, and concepts retained for longer periods of time. The five Es are as follows:

1. Engagement
2. Exploration
3. Explanation
4. Elaboration
5. Evaluation

The 5E teaching model stresses student exploration and discussion in full-class activities. Research indicates that many disadvantaged, ESL and LEP students learn laboratory process and social skills better (Bosser, 1983; Crowther and Robinson et al., 2007) when they are engaged in laboratory work. The direct involvement in manipulating materials is also supported by the constructivist learning model as a good way to learn and remember science information emphasized in the particular activity. There are times when science concepts are best shown and learned by teacher demonstrations even though student centered activities are still the preferred way of learning science.

One of the important aspects of using this method is to get a logical and comprehensive flow from the initial “gotcha!” (Engagement) to authentic assessment (Evaluation). Science education lends itself particularly well to this sequence since there are so many visual demonstrations relevant to just about any scientific topic. The sequence from engagement to evaluation is both progressive and logical (Tural, Akdeniz & Alev, 2010). It brings students to teachability and provides impetus for curiosity and imagination (Tzu-Chien et al 2009). It has been shown in numerous studies to be an extremely effective method for science topics and curricular units (Duran et al, 2011; Hitt, 2005).

A summary of the elements of the 5E Model is provided by Coe (2006):

Engagement

- Object, event or question used to engage students.
- Connections facilitated between what students know and can do.

Examples of engagement activities are short demonstrations, short (You Tube) videos, quick writing assignments, etc.
Exploration

- Objects and phenomena are explored.
- Hands-on activities, with guidance.

Examples of exploration activities are hand-on labs, guided and full inquiry activities, etc.

Explanation

- Students explain their understanding of concepts and processes.
- New concepts and skills are introduced as conceptual clarity and cohesion are sought.

In this part of the lesson more direct style instruction is appropriate. Student-led explanations are encouraged and ideal, but teacher input, especially to correct misconceptions is important.

Elaboration

- Activities allow students to apply concepts in contexts, and build on or extend understanding and skill.

All teachers want their lessons to be meaningful and relevant for the students. Most teachers use this elaboration section of the lesson to give the students additional avenues to expand their knowledge on the topic by suggesting additional activities and calling for ideas for new activities that will further demonstrate/explain key concepts, etc.

Evaluation

- Students assess their knowledge, skills and abilities. Activities permit evaluation of student development and lesson effectiveness.

Informal, formative, authentic, summative and student-designed assessment activities are all appropriate here (Ray & Beardsley, 2010). It is important that some kind of student product is collected at the end of the cycle, even if it is something as simple as scientific team group written observation sheets and instructor-designed questions answered.

A tabled summary of the roles teacher and learner are to assume during inquiry-based science activities were provided by Coe (MSU, 2006):
<table>
<thead>
<tr>
<th>Learner</th>
<th>Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>hypothesizes and predicts</td>
<td>questions and probes</td>
</tr>
<tr>
<td>explores resources and materials</td>
<td>models when needed</td>
</tr>
<tr>
<td>designs and plans</td>
<td>makes open suggestions</td>
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<tr>
<td>collects data</td>
<td>provides resources</td>
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<tr>
<td>builds models</td>
<td>provides feedback</td>
</tr>
<tr>
<td>seeks possibilities</td>
<td>assesses understandings and processes</td>
</tr>
<tr>
<td>self reflects and evaluates</td>
<td></td>
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**Inquiry and the Science Activity Experience**

Inquiry-based instruction has become a hallmark of science education and increasingly of integrated content areas, including science, technology, engineering, and mathematics (STEM) education (Crippen & Archambault, 2012; NSTA, 2012). Because inquiry-based instruction clearly contains surface, deep, and implicit structures as well as engages students to think and act like scientists, it is considered a signature pedagogy of science education. The nature of inquiry-based instruction and how it can be applied to the use of emerging technologies so that students not only learn the content of STEM, but can also begin answering the critical socioscientific questions that face the modern era is the true goal of the inquiry-based method in science education (Crippen & Archambault, 2012; NSTA, 2012; Robinson & Crowther, 2001).

According to science educators world-wide, the science education community mostly agrees that pedagogical practices based on inquiry-based methods are more effective for the teaching and learning of science with a focus on reasoning in a scientific context. However, the reality of classroom practice is that in the majority of European countries, these methods are only being implemented by relatively few teachers (Rocard et al, 2007; Tural, Akdeniz, & Alev, 2010).

Essentially, an inquiry-based science education (IBSE) lesson or activity consists of what might be referred to as a “stripped down” school science experiment. Many of the so-called “experiments” done with students in science classes are really nothing more that exercises in step following from a recipe book. The inquiry philosophy allows students to construct a question then gives them the choice of follow-through methods for determining the answer to the inquiry. This establishes a truer inquiry environment in the classroom. While not all activities done in science classrooms will be at this level of “pure” inquiry, the addition of some activities that reach this ideal will give most teachers the impetus to design (or redesign) the majority of science activities with this as a foundation (Robinson & Crowther, 2001). As this attitude
becomes embedded and more prevalent in the instructor’s philosophy of teaching, the classroom comes to resemble a laboratory rather than a lecture hall (Brand & Moore, 2011). This aspect of freedom to discover on the part of the student becomes a motivational factor in their desire to learn and embrace scientific principles (Duran et al, 2011).

The National Science Education Standards (NSES, p 23) defines scientific inquiry as "the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Scientific inquiry also refers to the activities through which students develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world." The Science as Inquiry Standard in NSES includes the abilities necessary to do scientific inquiry and understanding about scientific inquiry.

Scientific inquiry reflects how scientists come to understand the natural world, and it is at the heart of how students learn. From a very early age, children interact with their environment, ask questions, and seek ways to answer those questions. Understanding science content is significantly enhanced when ideas are anchored to inquiry experiences. Students also learn what DeBoer (2006) described as questions not having “right” answers but rather from the study of the evidence, answers being more or less “defensible” (p 165).

Scientific inquiry is a powerful way of understanding science content. Students learn how to ask questions and use evidence to answer them. In the process of learning the strategies of scientific inquiry, students learn to conduct an investigation and collect evidence from a variety of sources, develop an explanation from the data, and communicate and defend their conclusions.

A simple method to test inquiry-based learning using an existing laboratory activity would be to:

1. Strip down the Introduction section in any lab hand-outs given the students or forego formalized “hand-outs” altogether.

2. Initiate some kind of Engagement that causes the students to “wonder how that happens”.

3. Have students construct their own hypotheses and brainstorm ways to test them within their student teams.

4. While only describing and modeling complex scientific skills, allow students to construct a “materials and methods section” for their investigation.

5. Act as facilitator and advisor on the “project” and let the students themselves take charge. Make it your charge to set the parameters but not dictate the specified learning.

6. Model scientific thinking, behavior and philosophy, remembering that the spirit of inquiry is in questioning, not answering.
7. Design and set-up of activities should allow for total teacher access to students during activity periods. These periods of time will increase student-teacher interactions and allow for maximum informal assessment and observation.

More study on this topic is sure to yield a better understanding of both a teacher’s perspective on the nature of science and the underlying principles behind IBSE. The underlying structure of the discipline appears to be the driving factor in teachers' conception and enactment of inquiry in the classroom. Encouraging to the profession is finding that teachers' conceptions of inquiry are flexible and often adapt to disciplinary contexts (Breslyn, & McGinnis, 2012). In spite of the philosophy or the approach of individual science educator, a commitment to IBSE and the true nature of science, i.e., questioning and discovering, will yield increased student learning and engagement.

References


Waterfall picture used by permission-Royalty free stock photos. All pictures are free for commercial and personal use. Retrieved from: http://www.publicdomainpictures.net/hledej.php?hleda=quinault+waterfall
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Disclaimer

"Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation."

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Elementary School Activities
Melting Ice and Rising Sea Levels as Part of the Unit Lesson on Weather and Climate

Donna Chaney, Virginia Palmer Elementary School
Grade-Level: Elementary, Grades 5-6

Objectives

- Students learn which masses of ice pose the biggest threat for rising global sea levels.
- Students are introduced to climate and weather in small group reading and discussions with the teacher.
- Students understand how predictions, observations and weather data interpretation are accomplished.
- Students perform some investigations related to weather, climate and global warming through
- Students engage in various readings, class discussions, and weather experiments.

Overview

The initial concept of the study on weather and climate introduces students to the rising concerns of the melting polar ice caps and the causes and effects on the world population. Instructors may accomplish introductory studies as they see fit. Students generally are introduced to weather and climate in small group discussions and discuss the importance of diagrams, pictures, symbols, and the scientific process in all lab experiments. The lessons reinforce the scientific process. Students gain a solid understanding of the nature of science; all lab procedures fit the inquiry method of science as a result of consistent focus on the scientific method. This is best accomplished in the early weeks of a new school year and ideally at all grade levels. Students are also directed in the hypothesis statements for two of the three hypotheses or for each science activity. In this activity students may be instructed to work in whole group with little direction on the final hypothesis statement regarding Melting Ice and Rising Sea Levels.

There are three lab experiments to be performed by the students. The first lab is designed by the students while the other two labs center on ice cores and land-locked ice and free-floating ice are teacher-directed. The ice core lab is an instructive and enjoyable activity for students.
Engagement

Classroom viewing of the video/DVD Extreme Ice (Dockstader, 2009) with ensuing discussions about how the ice was formed is a good first engagement for this topic. In anticipation of the final lab on which type of ice would cause the most damage to the world’s low-lying areas, students are introduced to the concept in this first engagement activity. It will not take much time for students to come to the conclusion that the free floating ice was taking up space in the water and that the land locked ice will cause the most damage. Most students will be willing to get involved in discussions concerning these opening ideas. Students are encouraged to discuss global climate change and its impact on sea level rise.

Nevada Science Standards

The science standards addressed in these lessons included:

N5A.1 Students know science progress is made by conducting careful investigations, recording data, and communicating results in an accurate manner;

N8A.4 Students know how to design and conduct a controlled experiment;

N8A.5 Students know how to use appropriate technology and lab procedures safely for observing, measuring, recording, and analyzing data.

ELA standards: cause and effect relationships and drawing conclusions using comparing and contrasting.

Basic Procedure

Three lab experiments were conducted throughout the lesson: one came as a direct result of a class discussion on icebergs. In the second experiment students work with ice cores, and in the final experiment, students conduct the melting of ice and rising sea levels. Students work in small groups and record all data into a science journal and conduct an experimental lab on melting ice and rising sea levels.

The students work together as a class to write their hypothesis for the final experiment. After leading the class on the other two experiments students are able to write up a hypothesis for this final lab on their own with minimal direction from the teacher. Encouragement and assistance is
provided to students on a case by case basis with the teacher acting more as coach/mentor than direction-giver.

Inquiry Cycle

This study begins with the question, “What is the difference between weather and climate?” and eventually leads to the final question,” Which mass of ice poses the biggest threat to rising sea levels?” Students are given the opportunity to perform three labs throughout this lesson.

Students begin the study of climate and weather by engaging in small group reading and discussions with the teacher. These small groups are asked to discuss the difference between weather and climate through the use of a National Geographic book, Visualizing Weather and Climate (Anderson, 2008), and discuss how scientists, meteorologists specifically, use predictions to learn about weather. It is important that students learn and identify the conditions that create weather and be able to describe the difference between the two.

Forming a Hypothesis

Throughout the weather and climate lesson students are directed to follow the entire scientific method throughout the study. Keep the hypotheses and labs simple so students are able to easily discover the answer by the end of the lesson. The hypotheses for the first two labs are discussed by whole group and the labs were done in small groups. The students were given little direction in the formation of the hypothesis for the final lab. Our initial hypothesis centers on the weather and climate.
The second hypothesis centers on whether the amount of salt affected the melting time of frozen water, while the final hypothesis centers on the melting ice and rising sea levels.

**Investigating Our Hypothesis**

**Lab one:**

*Does the amount of salt affect the melting time of frozen water?*

Follow through with the lab designed by the students at the beginning of the lesson. During the discussion of ice ask students if icebergs were made of salt water or fresh water. When the class is unable to agree on an answer (there *will* be disagreement), invite them devise a lab that can be done in class or at home.

After executing the student-designed lab(s) have the class gather seven empty water bottles and fill each with one cup water and various amounts of salt.

Bottle One remains salt free as the control bottle.

Students add one tsp salt to bottle two, two tsp salt to bottle three, three tsp salt to bottle four, four tsp salt to bottle five, five tsp salt to bottle six, and finally six tsp salt to bottle seven.

The water is frozen and the students begin their observations in the classroom by making sketches and noting the time the lab began.

The bottles are placed outside and the time it takes for the ice to melt is measured.

The ice is checked every hour.

Help the students to see that the more salt added to the water, the less solid the water froze and the quicker it melted.

**Analyzing Data**

Students should conclude that the initial lab revealed that the more salt added to the water, the less solid the water froze and the quicker it melted. They realize that icebergs are not made of salt water because if they were they wouldn’t last long in the warmer temperatures. Bottle seven had the most salt added and the water in that bottle did not freeze as solid as the other bottles. It
also takes less time for the ice to melt in bottle seven. What other ways could they find to test whether or not there is salt in an iceberg?

**Investigating Our Hypothesis Part 1**

Lab two:

*How does an ice core act like a time machine?*

Students are given the opportunity to work with small ice cores. Students are directed to discover how ice cores act like time machines. Prior to the lab students are given information regarding how scientists use ice cores to discover information about weather patterns over time. Students are to work in small groups making observations about the general description of the cores and use their notes to answer a list of questions. The year given at the beginning of the lab was the same year given in the 2011 EPSCoR Summer Institute, 1955. Students would easily understand that year as the year of the atomic bomb testing in the Pacific Ocean and could use what they learned about weather patterns and jet streams in the book *Visualizing Weather and Climate* (Anderson, 2008). Students worked in small heterosexual groups with an ice core approximately 20 cm in height. Each group was given a year to begin and after counting the layers the groups were able to determine how old their ice core was, what each layer represented, what an ice core is, and how it can be used as a time machine. Each group made measurements, sketches and completed a series of questions. At the conclusion of the lab a whole group discussion was held.
Analyzing Data

Using the initial lesson about weather and climate students discover that the layers represent two different times during each year. Using the initial year of 1955, gives the class a starting point. Discuss with them that 1955 was a year in which an event had happened that could be measured. Discuss catastrophic events throughout history and how that information is trapped in the ice. It is important that students understand that scientists do not use any random year but one in which there is some important data that can be pulled from the cores and that 1955 was the year of atomic bomb testing in the Pacific Ocean. Once they understand that, they are able to understand how a single ice core could date as far back as thousands of years just by looking for important data that would be trapped in the cores.

Investigating Our Hypothesis Part 2

Lab three:

*Which ice poses the biggest threat for rising global sea levels?*

Students are to read articles about global warming through the use of Feeling the Heat (Time for Kids, 2011). This article, discusses how the world, as a whole, is warming up and that the ice is melting at an alarming rate. The article also relates that mapmakers made a mistake when the 13th Edition of the Times World Atlas (National Geographic Society, 2011) reported that 15% of Greenland’s permanent ice cover had melted 15%. Students are asked to discuss how incorrect information can be harmful as well as beneficial to the general public. Students are alerted to the growing issue that some critics do not agree that global warming is the threat that researchers have claimed and that the loss of 15% was exaggerated and that even 1% isn’t significant and shouldn’t be seen as a big threat. A discussion/debate can be planned for later class sessions when more information has been presented.

This final lab centers on the overall concept of rising sea levels from melting ice. Through this experiment students will see that salt water that land-locked ice will cause the most damage because the free floating ice is taking up space in the water but the sea levels will rise significantly when the land-locked ice melts.
Students are to work in small groups. Three groups work with land-locked ice while the other three work with free-floating ice. Each group is given a small plastic container. The land-locked ice groups build their land (which represents land rising out of the ocean) with clay and place it into the container. Students build small houses and added clay people to their land. They then place a chunk of ice (made of five ice cubes) on top of their land. All groups pour one cup water in the container. The free floating groups add five loose ice cubes to their one cup water. They make an initial observation by measuring the water in their containers. Containers are set aside for the remainder of the day and another measurement is made the following day. Most students are able to determine that the land locked ice containers were going to overflow so they may take precautions to place several paper towels under their containers to soak up the overflow. It is a good idea to monitor their discussion and see if they will recognize this might happen. The ice in the free-floating containers melts faster and will not show any rise in “sea” levels.

**Analyzing Data**

When the water levels begin to rise in the land-locked containers students realize that it would be the loss of land-locked ice that would cause the most damage. Free floating ice is taking up space in the water and will not cause the water to rise. Have students write down all their observations and keep the discussion about the differences between the two systems alive.

**Extending Our Theories**

Students are encouraged to look beyond what is done in the classroom and to discuss this problem with their parents. They are also encouraged to watch the weather patterns now that they have some understanding of weather and climate, to look up information and to look at it with a critical eye. Students should be encouraged to watch for signs of weather and climate changes throughout the remainder of the school year and bring in evidence of extreme weather for class discussions.

**Integration of the Nature of Science in the Lesson**

Students are introduced to science lessons by reading in small groups and learning the difference between weather and climate. Students learn that scientists do not just make wild guesses about the weather but look into history to discover what has happened over time using various
strategies. This lesson can stress that an ice core is like a time machine and how important this information is. Students make scientific observations during three labs and are constantly reminded of the creative process involved in the creation of the salt water melting time lab and working together as a team to work through the scientific process/method. It is important to set the foundation by introducing the scientific process so students have a basis for studying science and a reason for testing and experimenting with different types of ice.

During this lesson students are given the opportunity to use reading strategies such as cause and effect, and predicting. Students use various vocabulary words in their writing and are held accountable for those words in class discussions. Integrating reading and language arts into science indicates a need for science to be taught to reinforce the use of non-fiction and informational texts. Take the opportunity to read in small groups and discuss vocabulary, clarify information, and process on differentiated levels the unit of weather and climate.

**Differentiated Instruction**

All students in the class are included in the labs and class discussions. Notes are given and projected on the active board. Students are encouraged to write all directions in their journals, some were given oral instructions one-on-one. All procedures are done in small groups and students are encouraged to work together assisting all students in their group. Materials are presented in whole-group or in small group discussions. The beginning of the series is done in small groups in leveled reading groups. Only one pre-made worksheet is used and that is discussed within a small group and worked on together within the group with teacher led discussions and directions. Student work is accepted in their journals in the form of writing, sketches and pictures. Having a T.A. or volunteer parent in the class during activities helps by providing more time for explaining concepts on a one-on-one basis. Instructor and volunteer circulate around the room and assist when necessary and where needed. Students benefit from the one-on-one assistance when writing up the scientific method as well as reviewing the material on the post-test. Circulating the room and assisting when asked also encourages students to be independent and work as a group working out the answers within their individual groups. Students will often ask other groups what they had discovered and they often compare notes and this should be encouraged. Students are encouraged to participate fully within their group and when whole group discussions are held. Make use of your ELA person at the school...
and integrate this unit into the ELA block to give the class additional insight on the reading and ELA standards.

**Assessment Strategies**

At the beginning of the lesson ask students to explain what they knew about weather and climate. In small groups discuss the difference and have each student write the definition of the words on 3x5 cards to keep with other vocabulary words. These words are revisited weekly. All students have a large ring with cards attached that include all vocabulary words and their definitions that they have been learning all year. Use of a pre-test at the beginning of the unit is always a great idea when many new vocabulary words will be introduced. Students are graded on participation, notes, and their journals. Make certain to have students learn the usefulness of journals for all subjects and use them extensively for all notes. Depending on the level of understanding and maturity, students may present their findings and conclusions to the class.

**Additional Information for Teachers**

Make sure to prepare ice cores ahead of time if you choose to do this lab.

Make 3 sets of ice cores for each group of 3 students: Pour a 3 cm column of water into the orange juice can and place can in freezer. Mix food coloring with water to make a grayish color. Remove can from freezer when the water is frozen and pour a 1 cm column of the gray water on top of the original 3-cm column of water. Place in freezer until the second layer is frozen. Continue pouring and freezing alternating clear and gray water into the can until the can is full in the following order: 2 cm clear water, up to 1 cm gray water, 4 cm clear, up to 1 cm gray, 5 cm clear, and one cm gray. Label the can “Core 1” and label the bottom and top of the can. Repeat this procedure for the other two ice cores using varying amounts of clear water, and 1 cm of gray water. Label the cans “Core 2” and “Core 3,” and label each bottom and top (French J., n.d.).
Alter the labs that you find on-line to fit the needs of your class and the time constraints for this unit. Teaching this lesson as a unit on weather and climate in order to provide a progress grade for science for my students works well or it can be used with the unit on earth science.

The first time through may involve lot of prep time for this lesson. Subsequent lessons won’t involve so much time preparing for the unit. Students learned the value between the difference of weather and climate and the use of various types of reading material to integrate the lessons.

When the students are allowed to prepare their own lab with the frozen salt water, their enthusiasm goes up. They like the freedom to prepare and present the lab.

Being able to have time in the computer lab for students to investigate some web sites and to do some web surfing on related areas is a bonus. If possible have students do more research and use their computer skills to get a solid basis for this unit. Use this opportunity to incorporate note taking skills and journaling as well as small group discussions rather than whole group discussions after viewing the video. Students can also get the opportunity to write up a quiz for the video and come up with a question for the Climate 101 web site.

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The Greenhouse Effect for Fifth and Sixth Grade

Chad Fawley, Pleasant Valley Elementary School
Grade Level: Elementary, 5th and 6th Grade

Summary

The idea behind this classroom project came from the movie Carbon Nation. The first couple of minutes that contained the cartoon about the carbon dioxide video were the focus for this activity on the greenhouse effect and the introduction to the unit. Viewing the film Carbon Nation gives an important perspective to the issue of global climate change that can be passed on to the students. Prior to the viewing of segments of the film and this activity students had to write any and all information about what they knew concerning global warming and the greenhouse effect.

Objectives

1. Get students to understand the concept of global warming.

2. Help students to identify ways that could help slow down global warming during their lifetime.

3. Students will build their own basic model of earth landforms and ocean surfaces to describe localized warming effects and overall global warming effects.

Materials

a 16 inch by 16 inch pizza box

construction paper

a piece of clear plastic wrap to cover the box

a thermometer.

Students work in pairs to build a thermo generator based on what they believe the current surface of the earth looks like.

Results range from very detailed to extremely minimalist. It is interesting to see what students perceive the earth’s surface looks like using just simple material as provided for in this lab.

From the very start, regarding this entire unit, continually emphasize the effects the students can have on local/personal level regarding global warming. They will get the overall idea but to understand the relevance at their level is something that will take continued teacher support and should be the main teacher task during the activity.
Science Standards

The overall concept of the entire unit is that global warming is having an effect and many of those effects are due to humans. The following Nevada state science standards are addressed:

N5A: Students understand that science involves asking and answering questions and comparing answers to what scientists know about the world.

N5A1: Students know scientific progress is made by conducting careful investigations, recording data, and communicating the results in an accurate method.

N8A3: Students know how to draw conclusions from scientific evidence.

N5A4: Students know graphic representations of recorded data can be used to make predictions.

N5A5: Students know how to plan and conduct a safe and simple investigation.

N5A6: Students know models are tools for learning about the things they are meant to resemble.

N5B3: Students know the benefits of working with a team and sharing findings.

L5C3: Students know changes to an environment can be beneficial or detrimental to different organisms.

Using the Inquiry Cycle

Begin the inquiry cycle by discussing, “What question are we really trying to answer?” and “What is a theory?” and “How can we model the earth’s surface?”

Take some time to get the students to understand the difference between hypothesis, theory, and law, perhaps even taking a day prior to the activity to teach these concepts.

Inspire discussion to help the students to come up with the question of “How does the color of paper affect the temperature of a space?” to make sure the students are on the right path.

Divide the class into groups of students, 5-6 per group and have them come up with a hypothesis to this question.

The answers will range from “No change” to “Our hypothesis is that the temperature will vary depending on the color of the paper used”, possibly even as insightful as, “The darker the paper, the hotter the box will get since it will absorb the sunlight” and “The lighter colors will reflect light and so will be cooler.”

Have students continue to discuss the process by which light affects overall and surface temperatures and how they could find a way to measure a change. Make a list of these on the board or easel paper.
Write all the possible hypotheses on the board and have the students vote as to what they think will happen based on the class’ ideas.

Wrap up this part of the lesson by discussing whether all hypotheses could be right and end with asking them how we can prove which one of the hypotheses is correct. Hint at the idea that some of the hypotheses are wrong, but do so with the ultimate nature of science in mind, i.e., that science requires a question first and then testing to see if the hypothesis is correct or not.

