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Science Literacy: Collection of Earth Science Lessons Emphasizing Writing in Science

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Emphasizing Writing in Science

By

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Abstract

The purpose of this project is to create lessons and projects for high school Earth Science classes encompassing science literacy, specifically focused on writing. With the recent release of the Next Generation Science Standards, science literacy has gained importance in science education. This being said, teachers need the pedagogical skills to implement and teach science literacy.

For this project, a literature review of science literacy was conducted which lead to a focus on writing in science. Past research of writing in science classrooms revealed that more than half of high school science teachers claim that they do not feel prepared to teach writing in science nor have the time to do so. The literature review of this thesis highlights the theoretical framework of learning through writing, the four writing strategies and difficulties faced by the teacher and students. The last section of the literature review brings ideas together in a discussion concerning the implementation of writing in a science classroom.

The final section of this thesis contains a series of lesson plans and projects developed for a high school Earth Science classroom. To develop the lesson plans four particular writing strategies were utilized. These include RAFT, SWH (science writing heuristic), Cornell notetaking and the Interactive Notebook.

The lessons developed incorporate different approaches for writing assignments, including several opportunities for student choice. Writing in science is possible at the high school level. The students' ability to learn science through writing will be significantly enhanced when they are encouraged and guided by a knowledgeable and dedicated teacher.

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Chapter I: Introduction

Rationale

The need for U.S. citizens to be scientifically literate is gaining importance, as everyday people are faced with making scientifically based decisions. Scientific advances and information presented each and every day is increasing faster than the science curriculums in school can be changed (Saul, Kohnen, Newman, & Pearce, 2012). Thus, having the skills to read, write and analyze science information is vitally important. Science literacy in school sets the stage for lifelong learning and teaches students how to continue to be engaged in science.

Our children are falling further and further behind in science. Between 1992 and 2009 the scores of our seniors on the NAEP have dropped 