Testing the Hypotheses

In the next class session have student pair up and hand out a 16 inch by 16 inch by 2 inch pizza box with the top of it removed.

Give only minimal directions like this:

“Build what you believe is a model of the earth’s surface using only construction paper.”
Do your best to answer as few questions as possible, rather referring them to the globes or atlases or maps that have been provided around the classroom and give no further details.

Give them 30 minutes to complete the activity in class, using only construction paper and tape for this first try.

It may be that they leave more confused and frustrated than anything, but that really is the purpose of this first try. They are constructing knowledge based on hypothesis and testing within the context of the scientific method and it takes time, effort and brainstorming.

The next class session begins with a question and answer session. Discuss the idea, if it comes up, that some guidelines for approaching building the model are needed. Give the groups 10 minutes to come up with some rules or guidelines to make sure everyone completed the model in a similar fashion. Be sure to remind them that the earth’s surface has been mapped and therefore all of the projects should be similar and this is the point of the discussion and group guidelines designing session.

The point is not to have all of them to look exactly alike, but to follow the same guidelines in building their model. Point out that time outside of class doing some research on the internet would be helpful. Give them the rest of the time to take the current boxes and modify what they had already done.

After completing the boxes on an assigned date and bringing back to class, discuss how they can measure the differences in each box. Some of the possible ways this will happen is putting them in order from the darkest to the lightest based on color paper used. It can be a challenging process trying to get 32 5th grade students to agree on which boxes were darker but this will be the best way to organize the projects for the next part. Allow them a guided discussion period even if it takes up the rest of the time for that day. After consensus number the boxes and set them aside until the next science class.

“Investigating the Hypothesis” is set for the following class time. First, discuss what a variable is and that we want to control as many as possible to get accurate test results. Use a demonstrated example if necessary.

Students place a thermometer in their box. Have them place it in the same location in every box so that this variable will not change and explain this variable control factor to them. Again, discuss and emphasize variables with them.

Next cover the box with the clear plastic wrap and place them in same area that faced the afternoon sun so as to control that variable as much as possible also.

Have students check their boxes at 5 minute intervals for 30 minutes and record the new temperature for each interval on a sheet of paper. Have them keep the data they took for the next class.
Give each group a sheet of graph paper with both of the axis already labeled so that we would get graphs that we could compare. This should be one of the skills they are working on in math and the scientific graphing will add relevance and reinforcement to that.

Have an example posted somewhere for the class so that all the graphs look similar in design. Instruct them to make a line graph with each of the six points. Agree on a starting temperature for the graphs so that there will be a common first point on all the line graphs.

The graphs are posted above each box and do a museum walk where each of the students walk around to each box, look at it, and discuss with their partner any interesting information gained or observations they made.

Compare the order of light to dark boxes to the temperature graphs for each one. For the most part the students will be pretty accurate in the ordering of the boxes. Have them look at the data collected and tell them to determine if there are any trends that they can see based on the graphs.

Students return back to their original groups and take out the hypothesis they had come up to begin with. Have each group share their hypothesis and whether it was correct or not based on the evidence we had collected.

For “incorrect” hypotheses discuss how scientists use an incorrect hypothesis and conclusions drawn from the experiment conducted to help them guide their next hypothesis and experiment.

Finally, the overarching questions can be addressed: 1) How did building this model help us better understand global warming? 2) How can we use the data to change the earth’s surface? Don’t give them an answer but allow them this as a take home assignment to complete. Each question is given with an expectation of a 4-5 sentence response.

**Differentiated Instruction**

One of the ways to differentiate instruction is to select the partners for the students during the experiment. Make a conscience effort to pair up a stronger science student with one that is not as confident. Fall back into a whole class exercise by having the students take out their highlighters and highlight the answers the class is looking for. The students who answer the questions have to refer back to the reading and tell in what paragraph they found the answer. Then highlight the answer and write complete sentence answers into science journals. Make use of the overhead to make sure everyone was on the correct track when answering the questions. If available one-on-one time with students who are struggling is ideal.

In the computer lab the students are able to work at their own pace in watching the videos and answering the questions. They are not able to move forward or complete a lesson until all the questions are answered correctly. If students are able to finish before the struggling ones complete their work, give them another activity to complete about global warming on the computer.
Those students who were given individual or small group instruction may do better and feel more successful just from the fact they will not be afraid to share their answers in a small group. Also, pairing the students according to some criterion, allows the students a chance to step back and watch yet still participate. Intervene with groups if one student wants to do all the work and the lower academic student does little and give specific tasks to these people. In addition, do your best to match students with various strengths like a strong science person with a strong math person.

Assessment Strategies

They receive a grade for participation on the building of the model and the line graph they create. The activities graded range from in class work, take home, and partner activities. The activities composed of paragraph writing, short answer, true/false, fill in the blank, and multiple choice questions are graded accordingly. The assessments include drawing and explaining their pictures, video lessons, and reading of materials that were age appropriate. An activity that the entire class goes through together is not given a grade.

Fifth and sixth graders are going to have an easier time when it comes to fill in the blanks, true/false, and even short answer. Give credit for the drawings and explanations of what each one meant. Assess whether they understand the four steps and could they put the information in their own words rather than just regurgitating information given to them, i.e., being able to explain it in their own words.

Additional Information for the Activity

The preparation for this unit take a great deal more thought time than for other science activities. It is not just open the book to a certain page and look up the vocabulary words! Gathering materials, especially trying to get enough pizza boxes, can be a challenge. You may have to order the pizza boxes online so plan in advance. One of the goals is presenting the material differently so that the students are encouraged to find out for themselves as much as possible. You will have to guide them through some unfamiliar terms and concepts but for the most part get them to find out based on what they did, not on what they were told. Remember that everything we know about science was discovered in exactly this fashion.

A concern is that with too much liberty classroom management will suffer. It is easier to keep them on task that you might think, especially when they are deciding on questions for themselves. For the most part they will want to be left alone to explore and an inquiry-style activity like this one is very good for that.

You are practicing a change in approach to teaching science that gives the students all an equal voice when it comes to designing hypotheses and looking at data. There was no right or wrong way to build the box which allows the students a chance to be creative without the fear of failure. Also, since they know that their hypothesis could be right or wrong without a negative effect, it
allows them to take more chances in trying to explain the results gained from the model. Instead of trying to make the data fit the answer, they are able to say the data did not match the hypothesis and that more testing would need to be done to try and come up with a correct hypothesis.

Conclusion

The students gain so much more from this way of teaching. The idea, especially at the elementary level, is not to totally do away with the worksheets, rather incorporate them in throughout the lesson using inquiry methodology as much as possible along with the hands on activities. Having student this focused on the nature of science and the inquiry methods gives science-appropriate results since there is scientific truth in this approach.

Please share your comments about successes with this method with Chad Fawley, c/o Pleasant Valley Elementary School, 405 Surrey Drive, Reno, Nevada 89511, 775-849-2761 or by e-mail: Chad Fawley < cfawley@washoeschools.net>

References


Climate Change Lesson Plan for 3rd Grade:
Snorkeling and Underwater With Jacques Cousteau

Kay Wilkinson-Brown, Westergard Elementary School
Grade Level: Elementary, 3rd Grade

Summary
This lesson is designed for third grade ESL students as part of a leveled reading group activity. It can be done as a small group of four students meeting daily Monday through Thursday for 30 minutes. This reading group that this lesson is based on is part of the Washoe County School District’s (WCSD) mandatory 90-minute elementary reading block. This lesson plan is designed for the fifth day of a five-day unit. It includes Nevada State Language Arts and Science, as well as the WCSD ESL standards. The Sheltered Instruction Observational Protocol (SIOP) model for lesson planning was utilized which helps in meeting all objectives as well as assisting in taking into consideration each student’s speaking, reading and writing abilities.

Making use of the leveled readers that accompany the reading program mandated by the District gives students a richer reading experience by pairing other books, particularly nonfiction with a more advanced reading level. This allows students more text-to-self and text-to-text connections which in turn gives students more opportunities to express themselves through discussion and writing. This also gives a richer experience so they will become accustomed to nonfiction text which comprises a large part of the Reading Criterion Reference Tests.

Goals in This Lesson
- Allow each student to participate in the experiments
- Students record their predictions and what actually happened
- Students record their observations at each stage of the experiment
- Extend the lessons for writing and reading activities

Summary of Procedures
To begin the lesson, reread the last chapter of Jacques Cousteau. Discuss what pollution is and why Jacques Cousteau was worried about what was happening to our oceans. Introduce the experiments with water that are to be done as a follow up to the reading. Explain that the students will examine what happens to water when put in detergent, bread, toilet paper, sunscreen, paper, and coins. Students write their predictions and then make observations of what actually happened in their ocean journals.

Have students write and discuss their observations. Further have them document what happened to the water one week later and finally two weeks later. The students will make many discoveries, some common sense and some that will surprise them especially that the detergent does not make a lot of bubbles. The bread floats and continues to
float for over a week. They will see that the toilet paper never did disintegrate over two weeks of observing. They discover that the paper, as well as the coins went to the bottom of the bowl and never floated. They discover that the sunscreen when squirited in a continuous ribbon, sinks quickly to the bottom and then slowly over the next two weeks broke up in white globs and turned the water white. The water bowl in which the sunscreen was in never did acquire the scent of the sunscreen.

Science Lessons Incorporating the Science Inquiry Cycle

A. Concepts addressed by the lessons:
- How humans contribute to pollution of our oceans and ocean climate change.
- What happens to things we put in our water.
- What we can do to protect our water.

B. Nevada Science Standards:
Nature of Science
- N.5.A.1 – Students know scientific progress made by conducting careful investigations, recording data, and communicating the results in a scientific manner.
- N.5.B.3 – Students know the benefits of working with a team and sharing findings.

Life Science
- L.5.C.3 – Students know changes to an environment can be beneficial or detrimental to different organisms.
- L.5.C.4 – Students know all organisms, including humans, can cause changes in their environments.

Earth Science
- E.5.A.3 – Students know most of the Earth’s surface is covered with fresh or salt water.

C. Basic Procedures:
This lesson is for Day 5 of a five-day lesson. It builds upon the reading and work of the previous four days. On Day 1, students are told that they will become oceanologists. Using a KWL chart, students are asked what they know about the ocean. Vocabulary is introduced for the story, Snorkeling using a Content Cognitive Dictionary. The students read the story first together as a group, then with partners for fluency. On Day 2, vocabulary is introduced for the story, Underwater with Jacques Cousteau. As this is a more advanced story, read the story to them and then stop to discuss meaning and review vocabulary. On Day 3, review vocabulary and reread Underwater with Jacques Cousteau and review Snorkeling. Discuss coral reefs and the diverse animal and plant life they are home to. On Day 4, students will examine the difference between fresh and salt water with water samples and record their comments. Include daily discussions on what is happening to our oceans and the ways people can help the oceans and continue to review the vocabulary and review the two books. On Day 5, the science experiments are conducted. Examine what happens to water when detergent is put in. Then continue experimenting in the
same way with bread, toilet paper, sunscreen, paper, and coins. Students are to write what they think will happen and then what actually happens in their ocean journals. They will describe their observations in detail in their journals as well. They should document what happens to the water one week later and finally two weeks later.

Start off the experiment by adding detergent to a bowl of water after asking the students to write what they think would happen. Explain to them that this will be the pattern with the subsequent investigations.

On the day of the experiments, the students record their predictions and their observations on a sheet of paper with these headings:

<table>
<thead>
<tr>
<th>What will happen when?</th>
<th>What do think will happen?</th>
<th>What actually happened?</th>
</tr>
</thead>
</table>

Detergent is added to the water?

Bread is put in the water?

Toilet paper is placed in the water?

Sunscreen is squirted into the water?

Coins are thrown into the water?

1. Questioning and Theorizing
   Before each experiment, explain the activity and procedure. Have students write their predictions on their sheets.

2. Forming Hypotheses
   Students record their predictions as to what would happen before each experiment. They also predict what they thought they would see the next day and then one week later.

3. Investigating Our Hypotheses
   Students record their observations and we discuss them.

4. Analyzing Our Data
   The bowls with the items inside are kept and observed for over two weeks after conducting the experiments.
5. Synthesizing  
The students collect data and formulate the reasons as to what is happening to the water.

6. Extending Our Theories  
Discuss what would happen to the water if:

- All the items were mixed together?
- If everyone dumped things into our waterways?
- What would happen to the animals and plants that live in water?

Integration of Climate Change Standards into the Science Lesson  
During the course of the lesson discuss how people contribute to the pollution of our water. The students write about why they want clean water and what happens to water, once polluted. Discuss why and how pollution is changing our water and most importantly, our environment.

Your students possibly have never participated in this type of lesson before so it may be a learning experience for them. Although challenged by English proficiency, most will fully participate and gain the core knowledge described by the science standards. This lesson opens their eyes to a new world where even though they are third graders, they could be scientists. They learn that they can work together like scientists to predict, observe, discuss, record information and draw conclusions based on their findings.

Pertaining to climate change, the most important knowledge that gained from this lesson is from the Life Science standards:
- Students know changes to an environment can be beneficial or detrimental to different organisms. (L.5.C.3) and
- Students know all organisms, including humans, can cause changes in their environments. (L.5.C.4)

**Differentiated Instruction**
In most classes, there is a wide range of speaking, reading and writing abilities. Falling back on the standard sheltered instruction methodology so that any Non-English Proficient (NEP) or Limited English Proficient (LEP) students have the support they require. Students are allowed appropriate activities according their language proficiency levels. Yes or no answers are allowed for my Non-English proficient students. For LEP students, they use their best spelling and many times, it is hard to understand. For example before the experiment, the students first write their predictions as to what would happen to the items in the water. Then each student had an opportunity to say what he or she had written. Validate each response and then do the experiment to see what actually happened, have a discussion and then they can write it down.

**Effective Use of Assessment Strategies**
A. Planning for this lesson may differ from previous methods with incorporated science standards. You need to anticipate what students will do and how they will act.

B. Be aware of students’ predictions and their writing. Through the use of informal assessments on their predictions and their writing, assess if you are accomplishing your objectives in this lesson. As many students are English language learners, they are developing their writing skills. This is really true for all students in third grade.

C. Use formative assessment to ensure that students are actively involved during the lesson. Ensured that the students are on-task. Keep in mind that the students will be excited during the lesson which equates to learning. They typically cannot wait for their turn to do an experiment.

**Additional Information for the Lesson**
A. If this is the first lesson plan you prepare that incorporates science experiments, be ready for pleasant surprises. Students actively participate in, conduct and observe, and quickly learn to take charge of the scientific process. This lesson will take more preparation time, especially if you are not familiar with inquiry-based science teaching. Incorporate the Nevada Science Standards and you may discover that students have little experience in participating in science experiments. This is a good thing to change!

B. The students will be excited with this hands-on lesson plan. They will have a hard time
waiting for their turn to do their experiment. They thoroughly enjoy the lesson and being active participants in the experiments.

C. The students will be highly motivated and focused on what was going on since this is hands-on and each student is able to do one or more of the experiments.

D. The students may be very animated, focused on the experiments so be prepared for a lot of activity in the classroom. Keep an eye on them, but as much as possible let them be in charge of their own learning.

**Author’s Comments**

I enjoyed this lesson and learned a lot from it. I discovered that unexpected things occur. I was surprised at the results of my own hypotheses. I was sure that the toilet paper in the water would eventually disintegrate, but it did not. I thought that the sunscreen would float and it stayed on the bottom of the bowl and slowly disintegrated, turning the water white. I also thought the paper would float, not sink to the bottom of the bowl.

Please share your comments about successes with this method with Kay Wilkinson-Brown, Westergard Elementary School, 1785 Ambassador Dr., Reno, Nevada 89523, 775-746-5800 or by e-mail: Kay Brown <KWBrown@washoeschools.net>

**References**


Water and Global Climate Change
Frances Squires, Jerry Whitehead Elementary School
Grade Level: Elementary, Middle School

Summary
In the fifth century BC, the Greek philosopher Empedocles defined water as one of the four elements: earth, air, fire, and water. Water was thought to be the primal substance from which all other substances were made (Marks, 1998). At the end of these lessons students will be able to describe how water moves in a cycle, going through many stages and that these stages affect climatic patterns. Students will also be able to demonstrate knowledge of the fact that Earth’s surface is made up mostly of water with the majority of that being salt water. Finally, the children will be able to describe the difference between weather and climate. The class will participate in many different activities to accomplish these goals. The students will be engaged with an activity, will explore the concept, will explain their findings, elaborate on the concept in a real world context and then be evaluated on the learning. These will be used as a springboard for many of the discussions, including the difference between weather and climate. These will be used later in the lessons as well. The class will use a Cognitive Content Dictionary for vocabulary acquisition. Students will examine maps and globes of the earth and complete a map that shows the oceans as well as the polar ice caps, continents and currents. An activity that demonstrates the world’s water sources (see all the water in the world) will be completed along with an in-depth examination of the water cycle. Finally they will look at water pollutants and how they affect the water cycle. When finished they will engage in the “Drop of Water “game. The children will roll a die and it will land of one of six locations from which to begin their journey. Then they will describe their journey as a drop of water. If time allows students will do an activity to experience what happens when polar ice caps melt and discuss an article on the islands of Kiribiti and Maldives where the people may have to relocate due to water issues.

Science Lessons Incorporating the Science Inquiry Cycle
The focus of the sixth grade science curriculum is Earth Science. Many public schools have chosen to remove the emphasis on science in the general curriculum as raising reading and math scores took predominance with the No Child Left Behind movement. The sixth grade standards are drawn from the 8th grade standard documents. This lesson incorporates some from the 5th grade documents so as to ensure that students have the proper background information to be successful in this field of study. The concepts addressed in this lesson are as follows:

- The Water Cycle
- The percentages of water on Earth
- Water as it relates to weather
- Water as it relates to Global Climate Change
- Water as essential to the Earth and life on Earth
- Climate vs. Weather

Nevada State and Washoe County School District Standards

E.5.A.2 Students will know the processes of the water cycle, including the role of the Sun.

E.5.A.3 Students know most of Earth’s surface is covered with fresh or salt water.

E.5.A.4 Students know the role of water in many phenomena related to weather (e.g. thunderstorms, snowstorms, flooding, and drought.)

E.8.A.2. Students know how the processes involved in the water cycle affect climatic patterns.

E.8.A.3 Students know the properties that make water an essential component of the earth system.

E.8.A.5 Students know the difference between local climate and regional weather.

N.8.A – Students understand that scientific knowledge requires critical consideration of verifiable evidence obtained from inquiry and appropriate investigations.

N.8.A.1 – Students know how to identify and critically evaluate information in data, tables and graphs.

N.8.A.2 – Students know how to critically evaluate information to distinguish between fact and opinion.

N.8.A.3 – Students know different explanations can be given for the same evidence.

One of the things this lesson focuses on is the integration of climate change standards into the science lessons. The Concept Statement that students will be able to identify is that, after careful study, the climate of the planet is changing. Students are able to identify the role of water as it relates to earth in general and the climate specifically. At the end of the unit the children should have had experience with all of the applications identified in the above standards.

Basic Procedures
Observation charts are placed around the room. The lesson begins with groups of children moving from poster to poster writing their observations on the charts. This can be anything at all that they would like to take note of. These will be referred to all through the lessons. Because
this poster will only allow for so much information, one example is given below, the “Polar Ice Melt” lesson. “All the Water in the World” lesson will be completed first.

1. Questioning and Theorizing

“What would happen if the polar ices caps, which hold 2% of the world’s water, melted?”

2. Forming Hypotheses

The classes will typically divide with their hypotheses into two main groups: 1) that the water level would rise and cause flooding; 2) that the ice, because it is expanded water, takes up more room than water so there would be no change in the water level.

Basic Demonstration/Activity
The children fill a pan with half sand and half water. They measure the depth of water in the pan. They compute the depth of a block of ice. They compute the area of the water surface. They check the ice, water and sand hourly, continuing to make measurements.

Investigating our Hypotheses
Instead of 30 pans of water scattered about a small room, have the class do one model, or up to four models. This can be a challenge, because they will all want to be involved, so be sure divide up assignments fairly. Have groups of two take turns with each assignment, each group of children filling out the forms together. Round the decimal numbers to the easiest form to keep the math in control. Keep the focus on the science rather than on complicated math.

To analyze the data, have two children take turns checking the pan every hour. They should all report that the ice block is getting smaller and that the sand is becoming wet. The water level in the pan should rise slightly. The sand under the ice block will be cold, but not especially wet. The sand that was not under the ice block begins to become saturated.

The students will be constantly up looking at the progression of the ice melt. They will comment about who is right and who is wrong because of the high interest level. A lot of new questions may arise as a result of this experiment: What would happen if we used a different type of sand? Should we have used more water and sand? Should we have used a bigger ice-block? Be prepared to re-investigate this many more times.

What ends up happening next is that the kids wanted to do it again and again. Use this teachable moment to emphasize that scientists repeat their experiment to see if the results are the same.
Incorporate a discussion of what might happen as a result of the fresh water mixing with the salt water. The fact is that this one little activity sparks so much enthusiasm that you will be able to re-visit material related to it all year long and use it as a reference for all other climate, weather and earth science activities.

**Differentiated Instruction**

Use of the Guided Language Acquisition Strategies (GLAS) to meet the needs of ESL and SPED students specifically, and as an aid for all students who may struggle with the concepts is extremely beneficial. Tools suggested include: maps, pictorial input charts, poems and chants, cognitive content dictionary observation charts, and process grids.
Assessment Strategies

- Assessment tools and methods
- Pre-assessment to access prior knowledge and to get an idea of what children already know about this topic.
- Formative assessments, journals, and discussions to measure the learning that is taking place.
- Student work samples
- Worksheets

References:


Additional Resources


This site takes children to some simple reading material and follows up with a quiz. The quiz can be taken again and again and offers immediate feedback. It is accompanied by an easy to understand map of the water cycle.

This has information of the islands in the Pacific that are disappearing and the resulting refugees.

http://www.kidzone.ws/water/

This shows the water cycle and has activities (better for younger children).

WWW.epa.gov/safewater/kids/gamesandactivities.html

Use this site for more activities if needed.
Middle School Activities
Investigation #1 – Water
John Batcabe, Wooster High School
Grade Level – Middle or High School

Summary
Since water is the basis of all life and because the unique properties of water allow it to be that basis, a study of its properties is essential at all levels of school science study. Water properties such as surface tension, adhesion and cohesion, solution, density and specific heat are all characteristics that define how all chemistry progresses and all life exists. In the physical world water creates, changes and defines landscapes and earth structures. This introductory activity will allow students to explore these properties and experience firsthand that water is not like any other substance on earth.

Objectives
Students will answer the following questions as they perform nine different investigations of water:
1. What are properties of water?
2. How are the properties of water important to our understanding of the hydrosphere, the water cycle, chemistry and earth science?
3. How do the properties of water, when applied to other earth science disciplines allow us to look further into and understand global climate change?
4. How does inquiry-based science lend itself to understanding the properties of water?
5. Why can it be determined that all properties of water are consequences of the chemical arrangement of the water molecule?

Nevada Science Standards
The science standards addressed in these lessons included:
E.5.A.3 – Students know most of the Earth’s surface is covered with fresh or salt water.
E.8.A.3 Students know the properties that make water an essential component of the earth system.
N.5.A.1 Students know science progress is made by conducting careful investigations, recording data, and communicating results in an accurate manner;
N.5.B.3: Students know the benefits of working with a team and sharing findings.

N.8.A.3 – Students know how to draw conclusions from scientific evidence and that different explanations can be given for the same evidence;

N.8.A.4 Students know how to design and conduct a controlled experiment.

**Procedural Considerations**

This activity has been designed so that the teacher can deliver the instructions in a minimalistic way in order that students may investigate in a manner approaching a pure inquiry method. The following directions are purposely vague and may be transmitted to students on a copied sheet or written onto a white or chalkboard. Directions have been split into two parts, the first designed as an overview/general description, the second being a list of “hints” to get the students investigating. They may be used in their entirety, modified or as single parts. The first part also suggests ways for students to keep track of their findings during their investigation.

**Investigation of Water: Description of Activities**

1. Observe the properties of water on wax paper and on a penny.
   Materials: water; dropper; wax paper; penny.
   **Data:** Write all observations.

2. Paper Clips on water surface.
   Materials: water; 600 ml beaker; 7 paper clips; forceps.
   **Data:** 1) Describe the appearance of the water where it touches the metal.
   2) How many clips could you suspend on the water’s surface?

3. Observe ice melting for 5 minutes on a dry petri dish.
   Materials: ice; dry petri dish or large dry watch glass.
   **Data:** Write all observations.

4. Temperature reading of air and standing water.
   Materials: water (standing); thermometer.
   **Data:** 1) Record air (room) temp in °C.
   1) Record water temp in °C.
5. Water temp with ice.
   Materials: water; ice; thermometer; 600 ml beaker.
   Data: Record water temp after 5 minutes.

6. Water temp with ice and salt.
   Materials: same as above (same system); salt (to add directly to 600 ml beaker.)
   Data: record temp of system after 2 minutes.

7. Ice melting time.
   Materials: water; Styrofoam cup; 1 ice cube; thermometer.
   Data: 1) Record water temp-no ice.
       2) Record time to melt ice cube completely (in the water).
       3) Record final temp of water in °C.

8. Hot vs. cold.
   Materials: glass bottles; hot water; standing water; food coloring.
   Data: Write all observations and comparisons of changes in single color droplet.

9. Dry ice investigation.
   Materials: dry petri dish or large dry watch glass; dry ice; 600 ml beaker; thermometer*
   Data: 1) Observe dry ice on petri dish for 5 minutes.
       2) Record temp of WATER* after dry ice is added to it (after 5 minutes).

*DO NOT TOUCH THE THERMOMETER DIRECTLY TO THE DRY ICE!

DETAILS

1. many drops, move drops around, observe from all angles, penny competition, observe water on the top of the penny, write a lot! What is going on with that water?

2. use forceps to carefully place paperclips on the surface of the water-you will need to have the beaker filled with water nearly to the top.

3. one large, or 2 small ice cubes only

4. °C - ONLY in science (no °F)-read the temperature carefully.
5. lots of ice- mostly ice, not too much water, try to get a low temperature.

6. use the whole container of salt, stir carefully with thermometer

7. one large ice cube-time in minutes and seconds.

8. be sure to observe carefully for 10 full minutes.

9. make sure petri dish is totally dry-observe for five full minutes before placing the dry ice into the 600 ml beaker-beaker should be half full of water.

NOTE: You may place the thermometer in the water near the dry ice only. You are liable for the cost of a ruined thermometer. You are only trying to find out if the dry ice makes the water as cold as the regular ice.

ALSO: You will need a lot of good observations to answer the questions on the activity next time we meet, so work together and write a lot!

Notes on implementation and assessment for teachers:
1. The two pages of this activity/investigation can be copied and handed out to student teams.

2. The information in these instructions is skeletal by design with the idea being that students not being supplied with recipe-style directions are freer to investigate the properties of water in a more inquiry-style manner.

3. The teacher can choose to go through the instruction sheet with the students, modeling some of the techniques students will use, or just allow students to read the sheets in their teams and design their own methods.

4. This activity is designed to allow teachers to mix and match activities, adding additional experiments or deleting ones that are not required by their curriculum.
5. The function of this activity is to allow student to investigate on their own and see for themselves how water behaves. This activity is critical especially for middle school and non-college-track students who have not had a strong science background. However, it is also a good opening activity for biology/chemistry students who may not have good lab skills.

6. Questions can be designed by the teacher to fit their program and pertain to each property of water displayed by each activity in the investigation. Alternatively, teachers can allow students to construct their own knowledge by having them write conclusions based on observations and describe the various properties of water in their own words in a well-written report.

7. The investigation can also be done as 90-minute activity incorporating the 5-E modeling, introducing water properties with an engagement demonstration or video and executing the several experiments within the 5-E structure.

8. Some YouTube videos that will hopefully still have active links when you read this:

Properties of water: http://www.youtube.com/watch?v=QH1yphfgfFI

States of Matter: http://www.youtube.com/watch?v=s-KvoVzukHo

Water Molecules, Parts 1 & 2: http://www.youtube.com/watch?v=sBZfPmICs-E http://www.youtube.com/watch?v=m0ITG5Q7zzI

9. This blog site from Leawood Middle School is really slick and a good class project for students who are adept at blogging or website design:

http://lmsblogs.org/all-about-the-properties-of-water/

Inquiries and comments regarding this lesson can be directed to John Batcabe, Wooster High School, 1331 E. Plumb Lane, Reno, Nevada 89502, 775-333-5100, or by e-mail: John Batcabe <JBatcabe@washoeschools.net>
Climate Change and the Carbon Footprint

Sara Sattler, Pine Middle School

Grade Level: Middle School Earth Science

Introduction

Students will participate in four distinct lessons building a background for understanding Global Climate Change: cycles of matter group poster presentation; graphing local weather patterns to compare weather and climate; web investigation of the Greenhouse Effect; and comparing densities of liquids labs. The lessons can be done as a cohesive unit or be spread out over the course of a semester in order to tie climate change science concepts into other units of study.

Lesson Objectives

By the end of this lesson, students will:

1. Form definitions of the greenhouse effect based on prior knowledge, class discussion, and viewing diagrams.
2. Participate in group brainstorming sessions and class discussions related to the impact of the greenhouse effect and global warming.
3. Analyze global warming diagrams and resources to obtain a clear understanding of this scientific process.
4. Hypothesize about the effects of global warming on the climate and the world's populations.
5. Conduct research using a variety of primary sources to explore perspectives in the global warming debate.
6. Complete a Venn Diagram that compares various points of view on global warming issues.
7. Take a position on global warming and support this viewpoint with reasons, facts, and examples gathered during lesson activities.
8. Create a project that supports their point of view about global warming issues.

Lesson Outcomes
Students will:

- Participate in group brainstorming sessions and class discussions related to the impacts the greenhouse effect and global warming and submit proposals on how to reduce carbon emissions.

- Analyze computer carbon footprint resources to obtain a clear understanding of the impacts of individual carbon emissions.

- Develop and present a personalized Carbon Footprint Inventory for their entire family detailing energy usage by week and by month.

- Conduct research using a variety of primary and secondary sources to explore perspectives on green living.

- Take a position on global warming and support this viewpoint with reasons, facts, examples gathered during lesson activities.

- Create a project that supports their point of view about combating global warming.

Pre-Lesson
Take advantage of Earth Science Week’s Make a Poster Contest (Second week of October in most years) in the Climate Change category. Create a poster to place in the classroom, around school, or for home about anything you have learned about Global Warming and Climate Change.

Handout: Earth Science Week. Read and say, “Yippy” anytime it says “Earth Science Week”

Homework: Please ask your family to help you answer these questions:

What is a ‘carbon footprint’? How many loads of laundry does your family wash every week? How many miles of driving do you do? Do you recycle? Does your family subscribe to magazines or newspapers? Are low-flow water faucets installed? Do you always turn off the lights when you leave a room? Are your parents buying local and/or organic foods? Do you use public transportation instead of the car? Do you walk or ride your bike instead of using the car?

If lesson is done in the spring focus on Earth Day instead.
Lesson One: Engage
Website: Carbon Footprint zerofootprintkids.com
Instructions: Go to zerofootprintkids.com and take the test “What You Use”. Place your name and carbon footprint number on a post-it.
When you get back to class, place your number, in numerical order, on the Carbon Footprint Comparison Graph.
Discussion- What did this test show you? What does your carbon footprint say about you? Who has the smallest footprint, why? Largest, why? How did your footprint compare to that of the average footprint in Canada and other places. Does this make sense since the U.S. is the leader in carbon emissions?
Place the question sheet on the overhead.

The idea behind the calculator is that all of our decisions and patterns of behavior add up to a "footprint," which is just a way of measuring people’s demands on nature. The more we consume, the bigger our footprint is. Indeed, our footprint is global. Much of our food, our goods, our fuel, and our resources come from somewhere else. Plus, our waste, particularly our greenhouse gas emissions, can have an effect on people everywhere.

Freewrite (Prior Knowledge Check)
How do America’s carbon emissions affect other countries? What are some of the environmental effects of CO₂? How does CO₂ cause the Greenhouse Effect? What is the worst thing that could happen if ‘we’ keep living the way we do? How do we get rid of CO₂ gases in the atmosphere? Discuss answers, address any misunderstandings.

Lesson Two: Explore
Watch Video: Carbon Sequestering?
Board: Ask the students to offer facts that they know about global warming and CO₂ and write them on the board or on easel paper.
Examples: Fact: CO₂ emissions are rising and this is causing the earth’s climates to change.
          Fact: There is no way of reducing the carbons that are in the air.
Exploration questions: What does this mean about CO₂ emissions rising? If we can’t reduce carbon compounds in the air, what else can we do?
Watch Video: The Most Terrifying Video You’ll Ever See (9 min., 30 sec.).
http://www.elephantjournal.com/2009/12/the-most-terrifying-video-youll-ever-see/
Have students reproduce the chart from the video in poster form and address the issue of Taking a Stance - should we sit around and do nothing, or should we take responsibility and change our way of living? Each team should be able to answer this question.

Lesson Three: Explanation
Student Designed and Enforced Debate.
Divide the classroom into two sections: those arguing for and those arguing against.
Pass out sample debate instructions.
Example of students that have taken a stance and are fighting for the environment (out book).
Homework: Name three things that you can do to reduce your carbon foot print.
Name one law that Americans abide by in order to sustain a healthy environment.
Name one thing that America could do to reduce carbon dioxide emissions.
Name one thing that our school does in order to reduce their carbon footprint.

Lesson Four: Elaboration
Goal: Students will be accountable for their carbon footprint, living responsibly, and reducing CO2 emissions, working to make our communities more carbon-friendly.
Questions/Lecture
What does it mean when someone says, “Living Green”?
Example: Electro Power plant
Study: In class the information on the blogsite:
http://blog.thenewcenturyschool.com/tag/carbon-footprint/
Produce: In class, with team members, a four-point plan to canvas neighborhoods and help other families with reducing their carbon footprints.
Homework: Find an alternate source for energy that you can use. Keep in mind the carbon footprint. Write a paragraph about your energy choice.

Lesson Five: Evaluation
Going Green Project: http://goinggreenproject.blogspot.com/
Choose a project based on one of the articles in the website.
Complete Outcomes listed at the beginning of the Activity.
Make presentations as scheduled.
Background for Teachers
Is human activity bringing about alarming global warming scenarios and related catastrophes? Or is such thinking a myth brought about by flawed or incomplete science? Finding the answers to these questions has turned global warming into a highly politicized and contentious issue.

Until about 1960, most scientists thought it implausible that humans could actually affect average global temperatures. (See NOW's “History of Global Warming” at http://www.pbs.org/now/science/climatechange.html)

Today, most scientists agree that Earth's temperature has risen over the past century and that carbon dioxide is one of the primary greenhouse gases that contribute to global warming. Disagreement persists, however, over whether or not global climate change is a normal environmental variation, and over how big of a problem global warming could become for the planet.

Amidst such controversy, world leaders have met and outlined legal rules, known as the Kyoto Protocol, to limit the emissions of greenhouse gases. One hundred forty countries that collectively represent 61.6% of greenhouse gas emissions worldwide have ratified the Kyoto Protocol.

The United States does not support the Kyoto Protocol and disagrees with a number of its provisions. Instead, the U.S. is funding additional scientific research on the causes and effects of global warming, encouraging climate change technology research and development efforts, looking at how its own federal and state laws can regulate greenhouse gas emissions in the U.S., backing the research and development of renewable energy sources, and pursuing other strategies that it believes will address global climate change without major upsets to the U.S. economy.

**Assumed Student Prior Knowledge** Students should be familiar with the terms, "global warming," the "greenhouse effect," and "greenhouse gases." Also, they should be aware that the U.S. is a leading producer of greenhouse gas emissions that contribute to global warming. Adjust lead-in lessons accordingly.
Climate Change Part 2: The Greenhouse Effect

Teaching Strategies and Instructions


1. Before class begins, post the term, "greenhouse effect" where students can see it.

2. To begin the class, ask students to think without talking about a definition for the greenhouse effect. Give them a minute to formulate their ideas and then have them write down their definitions so they can share them.

3. At the end of the allotted time, ask students to share their definitions with one or two other students sitting nearby and compare the similarities and differences in their definitions. Allow a few minutes for student pairs or groups to then combine their definitions into one that they believe is the most accurate.

4. Begin a class discussion by asking several pairs/groups to share their definitions of the greenhouse effect.

5. Next, show students a Flash animation (found at the U.S. Environmental Protection Agency's Web site: http://www.epa.gov/globalwarming/kids/global_warming_version2.html) that accurately describes the greenhouse effect and how it likely contributes to global warming. You might have students take turns reading the dialogue balloons for the characters shown on the site. Alternatively, the EPA Web site provides a simple diagram with text explanation of the greenhouse effect at: http://www.epa.gov/globalwarming/kids/greenhouse.html. Ask students to make any corrections to their definitions based on what they've learned.

Part 2: Making Predictions about the Effects of Global Warming (20 minutes)

With an understanding of the greenhouse effect and global climate change, students can now make predictions about the potential impact of global warming.

1. Ask students to hypothesize about how the world's climate could change over the next 100 years if humans do nothing to limit the levels of their greenhouse gas emissions. Have them also make predictions about the effects such climate changes could have on humans.

2. Working in pairs, small groups, or as a class, students should brainstorm a list of their ideas related to these questions. Each student should record a copy of the list in order to refer back to it later in the lesson.
Part 3: Comparing Points of View on Global Warming (90 minutes)
1. Begin by discussing the fact that not everyone agrees about global warming and climate change. Use content from three NOW broadcasts to illustrate some of the controversy surrounding global warming.

   The Heat Over Global Warming
   http://www.pbs.org/now/shows/304/

   Climate Change and the Media Senate Hearings
   http://www.pbs.org/now/shows/249/climate-change.html

   God and Global Warming
   http://www.pbs.org/now/shows/343/index.html
   Climate Change and the Media Senate Hearings
   http://www.pbs.org/now/shows/249/climate-change.html

   God and Global Warming
   http://www.pbs.org/now/shows/343/index.html

   • Handout: Global Warming Venn Diagram (PDF file)
     http://www.pbs.org/now/classroom/globalvenn.pdf

   • Handout: Global Warming Project Ideas (PDF file)
     http://www.pbs.org/now/classroom/globalproject.pdf

2. Pose the following question: In your opinion, has human activity caused the world's climate to change over the past 100 years?

3. Distribute copies of the Handout: Global Warming Venn Diagram (see above) and review the directions for completing the diagram.

4. Using the resources listed on the handout, have students work in pairs, small groups, or as a class to complete the graphic organizer. Encourage students to examine at least 4 of the programs listed as a means of gathering information representative of a number of different sources and points of view. Students should use at least two programs from the “NOW Programs” list and at least 2 resources from the “Other Global Warming Resources” list. As students research, direct them to note specific facts and use the back of the sheet to note more in-depth details and cite their sources. This information will be used in class discussion as well as in a later project.

Part 4: Forming Opinions about Global Warming (30 minutes)
Now that students have explored a variety of perspectives on global climate change, they will take a position on the issue and support it with data from their previous research.
1. Ask students to write 2-3 persuasive paragraphs to answer the following questions:
   - In your opinion, is global warming an imminent world threat? Why or why not?
   - Based on your opinion, what actions do you believe should be taken to address the global warming issue? Remind students to support their opinions with specific information from the brainstorming lists created in Part 2 and their completed Venn Diagrams from Part 3.

2. Once students have organized their thinking on paper, give them the opportunity to share their opinions with at least one other student in class. Do not allow discussion or debate; rather, allow students to practice sharing what they have written so that others can hear the reasons behind their positions.

**Part 5: Final Project (45 minutes, plus outside preparation time)**

1. Invite students to choose a project from the Handout: Global Warming Project List (see above). Alternatively, students could design a project of their own with teacher approval. The goal of the project is for students to create something substantive that they can use to share their positions on global warming and to increase awareness about its related issues.

2. Allow students one class period to begin work on their projects, then assign a completion date. When projects are completed, display student projects and/or have students present them to the class as a way of demonstrating their point of view on global warming issues.

**Assessment Recommendations**

Consider the following assessment ideas:

1. Give students completion grades for participating in class discussions and filling in the Venn Diagram worksheet.
2. Using a scoring guide or a peer-evaluation rubric, provide students with feedback about the effectiveness of their persuasive writing responses to the questions posed in Part 4 of the lesson.
3. Using a scoring guide and a self-evaluation rubric, have the teacher and the student evaluate his/her project using criteria established prior to completion of the assignment.
4. As students present their projects to one another, have their classmates complete a peer evaluation form that assesses the effectiveness of the project in terms of providing factual information to others.

Please share your comments about successes with this method with Sara Sattler, c/o Pine Middle School, 4800 Neil Rd Reno, NV 89502, 775-689-2550, or by e-mail: Sara Sattler <ssattler@washoeschools.net>
Lesson Title: Food Waste and Sustainability Investigation

<table>
<thead>
<tr>
<th>Grade Level: Middle School Grades 7 and 8</th>
<th>Subject Area: Life Science</th>
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<tbody>
<tr>
<td>John Armbruster, Depoali Middle School</td>
<td>Lesson Length: Multiple Days</td>
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Lesson Overview:
This 5E lesson introduces students to food waste and sustainability by engaging them in a local site-based investigation. Their local investigation prompts them to dig deeper and research the environmental, economic, and social consequences of food waste at national and global scales. Students research real world examples of food waste reduction initiatives and evaluate them as potential solutions at their school. Students develop a plan to reduce the amount of food waste produced at their school and deliver a detailed presentation to their class.

Phase One: Engage the Learner

Begin the lesson by posing several engaging questions to students and direct a class discussion on the topic of food waste:

- “What are some examples that you have seen or know about where perfectly good food was thrown in the trash?”
- “Where does the food waste go after it is thrown in the trash?”
- “What are some reasons that students throw away food instead of eating it?”
- “What kinds of foods get thrown in the trash in the school cafeteria?”
- “How much food is thrown away on a daily basis in the school cafeteria?” (Driving Question)

The last question in this list is intended to drive the investigation in phase two. Ask students to record their estimation of the amount of daily food waste at their school. Present students with some statistics about the shocking amount of food that is wasted in the U.S. [http://www.epa.gov/foodrecovery/](http://www.epa.gov/foodrecovery/).

Have students work in small groups to brainstorm possible ways to measure the amount of food waste produced at their school. Possible methods for measuring food waste include: placing special trash bins for the collection of food waste in the cafeteria, asking students to record the amount of uneaten food that they personally throw away in the cafeteria, surveying students in the cafeteria about how much food they throw away in the cafeteria.

Students will share their ideas about measuring food waste, and the teacher will direct a discussion weighing the various options proposed by students. During this discussion the teacher will use guided questioning in order to point out advantages and disadvantages of different methods. The teacher will guide the discussion in favor of measuring the mass of food waste produced using special trash bins in the cafeteria.

After discussing possible methods for measuring food waste and deciding on the preferred method, the teacher explains that because of health and safety concerns the class will only be able to collect uneaten fruits and vegetables that get discarded in the cafeteria.
What is the teacher doing?
- Direct discussion on food waste.
- Provide guidance to students while devising a plan for measuring the amount of food waste produced in the cafeteria.

What are the students doing?
- Respond to the question “How much uneaten food gets thrown in the trash every day in the school cafeteria?”
- Estimate the mass/weight of the food waste produced daily in the cafeteria.

Phase Two: Explore the Concept

Students will work in small groups to outline a plan for collecting and measuring the amount of fruit and vegetable food waste produced by students at their school.

Students will collect uneaten fruit and vegetable waste in special trash bins that have been clearly marked and placed in the school cafeteria. At the end of a predetermined time period the waste will be transported to an area where the food waste can be taken out of the bin and data collection can take place.

Paying close attention to health and safety concerns, students will observe and record the types and amounts of fruit and vegetable waste that was collected in the designated bins. Consider using a food waste log like this one provided by the EPA. [http://www.epa.gov/epawaste/conserve/pubs/food-waste-log.pdf](http://www.epa.gov/epawaste/conserve/pubs/food-waste-log.pdf)

With direction from the teacher, students will analyze and present their data in the form of tables and graphs. There are several possibilities for representing the data including: using tables to show the amount of food waste collected on each day or week, using a bar graph for the total amount of food collected per day or week, using a pie chart to show the percent of each food type collected.

After students have modeled the data using tables and graphs have the students summarize their findings in written form.

What is the teacher doing?
- Provide students with surgical gloves
- Weigh food waste.
- Direct students when calculating estimates of food waste.

What are the students doing?
- Work in small groups to devise a plan for measuring food waste.
- Place special trash bins in the cafeteria for fruit and vegetable waste.
- Create signs for the trash bins
- Make observations and record data
- Analyze data and generate tables and graphs
Phase Three: Explain the Concept and Define Terms

Students will use informative resources such as news articles, government reports, food waste blogs, podcasts, and documentary films to learn about the role of agriculture in global climate change and how reducing food waste may have a mitigating effect on climate change. Students will also research real world examples of food waste reduction initiatives and evaluate them as potential models for reducing food waste at their school.

Suggested reading (all links were obtained from http://www.wastedfood.com/press/):


Suggested Podcasts:

- [http://www.epa.gov/waste/conserve/foodrecovery/podcast/foodwaste111512.mp3](http://www.epa.gov/waste/conserve/foodrecovery/podcast/foodwaste111512.mp3)
### Phase Four: Elaborate the Concept

Using presentation software, students will work in small groups to develop a presentation to promote a plan for reducing the amount of food waste at their school.

<table>
<thead>
<tr>
<th>What is the teacher doing?</th>
<th>What are the students doing?</th>
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<tbody>
<tr>
<td>• Provide students with access to computers and presentation software.</td>
<td>• Describing the problem using evidence from informative texts and their own school investigation</td>
</tr>
<tr>
<td>• Provide students with a presentation rubric.</td>
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</table>

<table>
<thead>
<tr>
<th>What are the students doing?</th>
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<tbody>
<tr>
<td>• Examining a variety of resources</td>
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<td>• Taking notes</td>
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<td>• Group discussions</td>
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### Phase Five: Evaluate Students’ Understanding of Concept

Students will present their plans.

<table>
<thead>
<tr>
<th>What is the teacher doing?</th>
<th>What are the students doing?</th>
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<tbody>
<tr>
<td>• Evaluating student understanding and using a rubric.</td>
<td>• Delivering presentations to the class using presentation software.</td>
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<tr>
<td>• Prompting students with questions.</td>
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Please share your comments about successes with this method with John Armbruster, c/o Depoali Middle School, 9300 Wilbur May Parkway, Reno, Nevada 89521, 775-852-6700 or by e-mail: John Armbruster < JArmbruster@washoeschools.net >
Wetland Investigation 5E Learning Cycle
John Armbruster, Depoali Middle School
Grade Level: 6-8

Building Background Knowledge: Students will see three to five different types of plants of varying degrees of similarity. Students will complete observations, composed of a differences and similarities graphic organizer based on the five plants. After completing the observations matrix, students will summarize their findings in an open share session. This activity will provide students with preexisting knowledge relating to observing and identifying plant features, so that they are ready when we visit the wetlands.

Engage: For this activity students will be acting under the pretense that they are helping Washoe County Planners make plans for designing and building a manmade wetland area. The county needs students to identify several species of plants in the wetland area adjacent Depoali Middle School. In doing so, students will not only be classifying and identifying plants, they will be collecting the information essential for making a model of a wetland. According to the USGS “The characteristics of existing wetlands, in the same general area, or in an area with similar land uses, can be used as models for what might be expected of the project wetland” (Kentula, 2002). Students will be working in teams of three and each member of the team will have specific duties. These duties include GPS operator, Data Manager, and Measurement Specialist. All members of the team are responsible for recording observations and all data collected in their own field journal.

Explore: Students will visit a wetland area near school. When the class arrives at the wetland students will be assigned a predetermined location with a surface area of 1 meter by 1 meter. The sites have been chosen based on prior observation and selected for their diversity of plant species. Each site will be marked off with tent stakes and string and will include latitude and longitude.

Students will complete the observations and classifications matrix. They go to three different locations around the pond and will record the latitude and longitude that is written on a stake. They will find 3 different types of plants; photograph it, and record observations of each plant. They will have a total of 9 observations between the 3 locations. Students will be looking carefully for characteristics such as, leaf shape/pattern/flowers, stem shape/texture/color, dimensions/height/width.

Students return to the lab with their photos, data, and field notes. They will use text based and web based informational resources available at school to identify the species of plants that they
photographed and measured. All data will be entered into a class Excel spreadsheet so that data tables and graphs can be produced for the various findings from the field.

**Explain:** Students will generate tables and graphs to represent their quantitative data. As a group students will be asked to write a summary of their findings in their field journal and to briefly share them with the class.

Students will read informational text about native vs. non-native and invasive species of plants. The class will have an “accountable talk” discussion revolving around the question: what are the positive and negative effects of non-native plants on a native habitat?

**Elaborate:** Students deliver their findings in a mock presentation to the Washoe County Parks and Open Space Department. All presentations are required to be multimedia and incorporate technology. Presentations will be taped as though recorded for CSPAN or local public access news programming.

**Evaluate:** Pre- and post-tests will be administered to gather data on student understanding of the content. Throughout the multiday lesson students progress will be monitored with notebook checks, discussion, student presentations will be assessed based on a presentation rubric.
<table>
<thead>
<tr>
<th><strong>Student Outcome, Objectives and Assessments</strong></th>
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<tbody>
<tr>
<td><strong>Content Objective</strong></td>
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<tr>
<td><strong>Learning Objective</strong></td>
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<td><strong>Assessments</strong></td>
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### Materials

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<tbody>
<tr>
<td>1.</td>
<td>Field Journals</td>
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<td>2.</td>
<td>Pencil w/eraser</td>
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<td>3.</td>
<td>Measuring Tape</td>
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<td>4.</td>
<td>GPS Unit</td>
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<td>5.</td>
<td>Digital Camera</td>
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<td>6.</td>
<td>Classification Matrices</td>
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<tr>
<td>7.</td>
<td>Sunblock</td>
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<td>8.</td>
<td>Close toes shoes</td>
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<tr>
<td>9.</td>
<td>Bug spray</td>
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Please share your comments about successes with this method with John Armbruster, c/o Depoali Middle School, 9300 Wilbur May Parkway, Reno, Nevada 89521, 775-852-6700 or by e-mail: John Armbruster < JArmbruster@washoeschools.net >
Dear Students of Depoali Middle School,

The Project: We at the Washoe County Regional Parks and Open Spaces are working on a major project that will help clean the water in our streams, provide habitat for wildlife, and provide outdoor recreation opportunities for citizens of Reno. With one project we can address all three of these goals at the same time. How do we plan on doing this? With the help of students at Depoali Middle School, we are going to construct a wetland habitat. That’s right, with your help! The process for building a wetland area has many steps and can take many months, even years to complete. With your help we can get started right away and speed up the whole process.

Your Role: We chose to work with Depoali Middle School students for two reasons. First, because we are confident that you are smart and care about protecting the environment, and second because there is a wetland area within walking distance of school. Your task is to identify as many of the plant species that live in a wetlands area in Reno. When you are all finished you will present your findings back to Washoe County Regional Parks and Open Spaces, and we will use that information to keep the project moving. Thanks in advance for all of your hard work!!!!

Sincerely,
<table>
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<tr>
<th>Presentation Rubric</th>
<th>1-4</th>
<th>5-9</th>
<th>15-20</th>
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<tbody>
<tr>
<td>Presentation Structure</td>
<td>Presentation includes a Title Slide with names and a photo. The slides follow a somewhat logical path beginning with an overview, the methods you used (how you did it), your findings (data), explanation of data, and a conclusion with some suggestions for Washoe County employees.</td>
<td>Presentation includes a Title Slide with names and a photo. The slides follow a logical path beginning with an overview, the methods you used (how you did it), your findings (data), explanation of data, and a conclusion with suggestions for Washoe County employees.</td>
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</tr>
<tr>
<td>Evidence of and use of field data</td>
<td>Your data is presented somewhat clearly with tables and graphs. You include some pictures and labels of plants. You have a table to show which species are native or non-native to Reno.</td>
<td>Your data is presented clearly with tables and graphs. You include pictures and labels of plants. You have a chart to show which species are native or non-native to Reno.</td>
<td></td>
</tr>
<tr>
<td>Scientific Content and Vocabulary</td>
<td>Your presentation uses some scientific terms correctly. You use some scientific terms instead of non-scientific terms. You use some scientific terms to explain your recommendations to Washoe County employees.</td>
<td>Your presentation uses scientific terms correctly. You use scientific terms instead of non-scientific terms. You use scientific terms to explain your recommendations to Washoe County employees.</td>
<td></td>
</tr>
<tr>
<td>Recommendations to Washoe County Parks and Open Spaces</td>
<td>Your recommendations are somewhat clearly written. Your recommendations are partially based on data that you and your classmates collected. Your recommendations include a vague explanation for why a plant would be beneficial or not beneficial.</td>
<td>Your recommendations are clearly written. Your recommendations are based on data that you and your classmates collected. Your recommendations include an explanation for why a plant would be beneficial or not beneficial.</td>
<td></td>
</tr>
<tr>
<td>Presentation Quality</td>
<td>Your presentation is somewhat visually appealing. Your text that is mostly easy to read. You include at least two pictures that help the audience understand your findings. You have a somewhat appropriate number of slides. You read directly from the slide only some of the time.</td>
<td>Your presentation is visually appealing. You use text that is easy to read. You include several pictures that help the audience understand your findings. You have an appropriate number of slides. You do not read directly from the slides when presenting.</td>
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Alternative Fuels Activity and the Socratic Method
Alexandria Suchy-Mabrouk, Depauli Middle School
Grade Level – 7th Grade

Objectives
- To show students that all technologies have advantages and disadvantages.
- Have the students discuss those advantages and disadvantages together with respect.
- Initiate a dialog between students based on common scientific research.
- Introduce the topic of Global Climate Change using relevant, recent news.
- To engage students who otherwise would be behavior problems or shut down.
- Get students used to journaling and alternative assessment methods.

Concepts
One concept is how to determine if something is a fact or if it is an opinion. When students read the text for the second time they had to decide which parts were facts and which parts were opinion. Another concept is student communication of their ideas. Students had to discuss if using ethanol was ethical during the Socratic seminar. The last concept is to determine if students could explain the costs and the benefits of technological advances. They are to discuss these advantages and disadvantages during the Socratic seminar and write their responses to their questions in their compositions books.

Nevada Science Standards
There are two science standards explicitly addressed during this lesson. The first is N.8.A.2, which states that students know how to critically evaluate information to distinguish between fact and opinion. The second is N.8.B.1, which states that students understand that consequences of technologies can cause resource depletion and environmental degradation, but technology can also increase resource availability, mitigate environmental degradation, and make new resources economical. The lesson may be adapted to include more specific scientific concepts and ideas.

Basic Procedures
This is a good lesson to teach in the first month of school during what will be the first science class for many seventh grade students. Many of these students will not have a lot science background and few, if any, will be aware of the inquiry process inherent in the methods that this lesson focuses on. It is up to the teacher recreating this lesson to study the Socratic Method, familiarize themselves with it fully and decide exactly to what extent they wish to detail the procedures and lesson concepts with the students. See Appendix A for information about Socratic Methods.

The first part of the inquiry process is questioning and theorizing and will be mostly teacher led. Tell the students the question, which in this case is, “Is using corn ethanol wise/ethical?”
Students will have no input into the question that was created for this early lesson but future Socratic discussions may be more student-led and designed. After they were told the question, the article is read together as a class. Students pose questions on sticky notes during this time. A common first question written on the sticky notes is “What is ethanol?” Since many students need more background on what ethanol is, this ties in with the idea of inquiry. So show a short movie on where corn ethanol comes from and how it is produced. If time permits allow students a day in the library or computer lab to produce short presentations on ethanol.

Students are to form their own hypotheses and to answer the sticky note question. Have them write their hypotheses down in their notebooks before reading the article for a second time. In order to investigate their hypothesis by reading the same article for a second time, directed the students to underline portions of the text were facts and which portions were opinions using different color pens or highlighters.

Initiate a discussion about which parts they will be using to their support or disprove their hypotheses. As a class have them decide which facts should be used to form their own opinions, not other peoples’ opinions. For the analysis of their data (the article text) pose some questions to them: “What are some consequences if we stopped using ethanol?” and/or “What are some consequences if we continue to use ethanol?” These types of questions are designed to help the students analyze their research and organize their thoughts. The students write their own responses in their science journals and reference which lines in the text they used to formulate their answers.

The lesson at this point can take on the character of synthesis-learning. More direct questions can be posed like, “Is it wise to use corn ethanol?” They are to write response(s) in their journals. After finishing writing their response in their journals they are to read their response(s) to their shoulder partner. Initiate another class discussion of the question using a Socratic seminar. During the dialogue, ask only the initial question. If students begin to stray or add too many of their own opinions stop them and ask them to find a portion of the article that supports their position. For the extending theories part, ask students after the Socratic seminar is complete what they would do fix the current crisis that we have with the current laws about ethanol production in the United States. This is asked as a sponge. Students share their responses to the class.

Another learning exercise that can be added is to have students take the list of words that they didn’t understand and either guess what the words meant from the reading or look up their meanings. Most likely this second exercise will be done on a second day. They can also keep track of which words were defined using which method and why they decided to use that method. Additional questions about ethanol use can be incorporated such as: “What are some consequences if we continue producing ethanol?”; “What are some consequences if we continue
to use ethanol?” and/or “Is it wise to use corn ethanol?” As before students are to discuss their answers with their shoulder partner. Students generally begin to understand that issues are not black and white and both sides need to be listened to.

**Student Response in Actual Practice**
The most overwhelming result of this activity was the way the method of questioning caused student-led, appropriate discussion and that the students really enjoy doing this activity. When told that they had to move the desks back because class was almost over students, even the most unmotivated students, typically ask if they could keep doing the Socratic seminar for just a little longer. The next day students seem interested in when the class can do another activity like this one. An interesting observation is that many of the least motivated students were the ones that were most involved in the discussion or asking other students where the evidence in the text was to support their statements.

**Incorporating the Nature of Science Standards**
One of the nature of science characteristics is that students know that different people can draw different conclusions from the same evidence. This characteristic was made very clear during the Socratic seminar. Even though all of the students had read the same article they realized that different people had created different conclusions. In the case of this article it seemed mostly based two major points of view. The first is that all humans should have access to cheap food sources and the second that corporations should increase the price of food items. Some students felt that corn shouldn’t be used for ethanol because of rising food costs because people would go hungry while others felt that it was good for corporations to make more money because then in return the corporations might make more jobs. Both points of view were represented and all the students respected each other’s viewpoints. A second characteristic in the nature of science is being able to distinguish between fact and opinions. Students had to determine which parts of the article were facts and which parts were opinions. They had to underline the two categories using different colors.

After they underlined the article independently they compared their results with their shoulder partner’s results. Any discrepancy between the two had to be resolved and they had to come to a
consensus about which lines represented facts and which represented opinions. Then, as a class discussions regarding which they should be using to create and develop their own opinions: facts or opinions. A third characteristic in the nature of science is risk and benefit. Students realized that using corn ethanol has benefits for our society and but it also has many risks.

During the Socratic seminar and when they wrote in their compositions books they were asked to respond to questions that brought this to light. Students realized, and it is evident in their work, that there were good things about using corn to make ethanol, such as the fact that people are employed by the corn ethanol industry, and also bad things, that food prices were going up. This was also a majority of the conversation that took place during the Socratic seminar. Students respectfully discussed the issues surrounding corn ethanol, which included the ones already stated, clean energy, becoming less dependent on foreign fuel and a worldwide hunger crisis.

A fourth characteristic in the nature of science that this lesson addressed was ethical behavior. At the end of the Socratic Seminar students had to decide if using corn ethanol was ethical or wise. They had to write a short response to that question in their journals that is read later on. Their responses will generally demonstrate that they had a deep understanding of how complex the issue of using corn ethanol is in the United States. Some students even try to come up with solutions to the problem. Many of them will suggest that instead of having a strict law such as the one currently in place about how much of the United States’ corn harvest must be converted to ethanol that we should instead have different standards based on how much corn is grown. The larger the amount of corn produced the more ethanol that should be made and if the corn harvest is small, like this year, then the amount of corn used to make ethanol should decrease. These are only a few of the results teachers can expect when using this method

**Differentiated Instruction**
Differentiated instruction addresses both how students receive the information in this lesson and how they are able demonstrate comprehension of the topic. Students received the information using many different techniques. Two of them specifically are of value for this lesson outline. The first is using a method called close reading. During this students first read the article out loud together. They know the question that they will be answering in the end (for this activity: “Is using corn ethanol ethical or wise?”). During the reading they can write down any questions they have or vocabulary words that are unclear to them. These are collected on sticky notes on the board and looked over. The instructor can decide where to go next based on the feedback. The next time they read the article they do it silently and they are asked to underline anything that was a fact with one color and any opinions with another. The second way for them to gain knowledge about the topic was a short video about how corn ethanol is made, what it is and some of its uses. The feedback obtained from the students helps the instructor to formulate the questions used to help prepare them for the Socratic dialogue. Students were given two different ways to process the information. The first was independently. Students were asked to answer
three questions alone. After they had about twenty minutes to answer the questions alone they read their responses to their neighbors for help clarifying their point of view. Instructors are to make sure that they are trying to convince their shoulder partner that their view is correct. They were only supposed to use to the time to clarify their responses to the questions. There were two products that students had to produce. The first was being part of the Socratic Seminar and the second is their written response. Between the two all learners are able to develop a very strong understanding of what were the main issues facing corn ethanol use in the United States and that between one of those two method students had an opportunity to demonstrate whether or not they had a clear understanding of the issues.

Assessment Strategies
There were many different ways they were assessed during this lesson beginning with very informal to more directed assessment to a writing essay exam. After reading the article for the first time students got to write questions that they had or vocabulary that was on clear on sticky notes. These sticky notes were anonymous so students could ask anything they liked. The second way to assess their learning was by looking at the underlined articles. They had to underline which parts of the article were facts and which were opinions. These can be quickly scanned for accuracy and completeness with appropriate grade assigned. A third way to assess them would be to grade their responses to the questions in their journals. Reading through their journals and to see what they were able to comprehend from the article is most likely the best way to ascertain learning. Using the Socratic seminar itself as a basis for grading is authentic and effective. Students were part of a student led discussion, where the purpose was to decide if using corn ethanol was ethical or wise. Setting up appropriate and fair rubrics will allow the instructor to make quick and accurate assessment. The final assessment was on their test where they were supposed to describe one benefit and one risk associated with corn ethanol. This wide range of assessment is both varied and in-depth. Conclusions about their understanding of the topic are assured by using two or all of the suggested methods.

Additional Information for Instructors
Journal entries made by students are the 21st century version of portfolio assessment. Specifically, start them on journaling the first day of class. Set up guidelines appropriate to grade level and subject matter.

A second important aspect of this activity is the shoulder partner’s evaluation during the Socratic seminar. They are labeled as student #1, student #2 and student #3. For a real life example, student number #1 makes the point in their answer that the United Nations is predicting a food crisis and thus we could have more corn to eat if we stop making ethanol all together. They tried to make a connection to this fact and the actual price of corn, which is not a clearly formed thought. Their evaluation for the Socratic seminar is favorable and they were very involved and clearly participated in the dialogue. Student #2 has stated some consequences of what will
happen if we stop using corn and referenced which lines in the article support their stances. The writing however is choppy and not clearly formed ideas. They appear to not have participated during the dialogue at all other than listening to others speak. Student #3 has one idea stated but hasn’t backed up their opinion with any facts from the text. They were active participants during the Socratic seminar and were able to communicate their point of view and use the text to support their ideas during the dialogue. Working together like this with this type of partnership increases the level of communication and participation. Most instructors will be very impressed with the level of thought and consideration that students put into the Socratic seminar.

Some students will not perform as well during the journal assignment but many of those same students will able to talk about their answers on the test in a fully formed and well-articulated manner. Allowing the many avenues for expression and self-assessment will give students the freedom to take risks and share ideas more genuinely than if more traditional approaches by way of teacher-directed, guided learning methods are employed.

Using the assessments, particularly the first one with the sticky notes, to really guide how the lesson was taught was an effective way to not only begin, but to get students used to the idea that they were being assessed but keeping the focus on production of ideas and expression. Instructors who put in the time and work within the basic construct of this method will be pleased and enlightened. Students love the Socratic seminar and really blossom when given the opportunity to study and learn in this fashion. In many classes observed it was noted that the students didn’t want to stop and behavior problematic students were well engaged. Most students ask when they can do the next Socratic seminar. Try to include one Socratic seminar per quarter during a standard school year and please let share your results

Please share your comments about successes with this method with Alexandria Suchy-Mabrouk, c/o Depoali Middle School, 9300 Wilbur May Parkway, Reno, Nevada 89521, 775-852-6700 or by e-mail: Alexandria Suchy-Mabrouk <asuchymabrouk@washoeschools.net>

References


Lesson Title: What is Sustainability?

<table>
<thead>
<tr>
<th>Grade Level: 7th</th>
<th>Subject Area: Life Science</th>
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<tr>
<td>Alexandria Suchy-Mabrouk, Depoali Middle School</td>
<td>Lesson Length: a week/ a week and half</td>
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The Teaching Process

Lesson Overview
Student will read and research sustainability and how it affects their daily lives.

Unit Objectives: Students will understand what sustainability is and what the different components of sustainability are.

Standards addressed
MS-ESS3-1, MS-ESS3-d

List of Materials
1) Computers with internet
2) Articles

Instructional Sequence

Phase One: Engage the Learner
Students will take a carbon footprint quiz such as the one at: [http://www.cooltheworld.com/kidscarboncalculator.php?PHPSESSID=0nfse3b38r7vmi86d0iffn68m4]. Then have students line up from greatest amount of emissions to least. Students will then be paired (one high emissions student with one low emissions student) and they will talk about ways they can reduce their emissions.

Phase Two: Explore the Concept
Students will do a close read of the article found at: [http://www.cooltheworld.com/kidscarboncalculator.php?PHPSESSID=0nfse3b38r7vmi86d0iffn68m4]. During this part of the lesson students will be asked to write down questions they have or vocabulary that they don’t know on post it notes and then these will be posted in the classroom.

Phase Three: Explain the Concept and Define Terms
The post it notes that students create during phase two of the lesson will guide which concepts and terms you need to define for them during this phase.
Phase Four: Elaborate the Concept

Students will investigate and put together a presentation on different green buildings from around the world. They will be asked to answer questions such as: “What green technology does this building use?” and “How does this technology help the environment?”

Phase Five: Evaluate Students’ Understanding of Concept

Students will write a short response about which of the technologies that were presented during phase four would best benefit Depoali Middle School if they were implemented, why they believe they are the best, and what would the benefits be if they were used here.

Please share your comments about successes with this method with Alexandria Suchy-Mabrouk, c/o Depoali Middle School, 9300 Wilbur May Parkway, Reno, Nevada 89521, 775-852-6700 or by e-mail: Alexandria Suchy-Mabrouk asuchymabrouk@washoeschools.net
Lesson Title: Wind Energy

<table>
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<tr>
<th>Grade Level: 8th</th>
<th>Subject Area: Physical Science</th>
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<tr>
<td>Alexandria Suchy-Mabrouk, Depoali Middle School</td>
<td>Lesson Length: two weeks</td>
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The Teaching Process

Lesson Overview- Students will understand how wind energy is used in the United States and then they will have to build their own wind turbine.

Unit Objectives: Students will understand how the wind can help eliminate our dependency on oil and what some limitation of wind energy are in the United States.

Standards addressed The following are Next Generation Science standards that are addressed in this unit: MS PS3-a, MS ESS3-d, MS-ESS3-E, MS PS3-g

List of Materials

1) Copies of the article for students to read
2) Computers with internet access
3) Materials listed in wind turbine lab

Instructional Sequence

Phase One: Engage the Learner

Students will do a close read of an article from the New York Times. ([http://topics.nytimes.com/top/news/business/energy-environment/wind-power/index.html](http://topics.nytimes.com/top/news/business/energy-environment/wind-power/index.html)) First read the article out loud as a class. Then have students write down any words or questions they have on sticky notes. Have students post these sticky notes somewhere in the classroom. Look at these after class to determine what kinds of questions they have and create an activity for students to answer some of the questions. The next day read the article again. Have students answer the following questions:

What are the consequences (good and bad) if we stop using wind as an energy source? (Support this with lines from the text)

What are the consequences (good and bad) if we continue using wind as an energy source? (Support this with lines from the text)

Phase Two: Explore the Concept

Students will be given an area of the USA and asked to research wind energy in that area. They will find out “how much wind is produced in that region?” “what are the benefits of having wind energy in that area?” and “what are some problems facing wind energy in that region?”

Example for Nevada: [https://www.nvenergy.com/renewablesenvironment/renewables/wind.cfm](https://www.nvenergy.com/renewablesenvironment/renewables/wind.cfm)

Students will present their findings to the class.
Phase Three: Explain the Concept and Define Terms

Lecture covering topics including but not limited to: convection currents, kinetic energy, the history of wind power, velocity, potential energy, wind, wind turbines, and work. Students will have guided notes that they will fill in.

Phase Four: Elaborate the Concept

Students will build a wind turbine as outlined in a lesson plan posted at [http://www.infinitepower.org/pdf/No8%2096-818B.pdf](http://www.infinitepower.org/pdf/No8%2096-818B.pdf). Students will build the turbine and complete the lab that is attached to the PDF.

Phase Five: Evaluate Students’ Understanding of Concept

Student will write a formal lab report. They will be told they now need to make a turbine that will work when wind speeds vary. They will take the wind turbine made in the previous section and modify to work under conditions where the wind varies. They will write up their findings in a lab report and share then with the class.

Please share your comments about successes with this method with Alexandria Suchy-Mabrouk, c/o Depoali Middle School, 9300 Wilbur May Parkway, Reno, Nevada 89521, 775-852-6700 or by e-mail: Alexandria Suchy-Mabrouk <asuchymabrouk@washoeschools.net>
Global Climate Change: Meet the Creatures
Susan Kaiser, Pine Middle School
Grade Level: Middle School

Summary:
To achieve the goal of getting students interested in science and assess their ability to do inquiry this lesson called “Meet the Creatures” was modified (B.J.’s Resources, n.d.). An alternative inquiry lesson, it guides students as they adopt and observe mealworms for 6 weeks. During this time they learn the larvae body parts, life cycle, and collect data on mealworm length and mass. Through these observations each lab group develops a question to test in an experiment. A variety of investigations are conducted which may include mealworm preferences for: light or dark; dry or moist environment; type of food; type of litter to hide in and background color. Some mealworms are challenged by mazes. The data collected is graphed and results presented to the class. The lesson typically is fun and interesting for the students and lays a good foundation for future inquiry activities. Most of your students will be writing a procedure and identifying variables for the first time. While there will be some discrepancies in the data students collect it provides many teachable moments for students and helps guide the instruction for subsequent lessons.

Science Lesson Overview:
A. Concepts addressed include: use of triple beam balance to measure mass in grams; measuring using centimeters and millimeters; making observations, recording and graphing data; working in a group; identifying variables in an experiment; analyzing and presenting results.

B. Nevada State Science Standards:
N.8.A.1. – Students know how to identify and critically evaluate information in data, tables, and graphs.
N.8.A.3. – Students know how to design and conduct a controlled experiment.
N.8.A.5. – Students know how to use appropriate technology and laboratory procedures safely for observing, measuring, recording and analyzing data.
L.8.C.1. – Students know cells grow, divide, and take in nutrients which they use to provide energy for cell functions.

C1. Students initially pose questions about the mealworms on their first day of observing them and describe them in their journals. After several weeks of observing the “creatures” as a group they review these questions to see if any could be tested in an experiment. They are provided with some examples from a book called Mealworms Raise Them, Watch Them, See Them Change (Mason, & Vaculik, 2001). Students then meet as a group and decide which question they will investigate.
C2. Students use a template to help them identify the variables in their experiment and propose a hypothesis of the outcome based on their observations to date.

C3. For homework, students work individually to draft a procedure and then pool their ideas to write a step by step procedure to conduct their investigation. Teacher provides mealworms, trays and paper supplies. Students brought additional necessary items to conduct their experiment in class. Mealworm responses are recorded in the data table on the template.

C4. Students make bar graphs to show the number of times mealworms responded in a certain way.

C5. Students look for patterns in their data in order to see if a conclusion can be drawn.

C6. Students compare their results to other groups who may have conducted a similar investigation to identify common findings. Some students also read further on insect development and abilities.

D. It is not necessary for teachers to take control over these experiments as the basic requirements are outlined in the resources provided. Some groups will synthesize their own questions but likely with mixed results. All students are encouraged to utilize a series of books on insects from the public library to research the “creatures” further and add to their understanding of their results. The goal of the lesson is to ascertain the students’ ability on the whole to do free inquiry.

Integration of and Comments on the Nature of Science
As the year continues and students become better at observing and recording changes the time will come when a discussion will be relevant. Students will already be aware that the mealworms respond to changes in their environment so too will the plants that they grow and observe for the school year. This idea will transfer to plants when students begin to chronicle when certain species bud and bloom. Students will also be able to compare to others the records of bloom dates in the past. The question will naturally arise as to what could be causing this shift rather
than simply telling them that our planet is warming. The students will be more open-minded about this idea as they will have discovered some evidence themselves. Additionally, as they include their “my spot” observations on the website they will be collaborating with other citizen scientists in the US and Canada. This is a very meaningful learning experience for a student. See Thomm (2013) for elaboration on “My Spot” science activities.

**Effective use of assessment strategies**

**A.** Begin with a pre-test on inquiry and mealworm anatomy. This same tool should also be used as a post-test to the unit. Students also complete portions of the “Meet the Creatures” packet which is collected midway in the unit to assess how students are doing and collected for grading at the end of the unit. Records of the student observations are place in their science journals as they collect measurements and wait until the pupa and adult beetles are formed. Simply looking over students’ shoulders as they are writing allow the teacher to see if they are using correct units and applying what was discussed in class. The use of popsicle sticks labeled with each student’s name so over the course of several days all students in class are pulled into the discussion is an effective way of involving more students in the discussions. As feedback is given audience members are asked to vote “thumbs up” to show agreement, “thumbs down” for disagreement and halfway to indicate uncertainty. This kind of formative assessment allows the instructor to see what students are thinking and who is struggling and who is on track.

**B.** The formative assessments reveal how many students are struggling with writing even in short phrases. Just because students can speak English well doesn’t mean that they can read and write it well. Lastly, encourage students to see the process of inquiry not as a lock step method (even if you use the template as a model) but rather as a journey. Students can get hung up on being right and miss the enjoyment of discovery. See to it that they understand that an unsupported hypothesis is still informative – it’s not just about being correct.

**Teacher Comments and Observations**

**A.** The goal for this lesson/unit was that all 7th graders have a similar learning experience so that by the end of the year they have gained similar skill sets and understandings. This has meant that our science department was meeting often, sometimes twice a week, to discuss the plan and our progress towards our goals. In approaching the ideal of making our science classes more inquiry-based we focused on the need to be open-minded about trying new things and giving up some of our old ways of teaching. The increased frequency of meetings was productive and provided much needed dialogue between colleagues and a support system for system-wide changes that we all agreed would benefit students.

**B.** What was different during the year this lesson was conducted was that the students seemed to be grasping these ideas earlier in the year because they conducted the inquiry experiments themselves (albeit with as much scaffolding as needed). It appeared to have really helped them
understand more concepts and scientific principles. All of the students enjoyed this learning experience with the mealworms even though some of them were uncomfortable touching them in the first days of the unit. Several mentioned how they felt responsible caring for the mealworm like a pet. They were excited to see how they changed forms as they moved through their life cycle. To see such a level of excitement for the entire six-week period is very gratifying.

C. The experience of designing and conducting the experiments themselves had a more lasting impact on the students’ performance. They were attracted to the mealworms and so were hooked into observing them predicting when they would change form. This scaffolded approach and giving kids lots of options to make decisions and work together helped them make the leap to a less restrictive lab experience that we could all feel successful about.

Please share your comments about successes with this method with Susan Kaiser, c/o Pine Middle School, 4800 Neil Road, Reno, Nevada 89502, 775-689-2550, or by e-mail: Susan Kaiser <SKaiser@washoeschools.net>

References


High School Activities
Oceans on Acid: Studying the Effects of Carbon Dioxide on Ocean Acidification
Sarah Hopper, Washoe Innovations High School
Grade Level – Grades 10-12

Introduction
This lesson introduces students to the concept of ocean acidification and how carbon dioxide is a major factor in the reduction in pH of the oceans. Many students in the major cities have never been to the ocean and do not realize our connectivity to it, and are hundreds of miles away from it. It is imperative for students to understand that local actions can have global impacts. No matter where we live we are dependent on the ocean and its overall well-being. This lesson will serve as a lead-in lesson to aquatic biodiversity.

Content Objectives
Students will be able to:
1. Create an ocean environment and manipulate the acidity to determine the effect of pH on shells (calcium carbonate).
2. Summarize the process of ocean acidification.
3. Brainstorm ways to reduce our carbon emissions.
4. Work with group members to create a presentation on their experimental results.
5. Write a letter using the RAFT writing activity.

Learning Objectives
After completing this unit on ocean acidification, the student will be able to summarize the process of ocean acidification. The learner will develop a general understanding of the impact of carbon dioxide on the earth’s oceans. They will become familiar with the issues associated with a decrease in pH and organisms’ ability to survive under these conditions. They will also describe how they contribute to ocean acidification and brainstorm ways they can reduce their carbon footprint after completing EPA’s “Carbon Footprint Calculator” online activity. They will gain an understanding of the issues associated with a decrease in pH and organisms’ ability to survive under these conditions after reading an article on ocean acidification and by relating their use of fossil fuels to those found in the article.

Nevada State Science Standards
Content Standard N12A
Students understand that a variety of communication methods can be used to share scientific information
N.12.A.2 Students know scientists maintain a permanent record of procedures, data, analyses, decisions, and understandings of scientific investigations.
N.12.A.4 Students know how to safely conduct an original scientific investigation using appropriate tools and technology.
Content Standard N12B
Students understand the impacts of science and technology in terms of costs and benefits to society.

N.12.B.1 Students know science, technology, and society influenced one another in both positive and negative ways.

Content Standard L12C
Students understand that ecosystems display patterns of organization, change, and stability as a result of the interactions and interdependencies among the living and non-living components of the Earth.

L.12.C.3 Explain responses to environmental change that enhance or reduce the chances of survival among organisms using examples.

L.12.C.2 Describe the factors necessary for organisms to survive and interact with their physical environment.

Materials
• Pieces of shells, coral, and chicken egg shells (serve as proxy for shells)
• Lemon juice, vinegar, cola, ammonia, water, soap and other household solutions
• pH test strip, pH probe, or red cabbage juice indicator
• A small dish for each sample
• Medicine dropper or plastic pipette
• Scale
• Magnifying lens
• Alkalinity test kit
• CO₂ test kit
• Thermometers

DAY 1: 85 MINUTES

Engagement:
1. Questions
   A. How many of you like seafood? How many of you like seafood such as clams, oysters, fish, or even shrimp?
   B. What if I told you that by burning fossil fuels we are threatening the wellbeing of our oceans and the organisms that live in it? The oceans we know now are not going to be the same as the oceans we know 100 years from now…
   C. But what if there were things you could do to change the ocean’s projected fate? What would you do? What can you do?

2. Activities
   • Have students do a quick write in their notebooks to answer the above questions.
• **Introduce ocean acidification topic and show video, **ACID TEST: The Global Challenge of Ocean Acidification.

http://www.nrdc.org/oceans/acidification/aboutthefilm.asp

• **Brainstorm questions to investigate as class**

**DAY 2: 85 MINUTES**

**Engagement:**

**Exploration:**
1. Students work in groups to complete “Shells and the Impacts of Ocean Acidification” Lab
2. Predict which solution will have a greater impact on dissolution of shell
3. Make observations before, during, and after lab
4. Take various measurements every 10 minutes to see how rapid change occurs.
   a) Measurements taken: pH of solution, alkalinity tests, CO₂ test, mass of shell, temperature of solution
   b) Observations taken every 10 minutes until end of class period
5. Informal assessment:
   a) How are the effects of solution A different from solution B on shells?
   b) How do you know?
   c) What do you assume to be true about the effect of pH on your shells?
   d) What is the connection between ocean acidification and the experiment you are doing right now?

**DAY 3: 85 MINUTES**

**Engagement:**
Ocean Acidification: http://www.youtube.com/watch?v=Wo-bHt1b0sw

**Explanation**
1. Briefly cover the process of ocean acidification using PowerPoint Presentation
2. Cover important vocabulary
3. Students will work in groups to create a presentation to give to the class to summarize their observations and discuss their results.
   ➢ Relate experiment to ocean acidification.
4. Hold group discussion and compare results with peers
5. Options for presentation: poster, brochure, or PowerPoint
DAY 4: 85 MINUTES

Extension
1. Students will read the article: 
   *This is your ocean on acid* by Brita Bell.
2. Have them relate their fossil fuel consumption to the issues found in the article.
3. Calculate Carbon Footprint for their household.
4. Students will brainstorm ways they can slow the process of ocean acidification by evaluating their own fossil fuel consumption.
5. Record class totals on board.

DAY 5: 85 MINUTES

Review
Teacher will summarize week’s learning activities before having students complete RAFT writing activity.

Evaluation
Have students do a RAFT writing activity
1. Role: Clam, Oyster, or Pterapod, (or another fish that is dependent on them for their food source).
4. Topic: Why they should cut down on CO₂ emissions.

Additional Information
This lesson is best conducted during the general discussion of climate change topics near the end of the school year. It can also be incorporated as an introduction to aquatic biodiversity. The pace of the lesson can be easily adapted for the student population the instructor works with. Since a lot of inner city students struggle with reading and many don’t have access to computers outside of class more time should be given to reading activities or implementing technology.
Keep the science of ocean acidification as introductory as possible the first couple of days but on the fourth day there is incorporated an article that does require the reader to have significant understanding of the science behind ocean acidification (though, in essence, it’s still very basic). Depending on the level of the students, instructors may wish to choose alternate reading assignments. It can also be done as a read-aloud in some portions and go back and highlight the key points within the article as a whole class because it’s imperative to incorporate as much science text as possible even if it is slightly complex.

The other aspect of this lesson that some students may struggle with is the RAFT writing activity. Especially for students that have never had exposure to this style of writing, it is confusing for them. Incorporating more of these writing activities from the beginning of the year would be a good build-up for this more complicated lesson.

The lesson will have a positive impact on how students view their relationship with the ocean even though they don’t live by it. This helps tie in the concept of global connectivity when later topics such as sustainability and climate change science are introduced.

Tying in the concept of ‘Carbon Footprint’, makes students aware of how they are contributing to climate change and brings awareness in how they can reduce their carbon footprint. Encourage them to bring in the items they will need to in order to make this a successful lesson (gas and electric bills, etc…). A beginning can be made on this by doing a preliminary energy use assessment earlier in the year with units on weather, energy or the environment.

**Additional Assessment Ideas**
The presentation should suffice as a good assessment tool. Having students create posters from which to present increases the differentiation of the assessment. Students can design additional hypotheses and experiments as part of the formal project or for extra credit. Extra credit can also be given for students creating video presentations of the project itself along with their additional experiments complete with results or not.

Please share your comments about successes with this method with Sarah Hopper, c/o Washoe Innovations High School, 777 W 2nd Street, Reno, Nevada 89503, 775-333-5150, or by e-mail: Sarah Hopper <shopper@washoeschools.net>

**References**


Climate Change: Ice Cores and Other Evidence

EPSCoR Nevada Education Project
Grade Level – Middle and High School

Purpose: In order to gain a better understanding of past climates, students will create and analyze ice cores.

Background: Ice cores contain an abundance of climate information --more so than any other natural recorder of climate such as tree rings or sediment layers. Although their record is short (in geologic terms), it can be highly detailed. An ice core from the right site can contain an uninterrupted, detailed climate record extending back hundreds of thousands of years. This record can include temperature, precipitation, chemistry and gas composition of the lower atmosphere, volcanic eruptions, solar variability, sea-surface productivity and a variety of other climate indicators. It is the simultaneity of these properties recorded in the ice that makes ice cores such a powerful tool in paleoclimate research. (National Ice Core Laboratories web site: http://nicl.usgs.gov/). This activity was adapted from T.E.A. Classroom Activities (2008) for use in the 2011 EPSCoR Northern Nevada Summer Global Climate Change Science Institute for Washoe County Science Educators at University of Nevada, Reno.

Objectives: Students will be able to:
1. Create an ice core for a particular climate zone;
2. Analyze and compare ice core data;
3. Translate (infer) the ice core analysis to create a mental picture of the environment at different time periods in the ice core;
4. Write a summary of the change over time regarding the climate/environment that one particular ice core depicts.

Overview
Students investigate climate changes going back thousands of years by graphing and analyzing ice core data from Greenland and Antarctica. They use information about natural and human-caused changes in the atmosphere to formulate predictions about the Earth's climate.

Students will:

- create a graph.
- explain the pattern of data on a graph.
- make predictions that go beyond the data.
- analyze and discuss the relationships among data on different graphs.
explain how ice cores provide information about Earth's past atmosphere and climate.

describe how natural and human-related (anthropogenic) factors can affect climate.

**Procedures**

1. Assign each group of students an anonymous ice core location, only latitude/longitude is given as a clue to its identity. The ice cores have temperature and CO$_2$ (or any other greenhouse gas, if CO$_2$ is unavailable) data available from 18,000-7000 years ago obtained from the [NOAA Paleoclimatology website](https://www.noaa.gov) (more info).
2. The data (CO$_2$ and temperature) will be given to the students in an Excel spreadsheet at the beginning of the lab and the students must make a graphical representation of the data to analyze and interpret.
3. The students also will use the NOAA website and the latitude/longitude that was given to determine where their core is from and when it was collected.
4. The students will then present all of their data and interpretations to the class.
5. After the presentations, the groups will use data from the [Carbon Dioxide Information Analysis Center](https://www.co2data.co) to make a graphical representation of the current available atmospheric CO$_2$ concentrations nearest to their specific location and will compare it to the past levels found in ice cores.
6. Students will answer several questions in writing throughout the lab.

**Goals**

Students should be able to do the following:

- Understand the link between CO$_2$ (or greenhouse gases) and temperature
- Be able to work with real data
- Be confident in searching the NOAA website
- Create graphs in Excel
- Perform qualitative analysis and interpretation of the ice core data

**Assessment**

The assessment will be done on the questions answered by each group throughout the lab.

1. What correlation did you find between temperature and CO$_2$ from the ice core data?
2. What fluctuations did you see in your core?
3. How did your data compare with the other groups' data?
4. What are the implications on future temperatures based on the current CO2 levels seen in your ice core data?
National Standards

Content Standard K-12: Unifying Concepts & Processes

Content Standards 5-8: A, B, D, F, G

Content Standards 9-12: A, D, F, G

Nevada Standards:

N.12.A.2 Students know tables, charts, illustrations and graphs can be used in making arguments and claims in oral and written presentations.

N.12.B.4 Students know scientific knowledge builds on previous information.

L.12.C.2 Students know how changes in an ecosystem can affect biodiversity and biodiversity’s contribution to an ecosystem’s stability.

E.12.A.2 Students know the composition of Earth’s atmosphere has changed in the past and is changing today.

E.12.C Students understand evidence for processes that take place on a geologic time scale

Pre-activity set-up

Teacher should be familiar with the following concepts (see resource links):

- Ice sheets - large masses of ice thousands of meters thick that cover most of Greenland and Antarctica; form from accumulated snowfall over thousands of years
- Ice cores - samples extracted from ice sheets; contain traces of air, chemicals, and dust
- Greenhouse effect - the trapping of heat in the atmosphere by carbon dioxide, water vapor, and other gases
- Global warming - the potential warming of the atmosphere resulting from increases in greenhouse gases due to human activities
- Students should be familiar with the following concepts:
- Climate - the average pattern of temperature and precipitation
✓ Atmosphere - the layer of gases surrounding the Earth; mostly nitrogen and oxygen with small amounts of carbon dioxide and other gases

**Materials**

- world map or globe

Each small group of 3 - 4 students will need:

- graph paper - 2 sheets
- poster paper - 1 sheet
- copies and/or transparencies of the graph template - 1 sheet
- ice core data set - 1 copy
- graph of recent data
- markers
- colored modeling clay - small block
- clear plastic straw (fast food variety)

**Lesson Duration**

Approximately one week ~ 4 to 5 hours of class time

1. Engagement and Exploration Modeling ice sheets and cores with clay and straws - 30 minutes

2. Explanation Students write and draw what they learned - 15 minutes

3. Elaboration

   a. Graphing and analyzing ice core data Making predictions about recent trends - 1 to 2 hours
   b. Group presentations of graphs and predictions Discussion of the relationships between different sets of data - 1 hour
   c. Investigation of recent climate data - 30 minutes
4. Exchange Discussion of human-caused changes in the atmosphere and their effects on the Earth's climate - 30 minutes to 1 hour

**Engagement and Exploration (Student Inquiry Activity)**

1. Organize the class into groups of 3 to 4 students. Distribute a small brick of clay to each group and instruct them to divide it among group members. Have students flatten the clay into a thin layer.

2. Explain that layers of clay will represent annual layers of snowfall in cold, polar regions.

3. Have students come up in turn and place their clay on a flat surface. (You may choose to do the demonstration on a map or globe.) Each layer should be placed on top of the previous layers.

4. Explain that constructing the mound of clay simulates the formation of an ice sheet from accumulated snowfall over thousands of years.

5. Explain that the deep layers in the ice sheet contain information about the atmosphere and climate from long ago. Ask how scientists might be able to access that information. Explain that we are going to use straws to simulate the drilling and removal of ice cores.

6. Give each group a clear, plastic straw. Have each group simulate the recovery of an ice core. By pressing the straw straight down through all layers of the clay and carefully pulling it out they should obtain a core with visible layering.

7. Discuss which parts of the core represent the youngest and oldest layers of ice. Ask students to describe any differences they see in the layers. Have students speculate on why actual ice layers may have different properties, appearance, or thickness.

8. Display and describe ice core images.

**Explanation**

Have each student write and/or draw in response to the following questions:

- What are ice sheets and how do they form?
- What are ice cores and what might they be used for?

**Elaboration (Polar Applications)**

Each group is now a science team responsible some actual ice core data. Their task is to graph, analyze, and report on their particular set of data. The information comes from the GISP2 ice core from Greenland and the Vostok core from Antarctica. You might want to have students find these locations on a map or globe. Both cores extended down a few thousand meters into the ice sheet providing information dating back over 100,000 years BP (before the present). Some data
sets indicate the amount of different chemicals (methane, carbon dioxide, sulfate, nitrous oxide) that were present in the atmosphere. Data is also provided on past temperatures, determined by measuring the ratio of oxygen isotopes in the ice. The data represents natural changes in Earth's atmosphere and climate.

Provide each team with one set of data. More than one team may get the same data. You may choose to have each group produce their graph on a large piece of poster paper (lined or grid paper works best). This will allow them to display their graphs for presentation and comparison of the data. You may want them to use the graph template either on a transparency or on paper that can be made into a transparency later. Transparencies will allow you to overlay graphs from different teams for easy comparison.

After finishing the graph, each team should discuss and record the following:

- description of the data including any trends, patterns or cycles they might discern. They should share the unit of measurement (e.g. ppbV - parts per billion of volume) and the magnitude of any changes
- prediction and rationale for what they expect the data might look like from the last point on their graph up to the present

· Have each team give their presentation to the class. These should include:
  - displaying the graph
  - presenting the analysis
  - sharing the prediction and rationale

Challenge the class to find any relationships between the data on different graphs. They might look for:

- similar patterns of temperature between the Greenland and Antarctic cores.
- a relationship between temperature and levels of greenhouse gases (carbon dioxide, methane, nitrous oxide).
- a negative relationship between temperature and sulfate levels. Discuss the meaning or potential reasons for these relationships.

Distribute and/or display the graphs that show recent data for gases and temperature. The rapid increases in some gases over the last couple centuries are examples of anthropogenic effects linked to human activities. Have each team record a description of the data and an evaluation of their prediction. These may be shared with the class.
Exchange (Students Draw Conclusions)
Have the class share their thoughts about the recent data. The following questions can be used to guide the discussion:

- How have human activities resulted in the rapid rise in the levels of these gases?
- How has the Earth's temperature changed over the last 1000 years? 140 years?
- Have increased greenhouse gases caused temperature levels to increase?
- How might sulfate in the atmosphere affect climate?
- What natural factors may affect the future climate?
- What effect might climate change have on our lives and those of future generations?
- Should we do anything about the possibility of global warming?

Evaluation
Students may be evaluated based on:

- Participation in group activities and class discussions
- Quality of the graph produced
- Presentation of the data with a logical analysis and reasonable prediction
- Written or oral explanation of how ice cores are used to learn about climate
- Written or oral description of how natural and human factors affect climate

Please share your comments about successes with this method with Dr. Jacque Ewing-Taylor, c/o University of Nevada, Reno, Raggio Research Center, Mailstop 432, Reno, Nevada 89557, 775-784-7784, or by e-mail: Jacque Ewing-Taylor <jacque@unr.edu>

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Climate, Climate Types and Global Climate Change

Deirdre Carney, Washoe Innovations High School
Grade Level – High School

Climate Change Classroom Project

Summary
The targeted scope of the lesson is to bring students to a significant understanding of the nature of Global Climate Change and how it may impact their experiences of natural phenomena in the northern Nevada area. It will personalize the experience of Climate Change in order to facilitate their understanding of the topic.

First a series of lessons beginning with an understanding of weather and weather patterns is completed early in a new fall semester. Introducing climate and climate types, exploring Global Warming & Climate Change is next. Finally students undertake to complete research of local impacts attributed to Global Climate Change.

Science Lessons Incorporating the Science Inquiry Cycle
This project involves a coordinated series of lessons that would both satisfy Earth Science Standards as well as prepare students for a specific lesson on Climate and Climate Change. A series of lessons contains foundational information about the Earth’s atmosphere and the water cycle. After, the focus shifts to local impacts of Global Climate Change. Prior lessons address students’ lack of familiarity and knowledge of local climate patterns. Students are asked to describe their knowledge of Truckee Meadows/Washoe County/ Lake Tahoe weather patterns. Lessons are developed so that students will easily describe when to expect the most precipitation nor relate common minimum or maximum temperatures and when they normally occur. The “Normal Climate Patterns” lesson is adapted from one online that would serve to allow students to become more familiar with what climate patterns occur in their local area. This allows for making connections with changes in weather patterns due to Global Climate Change and current or expected patterns. The expectation is that by the middle of the school year students explore how Global Climate Change is manifested in the local region. A solid understanding of the Greenhouse Effect is essential that the subsequent lessons on the mechanics of Global Climate Change. Lessons on the Greenhouse effect and a more detailed introduction to how measurements of CO₂ levels and Global Temperatures are part of the sequence of introductory unit.

Lessons Presented Prior to “Climate” lesson:
   Earth’s Atmosphere
   Water in the Atmosphere – Clouds
Water in the Atmosphere – Humidity
Earth’s Surface – Freshwater & Water Cycle
Weather and Weather Patterns
Climate Types
*Normal Climate Patterns
Greenhouse Effect
Evidence of Global Warming

Integration of the Nature of Science into Lessons
The lesson, “Normal Climate Patterns” is designed to address students’ perceived lack of knowledge about climate patterns in their city. The major objective is to allow students opportunities to access graphs for interpretation of data. These lessons are consistent with the following Nevada state standards:

Atmospheric Processes and the Water Cycle (Earth and Space Science Unifying Concept A)
Earth systems have internal and external sources of energy, both of which create heat. Driven by sunlight and Earth’s internal heat, a variety of cycles connect and continually circulate energy and material through the components of the earth systems.
E.12.A -Students understand heat and energy transfer in and out of the atmosphere and influence weather and climate.

Scientific Inquiry (Nature of Science Unifying Concept A)
Scientific inquiry is the process by which humans systematically examine the natural world. Scientific inquiry is a human endeavor and involves observation, reasoning, insight, energy, skill, and creativity. Scientific inquiry is used to formulate and test explanations of nature through observation, experiments, and theoretical or mathematical models. Scientific explanations and evidence are constantly reviewed and examined by others. Questioning, response to criticism and open communication are integral to the process of science.
N.12.A - Students understand that a variety of communication methods can be used to share scientific information.

Questioning & Theorizing
- Student teams state their predictions about some of the following:
- What months have the most rain and/or snow during the year?
- What is the average precipitation for the year?
- What month has the highest temperature?
- What month has the lowest temperature?
Forming Hypotheses
- Students discussed their responses to the questions above.
- Generalizations about what the climate data would demonstrate and whether their perceptions of Reno weather patterns were accurate or not. (as a class).

Investigating a Hypothesis
- Students use data from the NOAA website to create temperature and precipitation graphs for multiple years of data.
- Students produce graphs from the data and then interpreted the results.
- Students make notations in their Science Notebooks recording their interpretations of the data for temperature and precipitation.

Synthesizing
- Students conduct a Think-Pair-Share activity to discuss measurements that they find unusual.
- Call to their attention prior years that have spikes in precipitation that seem outside the norm.
- Students discuss how last year’s data was consistent with their experiences that last winter was “dry” or “wet” and bring to bear their personal histories.
Extending Our Theories

- Suggest that students look at nearby weather patterns in California or explore weather patterns like El Nino or La Nina that might be connected to an unusual increase in precipitation for a particular range of data.
- One offshoot of the lesson will be an increase in the students’ discussion of the local weather forecast.
- How are meteorologists able to use satellite data and computer models to forecast weather?
- Use computer modeling to help see how forecast of the landfall of Hurricane Sandy was accomplished.

Differentiated Instruction

With a diverse student population be sure to provide content in several ways. One way is to give a lecture to students on some portion of the content. Some students prefer to listen to the content as they complete notes in their notebooks. Students that have difficulty following auditory instruction can access the presentation of the content via Edmodo pages set up ahead of time for each class. These presentations include video clips or hyperlinks to related information to deepen the instruction. This is an effective way to reach non-traditional learners. Students may also complete notes in their student notebooks.

Students always have a component of the lesson designed to allow them to work with a partner to read additional information and discuss their questions or findings. Most students work cooperatively and make good use of partner activities.

The students can share their findings with their teams, table groups or lab partners. The expectation is that all students will update their Science Notebooks as a method to demonstrate their interaction with the content and as a tool to use during quizzes. If some students struggle to keep their Science Notebooks up to date, they have access to instructor or classroom aides on a regular basis during the week. Modification of both assessments: the Science Notebook and quizzes to accommodate students that require oral response. Allow students to modify their quizzes by making corrections to incorrect answers with demonstration of textbook notations that support their corrected answers. This has been especially useful in allowing students to understand the content a bit better by researching the correct answers and then explain how their original answer was incorrect.

Assessment Strategies

Informal Assessment

Students are monitored for their level of understanding of the concept. Students are observed during their Think-Pair-Share activities for their types of questions and responses. Particular
attention is paid to how they explain aspects of the content. Are they demonstrating a good understanding of the concept and able to express that using academic vocabulary?

**Formal Assessment**

The Science Notebooks are used to evaluate the ability of students to take adequate notes and make thoughtful responses where necessary. Students are encouraged to capture their thoughts or questions without feeling self-conscious. (I have found students often are reluctant to ask questions or share thoughts because they fear looking foolish). A Rubric is used to score the notebooks.

Quizzes are given three to five times during each quarter to assess students’ understanding of the content. These assessments include multiple choice questions and some short answer questions. Students may use their Science Notebooks to answer the questions. This is also to support the use of the Science Notebook as both an assessment tool for the teacher and as a resource that students will use.

Presentations and Peer Teaching methods include students demonstrating knowledge of the content through peer instruction. This will be a way for students to become an “expert” in one aspect of the content. The “experts” will teach 2-3 other students a particular topic and groups will reassemble and rotate over a few class sessions. Students are assessed on their presentation skills, content knowledge, and their own abilities as an audience member.

Their Science Notebooks should be collected and reviewed frequently during the unit. Bell Ringer assignments are graded on days when given.

**Teacher Notes on Implementing the Lesson**

The school wide changes include implementing “Blended Learning” strategies and PBIS (Positive Behavior Implementation) strategies in the classroom to name a few. This makes it challenging for me to ascribe changes in the student response to simply implementing this way of teaching science. I have an intuitive sense that incorporating a more research based and inquiry method of teaching has enlivened my teaching. Incorporating more opportunities for students to direct the exploration of the content seems to allow my students to learn about topics that they may have an interest in. It is interesting to me, however, to note that many of my students are struggling with my expectations that they will increase their level of participation and interaction with the content. It is my opinion that while there is an expectation that activating student interest in content is inherently positive students are not always prepared to increase their level of demonstrating competency or mastery. It is also my opinion that the student population that I have in my classes seems to be challenged more to write and express their understanding of the content more than in the past. Modifying lessons wherein students will be more responsible for outcomes creates an environment in which students take ownership of the material and become more accountable for their own learning. My
initial sense is that by reducing the level of teacher control the amount of student learning increases.

References


5E Water Wheel

Christopher English, Wooster High School
Grade Level – High School

Purpose: To build a hydroelectric electricity generating device in order to give students experience engineering a renewable source of energy.

Materials: Magnets, material for the waterwheel blades (wood, metal, 30 gauge magnet wire, source of running water, led bulbs, other light bulbs, some material for the center of the water (cork?)

Standards:
All Americans will:
- Ask questions and make observations to help figure out how things work.
- Troubleshoot as a way of finding out why something does not work so that it can be fixed.
- Apply a structured approach to solving problems including: defining a problem, brainstorming, researching and generating ideas, identifying criteria and constraints, exploring possibilities, making a model or prototype, evaluating the design using specifications, and communicating results.

Nevada State Science Standards:
P.5.C.5 Students know the organization of a simple electrical circuit (i.e., battery or generator, wire, a complete loop through which the electrical current can pass).
P.8.C.6 Students know electrical circuits provide a means of transferring electrical energy to produce heat, light, sound, and chemical changes.
P.12.C.6 Students know electricity is transferred from generating sources for consumption and practical uses.
P.8.B.2 Students know electric currents can produce magnetic forces and magnets can cause electric currents.

Engagement:
Hoover dam construction video clips, Niagara falls video clips, Science 360 Hydroelectric clips

Exploration:
Procedure:
1. In a group of 2 -3 use what you know about how electricity can be generated through induction to come up with a viable design for a waterwheel that can
generate enough electricity to light a light bulb.

2. Draw a labeled diagram explaining your groups’ design using pencil/paper, Google sketch up, or any other suitable computer software.

3. Construct the waterwheel.
   a. Craft your blades
   b. Attach blades to center of waterwheel
   c. Attach center of waterwheel to generator (crankshaft)
   d. Attach copper wires to your light bulb

4. Construct a generator that can convert the motion of your waterwheel into electricity.

5. Test the waterwheel with led bulb in the circuit.

6. Troubleshoot the waterwheel.

7. Measure the electricity production over a period of 5-10 minutes.

8. Measure current produced, velocity of water, pressure of your water, area of blades.

9. Calculate the power output of your waterwheel.

Explanation:

1. How is your waterwheel able to generate electricity?
2. How is motion able to produce electricity?
3. What is going on inside the generator?
4. How is light produced inside the LED?

Extension:

1. How could we create more electricity with a waterwheel?
2. How much electricity could we potentially produce?
3. What might limit our ability to produce electricity with water?
4. Determine the amount of electricity produced by a coal-fired power plant.
5. Calculate electricity production of a waterwheel given a certain flow-rate of water, and a certain size of generator. Compare this to the energy production of a coal-fired powerplant.
6. Analyze the cost/return on the building of a hydroelectric powerplant. Write an argument, backed up by mathematical calculations to convince a legislator that a hydroelectric powerplant would be great benefit to your area when it comes to energy production. Compare the power produced in your plant to a coal-fired powerplant.

Evaluation:

1. Discuss and compare power output results.
2. Discuss designs that would produce more electricity.
3. Grade hydroelectric powerplant analysis by rubric.
4. Practice problems involving electricity, power output/consumption, % of total energy produced by renewable sources.
5. One paragraph describing how a hydroelectric waterwheel can produce electricity to someone who knows nothing about the topic; Deliver to a family member or friend. Have them read it and ask you questions if confused. Teach them how hydroelectric power plants produce electricity.

Appendix: Water Wheel diagram

Inquiries and comments regarding this lesson can be directed to Chris English, Wooster High School, 1331 E Plumb Lane, Reno, NV  89502, 775-331-5100, or by e-mail: Christopher English <CEnglish@washoeschools.net>
Wind Machine: 5E Activity

Christopher English, Wooster High School
Grade Level – High School

**Purpose:** To explore wind as a possible source of electricity

**Materials:** Corks, Motors, Electrical Connecting Wire, Rulers, Rubber Bands, Paper clips, Tape, alligator clips (optional), wire cutters or pliers, cardboard, glue, pin, voltmeter, ammeter, fan or hair dryer, scissors.

**Precautions:** Keep fingers and materials a safe distance away from fan, careful with sharp objects and other materials. Utilize eye protection.

**Standards addressed:**
- P.5.C.5 Students know the organization of a simple electrical circuit (i.e., battery or generator, wire, a complete loop through which the electrical current can pass).
- P.8.C.6 Students know electrical circuits provide a means of transferring electrical energy to produce heat, light, sound, and chemical changes.
- P.12.C.6 Students know electricity is transferred from generating sources for consumption and practical uses.

**5E Activity**


**Exploration:**

**Procedure:**
1. Get a small motor and a ruler or piece of wood from teacher.
2. Attach motor to ruler with rubber band.
3. Cut two 30 cm (ruler length) pieces of electrical wire.
4. Strip ends of wire, and attach one end of each wire to the motor’s outlets.
   - Attach other end to alligator clips if available.
5. Cut out six pieces of cardboard, these will be the blades of your wind turbine.
6. Cut out more than one set of blades (longer and shorter) for comparison.
7. Glue six paper clips to cardboard blades.
8. Insert paper clips into cork (making a hole with a pin first may help)
9. Attach motor to cork by inserting the protruding metal piece of motor into cork.
10. Turn on fan, and attach alligator clips to voltmeter, record voltage.
11. Attach alligator clips to ammeter, record amps produced.
12. Experiment with design, try to maximize volt and amp output.
13. Using the equation Watts = Volts x Amps, calculate the power produced by your most efficient design.

**Explanation:**

**Questions:**
1. What are Volts? What are Amps? What are watts?
2. What is voltage? What is current? What is power?
3. What is electricity? What is an electric current?
4. Do blades with longer or shorter length produce more electricity?
5. What are some of the things you have to take into consideration when deciding what length to make your blades? The material of your blades?
6. If you were going to plan a wind farm, what are some of the things you would need to take into consideration?

**Extension:**

1. Determine the amount of electricity produced by a coal-fired power plant.
2. In an area with an average wind speed of 20mph, calculate how many windmills would be needed to produce the same amount of electricity as the coal-fired power plant. Choose a windmill design already in use/existence.
3. Imagine you are an owner of a private windmill company. Write a persuasive letter to a legislator or city planner presenting a strong argument for why they should use available land for a wind farm, instead of a coal-fired power plant.

**Evaluation:**

1. Discuss and compare results.
2. Discuss why results might vary from group to group.
3. How does this topic relate to science, technology, engineering, and mathematics?
4. What are some of the pros and cons of using wind turbines as a source of electricity?
5. Write a paragraph describing how Wind turbines are able to convert the motion of the air into electricity.

**Appendix:** Illustrations and Information:

1. Diagram of components of wind turbine.
2. Bernoulli’s principle of wind speed and pressure differentials.
3. Fan blade physics, curves and twists regulating fan speed.
1. Diagram of components of wind turbine

Lower pressure is caused by the increased speed of the air over the wing.

Since the pressure is higher beneath the wing the wing is pushed upwards.

2. Bernoulli’s principle of wind speed and pressure differentials

3. Fan blade physics, curves and twists regulating fan speed:
http://answers.yahoo.com/question/index?qid=20070311073857AAeQadF

Inquiries and comments regarding this lesson can be directed to Chris English, Wooster High School, 1331 E Plumb Lane, Reno, NV 89502, 775-331-5100, or by e-mail: Christopher English CEnglish@washoeschools.net
Environmental Research:
Student Driven Research Into Green Technology
Eric McCuskey, North Valleys High School
Grade Level – High School

Overview
Students are assigned the task of researching green technologies after viewing a video that described the need for alternative energy sources and types of technology available. The students assigned this project are students who volunteered for a pilot program at a public high school that will require them to ultimately complete large research projects of their choosing, but the lesson is applicable and relevant to all high school students. The ultimate goal is to give the students an opportunity to use the library and research systems available to them. A secondary goal was to teach them about greenhouse gases and ways to reduce the environmental impact of humans on the planet. Students are to perform research on randomly assigned technologies and create some presentation showing that they learned a great deal about the technology. Students then develop a tri-fold brochure to share what they learned with their classmates. Due to limited library access and technology there may be limits to the project. Use of this lesson is dependent on making library time and computers available to the students. This lesson is recommended to all science educators that have good library and computer lab access, especially in the newer schools that have dedicated these types of resources to current and relevant scientific studies such as global climate change.

Concept
The lesson addresses the concepts of literary review prior to experimentation, greenhouse gases, global warming and green technology. Effective communication, debate skills and coherent, cognitive presenting are secondary concepts for the student teams.

Nevada State Standards
The standards addressed are:
• N.12.A.1 Students know tables, charts, illustrations and graphs can be used in making arguments and claims in oral and written presentations. E/S
• N.12.B.1 Students know science, technology, and society influenced one another in both positive and negative ways. E/S
• N.12.B.2 Students know consumption patterns, conservation efforts, and cultural or social practices in countries have varying environmental impacts. E/S
• E.12.A.1 Students know the Sun is the major source of Earth’s energy, and provides the energy driving Earth’s weather and climate. E/S
• E.12.A.3 Students understand the role of the atmosphere in Earth’s greenhouse effect. E/S
• E.12.A.4 Students know convection and radiation play important roles in moving heat energy in the Earth system. E/S
• P.12.C.2 Students know energy forms can be converted. E/S
• P.12.C.5 Students know the relationship between heat and temperature. I/S
• P.12.C.6 Students know electricity is transferred from generating sources for consumption and practical uses. I/S
• L.12.C.3 Students know the amount of living matter an environment can support is limited by the availability of matter, energy, and the ability of the ecosystem to recycle materials. E/S

Basic Procedure
As an engagement activity students are shown a film by Peter Byck (2011), Carbon Nation (USA) Clayway Media. The film discusses the nature and science behind greenhouse gases and some of the technology and techniques to reducing emissions. It takes up to three days to watch the film during which time topic discussions from the film are addressed and student questions are answered. After the film student teams pull a stick from a jar. Each stick will have a different type of green technology that be required to research. The possible topics are the major alternative energy types: photovoltaic power, solar thermal, absorption refrigeration, siting – passive solar, wind power, hydroelectric power, geothermal power, biomass, renewable/green materials, grey water systems, geothermal hot water system, solar water heater, and fuel cell.
With the assigned topics students are to visit the library and get a day with the school librarian to learn about library research options and databases available to them.

The students working in teams of two or three research their topic and learn all that they can about their chosen renewable energy area. At the beginning of each class progress, problems, and ways to identify valid information versus junk are discussed by all student teams in the classroom setting. After a week students are told they are charged with putting together a brochure on their technology and are given a rubric for the grading of the project.

This may cause the students to change how they researched and what they were searching for. They will then begin planning how to employ their technology and start to figure out how to question other competing technologies. They are placed directly in competition with other students for domination of the green energy market. Student teams will then take their information and begin planning a strategy to find flaws or shortcomings in the other student topics to make theirs look better. Students are then given an additional week to put this together with the new directive that class time will be limited and the bulk of the remaining research must be done on their own (homework) time. Time in class should still be devoted daily to dealing with questions and problems.

Student teams do class presentations of their technologies allowing students to question each other and attempt to stump the presenter. Copies of each brochure should be made available to all students for these discussions. This activity as a kind of formal research project ties in directly with other school research projects and can be made into a cross-curricular project with the cooperation of instructors in other departments. The only input from the instructor should be helping students determine if a source was of good quality and periodic reminders that their
classmates are also researching their topic on the side in order to get bonus points or some other “prize” for having the best green company brochure.

**Green Energy and the Nature of Science**

The nature of science standards perhaps play the largest role in the assignment since students are required to review a large number of articles and journals containing a number of graphs and data sets that they have to interpret. Students are also charged with finding other sources in conflict and find a way to resolve or dispute the conflict to support their idea or previous statement. The concept of the Nature of Science lends itself especially to discussing the scientific method because some sources are not very valid or strong. You may assign extra credit for any team that can dissect and discuss how one or two sources of scientific “findings” are not valid or have weak science in their arguments.

The student teams must be able to identify and eliminate scientific method elements or be prepared to defend using them. During class introduction sessions instructors need to address the inevitable situations where student teams find something they really want to use, but know it was a weak source. In most cases they bring it up to test their arguments. Allow the other students the chance to debate it out for them and by the last few days it will turn out that most often the students that ended up working out the resolution on whether or not the data was sound will be the ones with the strongest projects. They will become very aware of how internet data can be biased and invalid! The project itself forces them to be aware of science standard N.12.B.2 and the efforts humans make to conserve resources and the environmental impacts of our existence.
Differentiated Instruction and Grading Rubrics

In most school systems the students come from a variety of backgrounds and this leads to them being at many different levels. This large gap makes differentiated instruction critical. Being aware of the varying student ability levels in a single class is important when talking with them when they ask questions because the expectation had to vary as well. The use of the rubric and the students having it in advance helps immensely because stronger students that would include all of the information as they do the project by nature, but the weaker students need the guide and structure. The grading should be standardized by the rubric while the comments and discussion vary depending on the student. Frequent check-ins with students made possible more direct oversight and significant help to the project. In doing so and working with students at the level they are at, will allow the instructor to gauge which teams need more one-on-one time and which teams are self-directing and pushing each other to produce more.

Every student was addressed at least twice a week in a one on one talk and the class as a whole spoke to each other every Friday. This informal assessment let students get feedback and ideas as they were working. The presentation allowed them to see how other students took what they were saying and to answer questions from peers. The presentation allowed the instructor to see how confident the student was in their knowledge and ask questions about their understanding of the science/technology while the brochure provided the chance to show language skills as well as student understanding given time to reflect and revise. The project lends itself to many grades if your goal is to get grades on paper, but it is much better at allowing the instructor to see the whole student.

Additional Research Considerations

Each student team is free to pursue their research and present what they feel comfortable with. When the students start the project, the first few days will see that not all are on task at the library and some will not be really working to their potential. What is most effective in getting all the groups on track and enthusiastic will be the daily and weekly check-ins and discussions. The one very motivated focused student who is pushing hard gets the others to realize they had to step up and start to focus and work harder.
Each project should be assessed informally by daily or weekly status checks that include the required five sources after a week in the library as well as the final brochures. The sources required to provide evidence of research and not just free time in the library. Team leaders are told they need to not only have the citation, but also what was the source being used for to avoid them simply finding five random citations. The recommendation to put the citations on index cards so they can be modified new sources added and others removed as they worked through the project provides a double check on student accountability.

Encourage hand-written citations so that the student is staying free of the rubric and truly researching the topic to learn all they can and not narrowing their view. The other students could be limiting themselves to just the rubric and not stretching themselves. So keep on the lookout for this. In science going beyond the obvious in key and this is not present in those two citations. Some student teams will stick precisely to the rubric exactly and only do the bare minimum. This should make two conclusions clear, first the rubric helps with students understanding the project but they tend to limit themselves with it, and that they chose a topic that they were not entirely passionate about.

Teacher Personal Notes and Comments
This project was very unique for me as a teacher because my initial idea had to evolve as the class developed. The students for this class were recruited from other classes. The time frame was in our pass classes which is 45 minutes first thing in the morning four days a week. These students started out in other classes and where given the option to join the class. None of the other classes require assignments and homework so they were volunteering to do more work for
the right to pursue an educational path of their choosing.

The initial video was not structured enough so including a guided worksheet with it to hold better focus and draw attention to big ideas was way to get around that. The research topics started out well and the students were excited because many of them had little to no background knowledge of what they were studying. This made for some excitement however the power of the distraction on the internet and in the library led to some issues as the age group is 15-17. I didn’t want to add more structure, but in the future I will add more check points. I think including a journal for them to write in each week reflecting what they have learned so they have a check point and bar to get over would really help the off task behavior, because even though they needed to complete a brochure they put it off. With the citations some students really didn’t find anything until the day before they were due. The freedom given and the open ended aspect of the original task was good and bad, because it really made the students start to analyze themselves as learners, while the freedom also set some up for failure and procrastination.

The chance to move around and talk to students instead of talking to the class and getting to address each student as an individual is an important part of the teacher role in this project. Helping them as opposed to trying to teach the whole class, while some students are involved and others stuck waiting makes a big difference in student motivation as well. This really opens the opportunity to free them to learn at their own level. Instead of the doing a typical book lab
that has a required write up and report, following a set procedure to force students to complete predetermined tasks in order to see set outcomes, they had a freer, more inquiry-based experience more in line with the overarching concept of the nature of science.

In this part the goal was for students to get to visualize a single replacement reaction as well as a non-reaction. Typically we accomplish this by have students place a nail in copper (II) sulfate and then prompt them to observe the color change on the nail and the color change of the solution we further go on to have them place copper wire into iron (II) sulfate and repeat the same process. Every step and measurement is done for them so they simply fill in the blanks while following the cookbook. This time they were told to get a penny that is post 1982 so it contains zinc and copper. They were given acid and told they could not use more than 50 mL. They had to observe the penny and somehow make a nick in the copper coat so they could see the make a nick in the copper zinc. They then were told to observe what happens in the acid and make a nick in the copper coat so they could see the zinc. They then were told to observe what happens in the acid and make a nick in the copper coat so they could see the zinc. Immediately other groups started making a lot of nicks because they wanted more bubbles and see if it made less bubbles. This proceeded until all of the students had their pennies in and were moving around to see who made the most bubbles. One group had no bubbles and the classes decided they forgot to nick the penny. The students in the group swore they did, so a group of five students really started looking and a kid noticed the penny was from 1976. They asked what that meant so I had the entire class look at a 1980 penny that I cut a large nick in and they realized there was no zinc and immediately a student said the bubbles are coming from the zinc.

While the pennies sat I had a student write the reaction for zinc and hydrochloric acid on the board. The class corrected it a few times to get the right reaction and a girl pointed out the hydrogen gas as a product meaning the bubbles have to be hydrogen. Another student asked why the copper penny didn’t bubble. We wrote the equation for copper and hydrochloric acid
and it appeared we should see bubbles and a student pointed out that copper must not react and a second student recalled the activity series and they soon realized what “no reaction” means. I did the activity because without set instructions there are very few critical questions to ask. Consequently I was free to move around and talk to students asking questions based on what they did and sending them to look at what other students did where a different approach helped. I feel not having to be so structured lets the students really interact with material. There was no formal assessment for the lab other than the discussion and seeing students excited and knowing that they had approached true nature of science, scientific inquiry.

Assessment
Student discussion during presentations can very profuse as they try to find flaws with the other teams’ research and technology to promote their own. The ability to effectively argue both sides is an excellent skill to learn and forces students to think about the topic they researched beyond the simple facts they find for their research. Additional ways to assess student learning should include informal assessment techniques daily as the projects are being developed. These should include but are not limited to:

- Using oral questions after research periods.
- Student teams are required to turn a daily status report that contains observations, diagrams and answers to questions at the end of each period.
- Building upon the questions they were already asked is a good technique to drive home points and informally assess what they learned. Review of these at the end of class is very effective as well.
- Incorporating journaling as a way of thought organization, individual student reflections, and team project ideas is an excellent method of getting to see what they are learning and planning.
- In the second phase of the project research use needs demonstrated by student teams to design short but relevant activities on green energy and climate change science that will spur the groups to push themselves beyond the question they ask to the answers they seek.
Naturally the graded brochures and presentations based on the clear and explained rubrics (for each) will round out the assessment process.

Please share your comments about successes with this method with Eric McCuskey, c/o North Valleys High School, 1470 E Golden Valley Road, Reno, Nevada 89506, 775-677-5499 or by e-mail: Eric McCuskey<emccuskey@washoeschools.net>

References


Lesson Title: What is a Biome?

Grade Level: 9-12

Genevieve Dierenga, Wooster High School. Lesson will employ inquiry and guided inquiry elements along with a 5E model approach. It can be modified for middle school science classrooms.

Subject Area: Environmental Science

Lesson Length: introduction - about 1 class period. Research and biome construction 4 class periods. Presentation 1-3 class periods depending on length of presentations and number of groups.

The Teaching Process

Lesson Overview
This is an introductory lesson to the concept of Biomes

Unit Objectives: Students will understand that various areas of the planet can be categorized into groups called biomes. They will then study these biomes in more depth.

Standards addressed: MS-ESS3-I,MS-ESS3-d

List of Materials
Various plants - preferably from different areas or biomes. For example a cactus, a fern, a flowering plant and a conifer. Students could bring in plants from home or investigate plants that are found on the school grounds if applicable. Also pictures of many types of plants will be needed. Library or computer lab could be used for research. Building dioramas will require a box for each group and various creative materials such as markers, pencils, paper, scissors, glue and any other materials that inspire students to create a visual representation of the biome they will build.

Instructional Sequence

Phase One: Engage the Learner

Students often enjoy talking about themselves. Students will share about where they have been or where they want to go on a "dream vacation" by drawing a quick representation of a chosen location. Then the teacher and students discuss the similarities and differences found in the drawings. What kinds of plants did they draw? What types of animals? Some students may even use Biome names in the discussion – if so this should be pointed out as a great way to describe the location.

What is the teacher doing?
Teacher asks students to draw a picture of either their favorite place they have been or the place they would like to visit on a dream vacation. Emphasizing the plant life and animal life they either have seen or will see.

What are the students doing?
Students are drawing (a time limit maybe given) a picture that should include plants and animals. Various locations should be represented by the class.
### Phase Two: Explore the Concept

Students will categorize plants and animals into groups.

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<td>Teacher supplies the students with various real plants as well as many color pictures of plants and animals. Teacher allows students to sort these into whatever groups make sense to the students but guides students to sort based on meaningful physical structures...not based on criteria such as how much they like the picture or if they have seen this in person before.</td>
<td>Students are sorting the plants and animals into groups. They can choose how to sort but have guidelines that include physical structures that are common among the items being sorted.</td>
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### Phase Three: Explain the Concept and Define Terms

The Biomes are named and defined. The teacher offers real examples that may include actual plants, pictures of biomes or video clips from various biomes. Pictures from Biosphere 2 could be used to illustrate how the study of biomes and their interconnectivity is beneficial on many levels. As students and teacher define the biomes students may resort their pictures and plants based on the common Biome types.

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<td>The teacher defines and explains what a biome is and uses the actual names of the biomes. The teacher uses the groupings the students made and where applicable explains what groups are really called and how these groups are defined by environmental scientists.</td>
<td>Students are taking notes and are defining the groups they previously constructed. Where applicable they may move the pictures of plants and animals around to create new groupings that are more accurate based on the predetermined groups agreed upon by environmental scientists...biomes Students may watch video clips from Biosphere 2 or from various movies available that teach about biomes in order to gain a more accurate mental picture of each Biome. You Tube is also a source of video clips.</td>
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Phase Four: Elaborate the Concept

Students elaborate on their understanding of the concepts of biomes. They will get into groups. Each group will be responsible for researching a specific biome. The group will construct a diorama of the biome and then they will present it to the class. The requirements for each biome should be very specific so that students know what is expected. For example guidelines should include the number of producers, consumers and decomposes represented in the diorama.

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<td>Teacher monitors each group making sure they are on the right track. Each group will be responsible for a biome so all groups must participate. The teacher will make sure each group does not incorporate misinformation into their presentation. The teacher will confirm that critical correct information is also included.</td>
<td>Research and construction of the biome diorama should be carried out by all of the members of the group. Students that are not fully participating should be given specific responsibilities and should be held accountable. Students will physically construct a Biome in a box. They will need to color, cut, paste etc. in order to make the box appear as close to the actual biome as is possible.</td>
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Phase Five: Evaluate Students' Understanding of Concept

The final stage of the unit has a dual purpose. Students will present their findings as a group to the class. Classmates will evaluate each other's thoroughness of presentation. Specific guiding questions should be used to guide students as to what to look for. Examples of this include: What producers are found in this biome? How fast is the rate of decomposition?

The teacher will use this time to evaluate each group's understanding of the biome they were assigned.
What is the teacher doing? Listening to each presentation and evaluating each group based on the specific guidelines given.

What are the students doing? Listening to each presentation and answering questions or evaluating their classmates as they present. Active listening is important during this step so that students finish this activity with knowledge of all biomes, not just the biome they researched and constructed.

Inquiries and comments regarding this lesson can be directed to Genevieve Dierenga, Wooster High School, 1331 E Plumb Lane, Reno, NV 89502 or by e-mail: Genevieve Dierenga<GDierenga@washoeschools.net>
Lesson Title: Comparing Types of Gardening

Grade Level: 9-12

Subject Area: Environmental Science

Genevieve Dierenga, Wooster High School. Lesson will employ inquiry and guided inquiry element along with a 5E model approach. It can be modified for middle school science classrooms.

Lesson Length: 1 day for intro, 3-6 weeks for the growing portion of the project (other material can also be covered during this time), 2 block days for processing results.

The Teaching Process

Lesson Overview: students will investigate and compare three methods of growing a specific variety of lettuce.

Unit Objectives: Students will understand the differences and similarities among traditional in ground growing, aquaphonics, and hydroponics. They will conduct a simple experiment to compare the cost effectiveness of the three methods. They will process and then plot the results on a graph. This will give the students 'real world' experience growing food as well as processing data. We will relate food production to a previous unit on populations. The previous unit encompasses human population numbers, the growing population crisis and using data to understand the demographics of the human population. This current unit will build on the population concepts. This project will compare three ways to grow food (Hydroponics, aquaphonics, and soil based) and the data will be used to determine which is most efficient. This can be related to the general concepts of food production for the growing human population.

Standards addressed: MS-ESS3-I, MS-ESS3-d

List of Materials
Each of the three set ups has similar materials but also requires their own materials.
All three - seeds, water
In Ground- a plot of land or tubs of soil.
Aqua phonics - fish, fish food, set up with pumps and flow device.
Hydroponics - tubs, floating device for plants, nutrients to add to water (these can be store bought or can be self-produced using various recipes found on line)

Phase One: Engage the Learner

Students are often engaged by food. We will begin by tasting various varieties of lettuce.

What's the teacher doing?
Leading a discussion on the necessity of food and how the human population is growing - yet must eat. The teacher will also pass out the lettuce that the students will try.

What are the students doing?
The students engage in discussion about food, people, starvation issues and numbers. They will taste the lettuce and vote on which variety of lettuce we grow tastes the best. The students are also viewing 3 growing set ups.
Instructional Sequence

Phase Two: Explore the Concept

Students are charged with setting up an experiment as a class. They will discuss and vote as a class as to which type of lettuce they will grow and how they will compare the success of each growing method.

What is the teacher doing? Teacher will guide students and confirm that students are using valid scientific methods to compare the success of each growing method. Teacher will help students when needed to plant seeds and to maintain the three growing set ups.

What are the students doing? Students will plant the lettuce and maintain the lettuce. Students will water as needed and will record all inputs into each system including man hours needed to maintain the sit-ups and grow the lettuce.

Phase Three: Explain the Concept and Define Terms

An explanation of how and where each system is really already used will be presented. Also an explanation of how much food is needed, produced and used by various societies and how the human population relates to this food is a critical part of this unit.

What is the teacher doing? Through lecture, discussion and perhaps a power point presentation the teacher shares various statistics and data about food use and consumption. The teacher encourages students to make connections between the human population crisis and the need for sustainability in food production.

What are the students doing? Students take notes, participate in discussions, and make connections between how many people there are and how we will continue to feed them all. They will relate this to the three types growing set ups and the need to discover the most sustainable methods of growing food worldwide.
Phase Four: Elaborate the Concept

After the lettuce has had time to grow (6 weeks max) the students will collect the lettuce and evaluate the success of each growing method. They could do this by weighing the lettuce. But students may determine another way to measure success (taste, quality). They will elaborate by processing and graphing this data. The graph should be clearly labeled.

What is the teacher doing?
Assisting students in collecting data as necessary. Supplying materials such as scales that might be needed to evaluate the quantity and maybe quality of the lettuce produced by each method of growing.

What are the students doing?
Collecting the lettuce and determining the success of each method. Processing and Graphing the data so that the can interpret the success of each method.

Phase Five: Evaluate Students’ Understanding of Concept

The final stage of the lesson has a dual purpose. Students will evaluate the success of each method of growing food and will determine which method is best for growing lettuce. They should be able to relate food production to human population in their lab reports. They should include the success of food production and efficiency of each model based on input and output.

What is the teacher doing?
Evaluating student knowledge and contribution to the experiment.

What are the students doing?
Evaluation of the success of each method of growing lettuce.

Inquiries and comments regarding this lesson can be directed to Genevieve Dierenga, Wooster High School, 1331 E Plumb Lane, Reno, NV 89502, 775-331-5100, or by e-mail: Genevieve Dierenga <GDierenga@washoeschools.net>
Dendochronology as a Tool for Teaching About Climate Change
Denise Tatar, Hug High School
Grade Level: 9 - 12

Summary
This plan is a single lesson on dendrochronology in the middle of a unit on cell structure and function. The goal of this lesson was for students to gain an understanding of plant cell structure and the seasonal variation found in plant cells. Insight into how scientists can use these cell properties to determine important information about past weather patterns and in some cases extract evidence of shifts in the Earth's climate are secondary goals. The ultimate goal will be for students to understand that dendrochronology provides proof that humans are the driving force behind global climate change.

This hands-on investigation allows students to compare two core samples; one removed from a living tree and the other, of unknown age, removed from a timber used to build a structure. Students are to determine the age of the structure wood by correlation of tree ring patterns. The hands-on aspects of this lab requires that students work together, with only minimal direction, to find the matching patterns in the cores. In addition, students are to research and describe other aspects of dendrochronology, especially as they relate to seeing how changes in climate are captured by the tree rings for analysis years later.

Most students understand that tree rings can be used to determine age, but only a few knew about how weather influenced tree ring structure. As an inquiry-style lesson, this activity provides background, relevant science and real research opportunities for the students.

Incorporating the Science Inquiry Cycle
A. Concepts
Plant cell structure varies in response to environmental conditions.
Tree rings provide a record of past environmental conditions.
Dendrochronology provides proof of a shift in global climate.

B. Science Standards
L.12B.1: Students know cell structures and their functions.
N.12A.2: Students know that scientists maintain a permanent record of procedure, data, analysis, decisions and understanding of scientific investigations.
L.12C: Students understand that ecosystem display patterns of organization, change, and stability as a result of the interactions and interdependencies among the living and nonliving components of the Earth.

L12.C2.: Students know how changes in an ecosystem can affect biodiversity and biodiversity's contribution to an ecosystem's stability.

**Basic Procedures**

1. Once it is confirmed that all students understand how tree rings are produced, they were asked how we could use tree rings to determine recent weather conditions and past climatic conditions.

2. When given two tree core samples, students are asked to determine how they could determine the age of the core with a known cut date, then hypothesize how they could use this core to determine the age of the core with an unknown cut date.

3. Students counted rings on each core and found the areas of correlated tree ring patterns.

4. Students then determine the age of the unknown sample and confirm the age with the presence of a forest ranger that lived in the area at the time and built a cabin to live in.

5. Students transfer this understanding of tree ring analysis to tree ring patterns in ancient bristlecone pines and sequoias.
6. Students view examples of dendrochronological data that provide proof of climate change and how it is influencing the range of the bristlecone pine in the White Mountains of California.

**Activity as Student-led Investigation:**

As much as possible create a classroom climate that supports a student led investigation and keep the activity as much as possible a hands-on lesson. Students will count the rings, made replicas of the rings on paper, and find the area of correlating ring patterns with their lab partners. Some students needed assistance with the math involved in determining age, but otherwise teachers were simply facilitators.

**Integration of the Nature of Science into the Science Lessons**

Although this particular standard does not seem directly related to climate change, it does address science standard N.12A.2. This standard focuses on importance of maintaining scientific records of procedure, data, analysis and decisions in scientific investigations. The subject of climate change may not spark much debate among students bordering on apathy. Therefore it is important to address the information in a way that is accessible, relevant and causes students to be interested in knowing more. So along with the opportunity that this lesson provides to emphasize the importance of an awareness of climate change, it also provides an opportunity to stress the importance for relying on proof when making decisions. Those who are not sure if climate change is happening need to become familiar with the data provided by tree rings, ice cores and other scientific research and students successfully completing this lesson will be in a very good position to make a decision based on fact.

As a way of introducing the unit, begin with a discussion of the bristlecone pine. The age of the tree is a great hook that cannot fail to start a conversation on what occurred during the life of a 4,800 year old tree. Students can then be introduced to the recent research that shows a shift in the bristlecone's range in the White Mountains. Standard L12.C refers to stability and change in an ecosystem in response to the interdependency between abiotic and biotic factors, and the bristlecone's distribution is a perfect example of these relationships.

**Differentiated Instruction**

The student population that many public school teachers work with dictates that differentiated instruction should be the norm in all classes. Much of the student population in classes are comprised of a large number of SIP, ELL and special education students. Students with special needs may be provided aids or co-teachers in the classroom to accommodate large numbers of this category of student. Utilize your resources to maximize student learning and interaction. The large number of ESL students in the classes requires close attention to the SIOP sheltered instruction protocol for students struggling with English and other ELL-designed instructional techniques for diverse student populations.
Assessment Strategies

Assessment for this lesson focused on student analysis of the tree core samples. For the SIP students, an oral explanation of the area of correlation on the cores along with the students demonstrating how they could determine the cut date and the first year of growth is an effective method of assessment. Other students can produce a more formal, written “explanation” of their findings. A few students will have difficulty transferring the pattern of rings from the core to the paper strips, so that section of the lab can be omitted from the assessment.

There will always be a wide range of abilities among the students in these classes. The answers to the questions are of secondary importance and are the focus of the closure portion of the class. As important are discussions as to how students will determine the age of the unknown core. With some students showing their work on the ELMO for the entire class is a good way to determine if learning took place. If able to devote more time to the mathematics of this type of correlation, the dates can be included in the assessment. The ability to correlate the cores should be emphasized for all students. Be alert for the opportunity to use informal assessment techniques during the execution of the activity.

Special education students with lower grade reading levels will require explaining instructions additional times and taking verbal answers to questions. Worksheets and other written lab products may be best assessed as a joint effort with the lab partner(s).

The math associated with this lab is typically the single factor that influences student completion of the assignment. Lessons with any type of math usually require a certain amount of time dedicated to introducing the math before the science lesson begins. A good idea prior to doing the activity is to include a lesson on correlation of dates before focusing on correlation of the tree rings.

Teacher Comments and Observations

The need for this lesson to fit within a specific time frame was the only way in which the lesson differed from an instructor’s usual preparation and teaching routine. The unit may be more effective when it is included in the unit on plants or ecology. Also scheduling the field trip to collect core samples will certainly change student interest and engagement.

Conversations with teachers from our feeder schools suggest that the Five E model of science lesson planning is standard. The approach typically used to teaching science did not change for this lesson. The use of the pre- and post-test was the only change, and, as discussed below, it did seem to change how students chose what to focus on during the activity. The intimidation of the word "test" on the paper may have resulted in students finding these points more important than if they are simply listed as objectives or in the lab analysis.

Pre- and post-test scoring was very interesting for most students. Many seemed more interested in these results that in the results of their weekly quizzes or tests! Students reported that they
liked being asked the exact same questions, and said that they focused on parts of the PowerPoint and activity that clarified these questions. Shifting to a more formal way of conducting a formative assessment designed more like the pre-/post-test format can be of great benefit in many science lessons. If this was begun early in the year many students would benefit from the immediate results and the emphasis on which concepts are most important in an activity. This also fits in well with the mastery based learning that many schools are beginning to emphasize.

This lesson was first done in 2010 and coincided with a timely visit to the Hug campus by ACE, the Alliance for Climate Education a week prior to the lesson provided students with an opportunity to find relevance and evidence of the practical application of the concepts they are studying in biology to real world issues. The initiation of the student driven DOT or “Do One Thing” campaign, had students analyzing their roles as individuals in contributing to and hopefully reversing climate change by pledging to do one thing every day to reduce their carbon footprint.

Please share your comments about successes with this method with Denise Tatar, c/o Hug High School, 2880 Sutro Street, Reno, Nevada 89512, 775- 333-5300, or by e-mail: Denise Tatar <dtatar@washoeschools.net>

References


Water, Climate Change and You

John Batcabe, Wooster High School
Grade Level – High School Chemistry

Introduction
Water plays a crucial role on our planet. Its physical properties make it uniquely suitable for life on our planet. Global Climate Change (GCC) threatens to change how we live on Earth, and learning about water provides students a window into a scientist’s eyes. It also provides an opportunity for students to make the connection between chemistry, biology and climatology. This activity focuses on the physical properties of water for the high school physical science or chemistry student.

Background and Introductory Lessons
As a pre-cursor to the lesson, students are asked what they know about water and its importance to biological systems. Students are then presented with several inquiry activities, and asked to explain their observations (see Investigation #1 – Water in Middle School Lessons). The physical properties of water are then explained to clarify observations. The lesson then moves to radioactivity, radioactive isotopes and their practical uses. This information is provided as a vehicle to discuss temperature proxies, specifically, how we know about past climate(s) through ice core data.

The socio-political aspects of Climate Change are avoided in order to have students look at hard science and scientific data and evidence that have been gathered. The main idea of the activity is to provide an opportunity for students to question the properties of water, and then ponder how science and technology combine to help us answer “big” questions, in this case climate change.

Success of the lesson is measured in several different ways. First, class discussions reveal that many students had already learned some information regarding the physical properties of water and the uses of radioactivity. In most cases, this knowledge was superficial, and warranted a more in depth investigation. Although many students will know what to expect from the experiments, the molecular models used to explain the observations are typically met with surprise. At the beginning of each day during this multi-day lesson, formative assessments can provide insight on the level of depth students were remembering. Students were also required to keep a laboratory notebook, and this record served as an assessment of their learning. Last, a written test was prepared to assess students background knowledge before the lesson, and then again after the lesson to assess what they learned.

Science Lesson to Incorporate Experimental and Descriptive Inquiry

A) Concepts addressed by the lesson
This lesson addressed the physical properties of water, and how those properties make water unique and essential to life on our planet. This lesson also addressed radioactive isotopes, and how they are used in scientific research. Climate change was addressed as radioactive isotopes help us understand past climate through historical records (ice core data).

B) Nevada State Standards
N.12.A.1 Students know tables, charts, illustrations and graphs can be used in making arguments and claims in oral and written presentations.
N.12.A.3 Students know repeated experimentation allows for statistical analyses and unbiased conclusions.
N.12.A.5 Students know models and modeling can be used to identify and predict cause-effect relationships.
N.12.B.1 Students know science, technology, and society influenced one another in both positive and negative ways.
N.12.B.2 Students know consumption patterns, conservation efforts, and cultural or social practices in countries have varying environmental impacts.
P.12.A.1 Students know different molecular arrangements and motions account for the different physical properties of solids liquids, and gases.
P.12.A.4 Students know atoms bond with one another by transferring or sharing electrons.
P.12.A.8 Students know most elements have two or more isotopes, some of which have practical applications.
P.12.C.3 Students know nuclear reactions convert a relatively small amount of material into a large amount of energy.
P.12.C.4 Students know characteristics, applications and impacts of radioactivity.

C) Basic Procedures
Attached is the lesson plan outline in the experimental inquiry format (Cantrell, 2010). The lesson started with a couple of activities that asked students to look at the physical properties of water. The following day a KWL was used to see if students could explain their observations. In this lesson, I substituted the meanings for K and W (traditionally “what we know” and “what we want to know”) with S and T (“what we’re SURE we know” and “what we THINK we know”). The investigation continues by having students perform another inquiry activity, documenting data and graphing results. This information is then extended with a second theme (radioactivity) within the lesson. After a teacher led lecture, students performed activities including Bohr models of different isotopes. Climate Change was then tied in by showing students how technology (the ability to measure radioactive isotopes) enables scientists to collect information about the earth’s past climate. Prior to the post-lesson assessment, students completed concept maps summarizing major concepts learned throughout the lesson.
Addressing Standards and Teaching Techniques

Because water is uniquely important to our lives, and because it is an easy substance to investigate in the lab, its physical properties are an ideal way to demonstrate the Nature of Science Standards. First, students were asked make simple observations of the behavior of water when putting drops on a penny, and then getting an aluminum foil “boat” loaded with pennies to float. Some students were asked to use the “heads” side and others the “tails” side of the penny, and all students repeated their water drop experiment three times. Statistical analysis (mean, standard deviation) was then determined so “heads” and “tails” could be compared. N.12.A.3

Second students were presented with the molecular structure of water, and asked to explain why the molecule behaves the way it does. The teacher then facilitated the discussion of polarity, and scaffolded what students know (opposites attract) with what they observed, but couldn’t explain in chemical terms. (The polarity of water and hydrogen bonding explain the high surface tension of water, and thus its ability to form spheres or rounded shapes on flat surfaces.) Students then performed an experiment where they observed the effect of adding salt to a water/ice mixture, and then boiling the mixture. These observations led to several questions, including, “why does our water boil at 96°C instead of 100?” and, “how does the water get down to -7°C?” An explanation of vapor pressure and colligative properties answered these questions, and succeeded in provoking more thought in students. Students were then asked to graph their own data, and compare it to that of another group. This activity showed the students that scientific experiments require record-keeping, collaboration, and repeated experimentation (N.12.A.1-3). The graphing a temperature curve of ice melting and water boiling - with and without salt – also enabled students to draw a conclusion from their own data. This demonstrated that the presence of salt affects the melting and boiling temperatures of water (a colligative property).

A teacher-led lesson was then presented regarding radioactive isotopes, radioactivity, and then practical uses of radioactivity. Later, students were shown graphs from the IPCC’s 4th report on climate change (2007) to demonstrate how radioactive isotopes can be used to measure paleoclimate. Global temperature from various direct measurements was shown, as well as that from several proxies including tree ring and oxygen-18 isotopic ratios from ice cores. After presenting several of these graphs, students were asked why and how they can believe in these complex data sets. N.12.A.5 Explanation included the fact that current predictions of climate change are based on thousands of observations, and dozens of models based on collaboration of hundreds of scientists worldwide. All of these are integral to Strand A. During the discussion, a student fortuitously asked, “How do we know that this really happens? I mean, do we really know that nuclear fission occurs in the sun?” This question led directly into “how we know what we know” and are “we” (society) ready to understand it argument. (N.12.B.1) The answer, of course, lies in the mountains of scientific data that have been accumulated over the past millennia, and that lots of people have contributed to the body of knowledge. This holds true for all scientific disciplines, whether it is nuclear fission or climate change.
**Differentiated Instruction**

Because much of this lesson is based on inquiry, it is accessible to many types of learners at different levels. The hands-on nature of the water drop exercise provides both visual and kinesthetic learners an opportunity to observe water's unique physical properties. Although students may not at first relate to the molecular model of hydrogen bonds, they can certainly see its effects when using a pipette to place drops on a penny, or when trying to float an aluminum “boat” loaded with pennies. These processes enable different types of learners to assimilate more information than if it were simply presented on paper or during a lecture.

Having students graph the time vs. temperature data provided learners to compare simple data sets, and view content while comparing them. This also enabled them to make a product that helped come to their own conclusion about the effect of salt on plain water. Several different students benefitted with this model. A few “slower” learners benefitted from the easily observable exercises. I believe these students had a much better chance of internalizing information due to the sensorial nature of the experience and then associating this with the conceptual explanation. Additionally, higher-level learners were more open to new information because they had the opportunity to get out of their seats and participate in an activity. The visual cues involved in the experiments enabled them to attain a higher level of understanding – one that is more likely to stick in their minds.

Additionally, students made Bohr models of atoms using play-doh. Students that had difficulty were only asked to make a simple atom, and perhaps tell me how they would make a different isotope. More advanced students were asked to make multiple models, showing different isotopes and ion formation. This helped students of all levels understand the primary concepts, but also pushed the higher level students beyond a simple level.

**Assessment Strategies**

A) **Assessment Methods**

Both formative and summative assessments were used in this lesson. Formative assessments took the form of question and answer during discussion. These discussions were both teacher-led and student-led. A KWL (TSL) was used to spark conversation, and to give an idea of the level of understanding after the opening exercise, but before further investigation. Other formative assessments were short written assignments that students performed upon entering the class. Usually 2-5 minutes to complete the task in the form of a “quick-write”. The information was reviewed before continuing the lesson.

Students were also required to collect time versus temperature data and graph their results. This served as a major assessment as it demonstrates a range of process skills, addressing many of the science standards including the Nature of Science standard.
Last, a summative assessment (a written test) can be designed and given (pre- and) post-lesson to evaluate the overall understanding of the concepts presented in the lesson. Using this tool will allow the teacher to determine how much was learned during the unit.

B) Student Production
These can include the statistical analysis of the water drop experiments, data collection for the colligative properties experiment, and the graphs that students generated from their data, etc. Students can also diagram on paper the Bohr models they made out of play-doh, and later of the models they do as a period opener. Teachers may also choose to have students do something more expansive like posters or presentations.

C) Use of Formative Assessments
I often start off a lesson by asking students what they know about a particular subject. In this lesson, the class participated in a TSL (KWL) where students were encouraged to say anything they thought was relevant to the topic – after doing the opening activities. This discussion will often reveal that many students have little knowledge of surface tension or hydrogen bonding, and most had no exposure to colligative properties or radioactive isotopes. Very few students will have learned the practical applications of radioactive isotopes. This information drives the lesson, and helps the teacher determine how fast the lesson should go and to what level of depth for each particular class. In some cases teachers may spend more time discussing the polar nature of the water molecule and how it dictates hydrogen bonding, surface tension and other unique properties such as the high melting and boiling points in order to advance them to the larger topics.

Using Bohr models to help explain the concept will help students to understand key concepts of radioactive isotopes and these models can be effective even with younger students and general science students. The play-doh activity (using play-doh to model atomic structure) can be done as a quick lesson and may be more effective than just having the students draw Bohr model diagrams.

Background and Expectations

D) Preparation
Most General Chemistry teachers do a unit on physical properties of water at the beginning of the new semester in the fall. Others teach the properties of water as an adjunct lesson to solutions instead of a self-standing unit. Teachers should be very familiar with these properties and have additional activities that can relate the properties of water in an inquiry-style lab or activity.

Since some teachers never teach about radioactive isotopes due to time constraints including this unit on radioactive isotopes as part of this lesson and tying it into a discussion of climate change can be a very effective way of including an often omitted topic that is uniquely relevant. The
practical use of radioactive isotopes is also a Nevada State Standard that often gets ignored. Preparing for this lesson and determining practical and relevant way of presenting it can be a very good way for teachers to include one more aspect of climate change science to the curriculum.

E) Different Student Responses
Because these activities require student participation and engagement, students are more likely to learn than if they are spoon fed information from a lecture. Students involved in asking questions to explain their observations, rather than being told the “answers” and then asked to observe them are more likely to own the knowledge and retain it longer due to accepting responsibility for their learning. Additionally, the inclusion of practical uses of radioactive isotopes, and particularly their use as temperature proxies as evidence for climate change, will engage many students who might otherwise tune out. Relating chemistry to current real-world issues will lead to more interest in the lesson.

F) Changed Approach and its Effect on Student Performance
In this unit using elements of inquiry-based learning, teachers can expect students to be more engaged than in more traditional skill and drill and lecture/lab methods. In particular the sensorial activities help students perform better and learn the material to a depth that exceeds lecture-practice systems. Inquiry methods and teaching to depth undoubtedly improves student understanding, not to mention interest level. Students exposed to information that tied together chemistry with real issues in the practical uses section, and this will improve their performance beyond the chemistry classroom.

G) Inquiries and Comments
Inquiries and comments regarding this lesson can be directed to John Batcabe, Wooster High School, 1331 E. Plumb Lane, Reno, Nevada 89502, 775-333-5100, or by e-mail: John Batcabe <JBatcabe@washoeschools.net>

References


Independent Investigation Guidelines

Step 1: Create a Question
- What do you want to find out?
- Does your question relate to the topic?
- Can you develop an experiment to answer your question?
- Does your question make sense? Is it confusing?

Step 2: Hypothesis
- What do you think will happen?
- BE SPECIFIC!
- Use complete sentences.

Step 3: Procedure
- What steps will you follow to find an answer?
  ✓ BE SPECIFIC! Label your steps using 1, 2, 3, etc.
  ✓ Would someone else be able to follow your directions?
- How will you collect your data?
- How will you ensure reliable results?
- What safety issues need to be addressed?

Step 4: Experiment & Data
- Be sure to display your data in an organized manner. Use a table or chart to help you show your results. Don’t forget to label!
- Include enough data to prove or disprove your hypothesis.

Step 5: Analysis/Conclusion
- What happened during your experiment?
- Did your results support your hypothesis?
- Write a summary of what you learned during your experiment and address your results.
- Explain any unexpected results.
- Are your results reliable?
- Did you use complete sentences?
Independent Investigation

**Question**
What do you want to find out?

**Hypothesis**
What do you think will happen?

**Procedure**
Design your experiment! Write the steps for your experiment in the space below.

**Safety Rules**
What safety rules do you need to follow during your experiment?
Middle East Water Treaty Negotiations
for Science and Survival
Susan Hastings, McQueen High School
Grade Level – High School

Introduction

Done as a cross-curriculum lesson, science teachers can include both social studies and English departments in creating a “world-class” project that can culminate in school-wide presentations. From the science end, the lesson is inquiry causing students to study climate change and water loss issues in a notoriously dry region. Appropriate for high school and older middle school students, the lesson runs a spectrum from climate change to environmental science to geo-political. It is appropriate for earth or physical science classes and environmental science courses as well, where implemented by local school districts. It should be planned for approximately seven class periods depending on personal modifications. The application of science in a real world situation could actually motivate students to try harder and apply themselves to learning some history and international policy along with ambassadorial style negotiating and bargaining. A Power Point presentation file accompanies this activity and can be modified to fit the needs of the individual teacher.

Objectives

- To bring awareness to issue of water shortages in the world
- Students will continue to investigate properties of water and weather
- Students will understand the effects climate change has had on local climates
- To see that collaboration and cooperation with neighboring countries is necessary and requires information-gathering skills and diplomacy
- To continue refining library and research skills
- Student can work cooperatively to accomplish goals, organize as a team and present findings and conclusions in a logical and effective manner

First Day Engagement and Pre-test

Engage: Fresh versus salt water distribution. Use a graduated cylinder to fill one 1,000-mL beaker exactly and add a few drops of food coloring. This represents the Earth’s entire supply of water. Use a graduated cylinder and pour 28mL of the total water into a second 1,000-mL beaker. If another 1,000 mL beaker is not available, use next largest. The 28 mL of water represents the Earth’s total freshwater supply. The remaining 972 mL of water is saltwater that occurs primarily in oceans. Divide the 28mL of freshwater by pouring into smaller containers: 23 mL for icecaps and glaciers, 4 mL for ground water, 0.7 mL for surface water, and 0.3 mL for the water in the atmosphere and soil.
A pretest is given containing content from the water cycle, focusing on river and stream systems and aquifers, and the foundation paper for the project – a 1993 paper from the National Geographic titled Water – the Middle East’s Critical Resource. This article is a wealth of information on the geologic/hydrologic configuration of the area and the religious/political/economic/political history of water usage and management in the area. Doing some work with students on the Pre-test topics is very useful in preparing them for this activity.

Water Treaty Negotiations Pre-Test

1. Source of a river or stream ______
2. Streams contributing to a larger river system ______
3. Change in slope of a river system ______
4. Rock that is a source of water ______
5. Region of a river system that diverges before emptying into a large body of water ______
6. Means of getting water from deep rocks ______
7. Area where deep waters come to the surface ______
8. Waterway that sends water from one area to another ______
9. Resource of greatest concern to people of the Middle East ______
10. Middle East Resource of greatest concern to the world ______
11. Bank that loans funds to countries for many large projects ______
12. Country at odds with other countries in the Middle East ______
13. Group of ethnic people living within Iraq ______
14. Former leader of Iraq ______
15. Major river system of Iraq ______
16. River separating Jordan and Israel ______
17. Israeli water company ______
18. Leader of Jordan ______
19. Country controlling the source of the Tigris and Euphrates ______
20. Resource represented by the Israeli flag ______

a. Israel
b. United States
c. Saddam Hussein
d. Tigris and Euphrates
e. Headwaters
f. Spring
g. Gradient
h. Delta
i. King Hussein
j. Turkey
k. Water
l. Kurds
m. World Bank
 Placement of the Lesson

Students will be familiar with these terms following a brief review of river and aquifer systems during preceding lessons on weather/climate/water cycle. We then started reading the ( ) article in class. Schools that are stressing literacy and reading comprehension want all lessons to include a component of vocabulary and comprehension. This can very easily be accomplished in this activity and can be done at the discretion of individual student teams and keep the inquiry theme going even so far as this construction of vocabulary. The following are important underlying concepts behind the full application of this activity and in order to affect total impact that it can have teachers are urged to be constantly looking for and encouraging these:

Understanding of:

- vocabulary, expressions, historical references, comprehension of ideas.
- emotional and philosophical impressions (so the students can get a feeling for the feelings and attitudes of the countries involved)
- teams are to “get into character” with the people of the country or group they represent.

There are six groups representing the following countries: Turkey, Syria, Israel, Iraq, Jordan, and the Kurds. To increase to eight groups use Lebanon and Armenia or Iran.

Day 2: Short You Tube video on water use in the Middle East.

Second demonstration showing water use comparing the U.S. with the Middle East, representing the per capita/per annum water capacity of the United States of 10,000 cubic meters with 1000ml of water (pour clear water from one 1000ml graduated cylinder into another 1000ml graduated cylinder in which I had put a couple of drops of blue dye.)
The water instantly turned blue – a little magic). Then do the same for the 260 cubic meters available to Jordanians by pouring 26ml into a small graduated cylinder with one drop of blue dye. The effect is stunning.

Discussion on personal water use with comments and ideas going onto an advanced organizer on the board. Write down all estimates for water use. Hand-out sheet with average water use from USGS. http://ga.water.usgs.gov/edu/sq3.html

Perform a “generic” student from usage of various students using the USGS web page referenced above.

Another good in-class use-test was this one based more on how much water a human needs to survive and be healthy: http://www.csgnetwork.com/humanh2owater.html

In-class quiz:

1. Which bathroom activity uses an average of twenty gallons of water?
   a) shaving
   b) showering

2. What percentage of overall household water use gets flushed down the toilet?
   a) 10 percent
   b) 15 percent
   c) 25 percent

3. Where is the most water used?
   a) a toilet
   b) a clothes washer
   c) during a shower

4. How much water does a leaky faucet waste each year?
   a) 30 gallons
   b) 300 gallons
   c) 3,000 gallons

5. Which uses the most water?
   a) washing dishes by hand
   b) washing dishes in a dishwasher

**Answers:**

1. a) Shaving uses an average of twenty gallons of water. Save water by filling the sink instead of running water as you shave. And by the way, five to fifteen gallons of water stream out of a standard showerhead per minute, so limit your shower time, too.
2. c) Of all the water used in the home, about 25 percent gets flushed down the toilet. Minimize flushing and check to be sure your toilet doesn’t leak by adding food coloring to the tank. If it is leaking, color will appear in the toilet bowl within thirty minutes. (Flush as soon as the test is done, as food coloring may stain the tank.)

3. a) Toilets use 25 percent of a household’s water consumption, with clothes washers coming in a close second at 22 percent, and showers 17 percent. Installing low-flush toilets, washing full loads of clothes, and taking brief showers with a low-flow showerhead all save water.

4. c) At one drip per second, a leaky faucet wastes between 2,700 to 3,100 gallons a year.

5. a) A water-efficient dishwasher unit uses between eight and fifteen gallons of water. If it’s full when you run it, it probably uses less than you would use washing the same number of dishes by hand.

Homework – record personal water usage and go to USGS site to calculate usage. This is being turned in and graded as a separate assignment. Students are required to do the personal water usage survey and print out the results page for credit.

Anticipatory set – pour blue food coloring into bottom of large graduated cylinder. Pour water into cylinder to 1000ml. Say, “This water represents the per-capita/per annum water capacity for the US in 1990.” Then into a small cylinder with blue dye (one drop) pour 26 ml. Say, “If you were a citizen of Jordan, this represents the per-capita/per-annum water available to you.”

Form groups. Reassess whether or not the team members chosen as Principal Investigators are responsible enough to be team leaders for this project. Consider consolidating some of the teams to reflect the 6 to countries and areas or be sure that existing eight teams are all strong enough and with the depth to complete this project. Based on combined pre-test scores teams decide together which country they want to represent: Syria, Turkey, the Kurds, Iraq, Israel, Jordan. Add Lebanon and Iran/Armenia if doing eight teams.

Day 3: Continue reading foundation article. This will take some time depending on the level of the students. Hand out supplementary information to leaders (articles). Leaders must keep a folio of their material and team member contributions.

Day 4: Day in the library to begin research and organize team duties. Continue reading and start some group time. Students should be organizing their issues and requirements. If possible arrange with the Librarian to have all print resources on the Middle East and the various Middle Eastern countries

Days 5 & 6: Research in library. Students will use reserved computers, stacks, and round table room. Each group will have a round table to work together. They should have a country report done by the end of day 6.
**Day 7.** Go over example treaty – The Colorado River Water Agreement. Take post-test.

**Day 8.** Arrange desks in circle with countries areas marked out. Group leaders will be the spokespersons for their group. They will negotiate a treaty agreement. Moderator will record the terms on the active board and “publish” the final treaty.

**Day 9.** Put final treaty together.

**Day 10.** Student Presentations. (This can be delayed for a period of time if instructor wishes to grade projects before allowing students to present.)

**Additional Assessment Ideas**

Even though it is a high school project, some students probably have never done real research before. Some groups will attempt to cut and paste from the internet whether it makes sense or not. Some students will simply refuse to work. In order to deal with this possibility I have asked team members to sign the sections they write and team leaders to check over their team members’ work and either rewrite it with their own by-line or sign it saying the person cut and pasted from the internet. This will allow the instructor to fairly assign individual grades based on the integrity of both team members and the work they did and the team leader’s skills in regulating team “parasites”. Teachers can also require that the member each do some presenting on the Day 10 presentations.

Encourage teams immediately after choosing countries to start doing research.

Additional instructions for teams:

*You need to produce a report on the history of water needs, issues, policies, etc., of your country. Include pictures, charts, graphs, maps and all pertinent data. You should be making a list of things you want to search for in the library.*

*The first section of the report should be an introduction about the importance of the issue of water resources and management.*

*The next section should be a history of water issues in your country including discussion of problems with neighboring countries.*

*The next section should be a discussion of water resources for your country.*

*Finally, you should outline a plan for future needs and cooperation with your neighbors. This will be used as a baseline for your negotiations.*

They are given instructions about references and suggestions about how to distribute the work.
Assign one person to research each section of the paper.

YOU MUST REFERENCE YOUR SOURCES – IF YOU DON'T THAT IS PLAGIARISM AND IT IS ILLEGAL. THESE SHOULD BE LISTED AT THE END OF YOUR REPORT.

IF YOU CUT AND PASTE YOU MUST INCLUDE A FOOTNOTE.

Keep track of vocabulary. You should have a list of vocabulary at the end of your paper.

PLEASE WORK AS QUIETLY AS POSSIBLE IN THE LIBRARY.

Each group should set up at a round table so you can work together after you gather your research.

The treaty negotiations were a good exercise in cooperation and working things out. Moderate the negotiations, keep them on task and offer suggestions and advice on how to negotiate, but let them confer with their groups and decide when to do what they would agree to come to terms. This activity can approach true inquiry-based learning if executed properly. You may find that students exceed your expectations when given the goals and rewards yet are allowed to create the learning and the project themselves.

Inquiries and comments regarding this lesson can be directed to Susan Hastings, McQueen High School, 6055 Lancer Street, Reno, Nevada 89523, 775-746-5880, or by e-mail: Susan Hastings <shastings@washoeschools.net>

References

Sources: City of Lafayette, Indiana, Utility Department; www.waterinfo.org; City of Westminster, Colorado; ConsumerReports.org. Read more: http://www.naturalhomeandgarden.com/Inspiration/2003-07-01/Water-Whiz-Quiz.aspx#ixzz1p8UdaC1s
[Date – Day # of Project]

Discussion Questions
After air, what is the most important resource in your life?
WATER
Where does our water come from in the Truckee Meadows?
THE RIVER, WELLS, RESERVOIRS
Where does the water in wells come from?
AQUIFERS
[Date – Day # of Project]
Get out your water use tables

Discussion Questions
What does water availability mean?
In the US the water availability per-capita is around 10,000 cubic meters
In Jordan it is 260 cubic meters.
If I represent the US water with 1000ml what is the Jordanian equivalent?
26ml
How much water do you use in a day?

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<tr>
<th>Source</th>
<th>Quantity</th>
<th>Length of Time</th>
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<td>Shower</td>
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<td>Brush Teeth</td>
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<td>Wash hands</td>
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<td>Shave</td>
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<td>Wash dishes (by hand)</td>
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<td>Wash clothes (machine)</td>
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<td>Flush toilet</td>
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<td>8 oz. water or soda</td>
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<tr>
<td>Cooking</td>
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Water Use Calculation

- Go to http://ga.water.usgs.gov/edu/sq3.html
- Get your daily water usage
- If there is something they don’t include, add it in afterward.
As we go through the material remember and make note –

**Who controls the headlands?**

- The headlands of a water system are where it all begins.
- Where are the headlands of the Truckee?
What are Tributaries?

- These are streams and rivers that flow into a larger river.
- What other rivers flow into the Truckee?
What does the delta look like?

What is a Delta

- When a river reaches a nearly flat gradient it starts to branch out into a delta.
Who shares Aquifers?

What is an Aquifer?

- An aquifer is a tilted water bearing rock. It is usually recharged in mountainous areas and the water flows down slope to deeper regions.
- We draw much of our water from aquifers.
Per-Capita Water Available in Middle East Compared to USA in cubic meters

1990 Per-Capita Water Available in Cubic Meters

- United States
- Iraq
- Turkey
- Syria
- Egypt
- Israel
- Jordan
Who Controls the Water?

We are going to divide into six groups – not exactly the same as the previous graph.

The six groups will be: TURKEY, SYRIA, IRAQ, THE KURDS, ISRAEL, and JORDAN.

There will be 4 or 5 people per group.

Pick a leader.

The leader will select which country you represent.

While we are going through the article you need to pay special attention to any mention of your group and take extra notes.
This is the Region for Your Project
Shared Aquifers

These are the shared aquifers between Israel and Jordan. Note they are recharged in the Golan Heights.
What you Should be Doing

You need to produce a report on the history of water needs, issues, policies, etc, of your country. Include pictures, charts, graphs, maps and all pertinent data. You should be making a list of things you want to search for in the library.

The first section of the report should be an introduction about the importance of the issue of water resources and management.

The next section should be a history of water issues in your country including discussion of problems with neighboring countries.

The next section should be a discussion of water resources for your country.

Finally, you should outline a plan for future needs and cooperation with your neighbors. This will be used as a baseline for your negotiations.
Before You Start Your Research

**Assign** one person to research each section of the paper.

YOU MUST **REFERENCE YOUR SOURCES** – IF YOU DON’T THAT IS PLAGIARISM AND IT IS ILLEGAL. THESE SHOULD BE LISTED AT THE END OF YOUR REPORT.

IF YOU CUT AND PASTE YOU MUST INCLUDE A FOOTNOTE.

Keep track of **vocabulary**. You should have a list of vocabulary at the end of your paper.

PLEASE WORK **AS QUIETLY AS POSSIBLE IN THE LIBRARY**.

Each group should **set up at a round table** so you can **work together** after you gather your research.
## How you will be Graded

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Appendix
Appendix - Socratic Method

By Heather Coffey

This article explains the history and theory of the Socratic method of teaching, which emphasizes teacher-student dialogue. The article offers suggestions for creating Socratic circles and Socratic seminars and provides resources for further reading.

Developed from Plato’s Socratic Dialogues, the Socratic method of teaching is a student-centered approach that challenges learners to develop their critical thinking skills and engage in analytic discussion. The Socratic method can be used at any grade level and with all subject areas, and lessons can be adapted to fit a changing society.

History of the Socratic method

An ancient form of discourse, the Socratic method is over 2400 years old and is reportedly founded on Socrates’ belief that lecture was not an effective method of teaching all students. According to Matt Copeland, Socrates valued the knowledge and understanding already present within people and thought that using this knowledge could potentially be beneficial in advancing their understanding. Copeland explains, “by helping students examine their premonitions and beliefs while at the same time accepting the limitations of human thought, Socrates believed students could improve their reasoning skills and ultimately move toward more rational thinking and ideas more easily supported with logic.”¹

The term ‘Socratic seminar’ appears to have first been used by the Great Books Program founder Scott Buchanan in his work with the St. John’s College New Program, and the concept has been popularized by organizations such as The Center for Socratic Practice, the Touchstones Project, Junior Great Books, the National Paideia Center, and the Coalition of Essential Schools.

Lynda Tredway explains that although this type of teaching practice has been explored throughout history, this teaching technique was reintroduced in the 1980s, as part of Mortimer Adler’s Paideia Proposal for comprehensive school reform.²

The Socratic method in practice

In the Socratic method of education, teachers engage students by asking questions that require generative answers. Ideally, the answers to questions are not a stopping point for thought but are instead a beginning to further analysis and research. Teachers can use the Socratic method in a variety of subject areas and across grade levels in order to challenge students to examine both contemporary and historical issues. In modeling the practice of Socrates, the teacher questions
students in a manner that requires them to consider how they rationalize and respond about topics. Copeland explains that it is important for teachers to clarify that these questions are not intended to create an environment of judgment, but rather to help students “examine their attitudes, beliefs, knowledge and logic.” The goal of the Socratic method is to help students process information and engage in deeper understanding of topics. Most importantly, Socratic teaching engages students in dialogue and discussion that is collaborative and open-minded as opposed to debate, which is often competitive and individualized.

Ideally, teachers develop open-ended questions about texts and encourage students to use textual evidence to support their opinions and answers. In the Socratic seminar, the teacher uses questions to guide discussion around specific learning goals. It is imperative for teachers to “establish guidelines to help students understand their roles and responsibilities” in the Socratic discussion. “Socratic questioning is a systematic process for examining the ideas, questions, and answers that form the basis of human belief. It involves recognizing that all new understanding is linked to prior understanding, that thought itself is a continuous thread woven throughout lives rather than isolated sets of questions and answers.”

**Socratic circles**

Socratic circles can be used to engage in the Socratic method in various subjects. Typically, when participating in Socratic circle activities, students first read a passage critically and then form two concentric circles. First, the inner circle examines and discusses the text and the second circle comments on the quality of the dialogue. Then, the two circles switch places and roles, and the process is repeated with the new ideas from a new circle. The outer circle is required to remain quiet while the inner circle reacts and dialogues, and conversely, the inner circle must listen quietly to the outer circle’s evaluation of their conversation.

Copeland explains that Socratic circles “turn partial classroom control, classroom direction, and classroom governance over to students by creating a truly equitable learning community where the weight and value of student voices and teacher voices are indistinguishable from each other.” Copeland suggests that Socratic circles help to develop “critical and creative thinking skills that will ultimately facilitate their growth and development into productive, responsible citizens.”

According to Copeland, Socratic circles encourage students to “work cooperatively to construct meaning from what they have read and avoid focusing on a ‘correct’ interpretation of the text.”

**Steps for Creating Socratic Circles**

Typically, Socratic circles must include a short passage of text in which students have already given a critical read, and two concentric circles of students — one circle focusing on exploring
the meaning expressed in the text and a second circle observing the conversation.

Basic structure:

1. Teacher assigns a short passage of text the day prior to the Socratic circle activity.
2. Students read, analyze, and take notes individually.
3. Students are divided into two circles.
4. The inner circle reads the passage aloud and discusses the text for about ten minutes, while the outer circle silently observes.
5. The outer circle evaluates the inner circle’s conversation and provides feedback to the inner circle.
7. The new inner circle discusses the text for approximately ten minutes and then is given ten minutes of feedback by the outer circle.

Socratic Seminars

Lynda Tredaway describes the Socratic seminar as “a form of structured discourse about ideas and moral dilemmas.” According to Tredway, the Socratic seminar is a 50-80 minute discussion in which 25 or fewer students react to a novel, poem, essay, document, or art reproduction. Students engaging in Socratic seminar generally sit in a circle and do not raise their hands to speak; instead, they make eye contact and observe body language in order to learn the cues for engaging in discussion.

In the Socratic seminar, the teacher usually provides questions that require students “to evaluate options and make decisions.” When Socratic seminars engage students in active learning, they “develop knowledge, understanding, and ethical attitudes and behaviors, they are more apt to retain these attributes than if they had received them passively.” Proponents of this teaching methodology propose that it also has the potential for character and communication development in addition to facilitating the improvement of self-esteem.

The Teacher’s Role in Socratic Seminar

In the Socratic seminar, the teacher is responsible for guiding students to “a deeper and clarified consideration of the ideas of the text, a respect for varying points of view, and adherence to and respect for the seminar process.” The teacher also counts the number and type of comments made by students and models expected behaviors for listening, thinking and interacting within the dialogue. Teachers often participate in student-led seminars, and in case, the dialogue is charted by students who tally the types of contributions made by classmates.
Developing Questions for Socratic Seminars

There are several methods of developing questions for Socratic seminars; however, creating an opening question can determine the success of the seminar. According to the Greece Central School District of New York, a good opening question must:

- Arise from the curiosity of the leader.
- Have no single “right” answer.
- Be structured to generate dialogue that leads to a clearer understanding of textual concepts.
- Require participants to make textual references.

The questions that follow the introduction to the seminar require students to make personal connections with the text and the world outside of school. For example, the questions might ask students to share similar or different experiences as those in the text. The teacher might also pose questions that ask students to clarify their perspectives and draw on textual evidence to support their claims. The questions in a Socratic seminar might also challenge students to make comparisons, give evidence for cause-and-effect relationships, provide suggestions for why this text might be realistic or unrealistic, and compare it to their personal lives. Sample questions may be found on the Socratic Seminars page at the Greece Central School website.

Guidelines for participants in a Socratic seminar

When implementing Socratic seminars in the classroom, teachers may want to create their own guidelines for participation. Examples of participation guidelines can be found on the following web pages:

- Socratic Seminars on the Studyguide.org website
- Socratic Seminars — Responsibilities: Participants on the Greece Central School District website

Notes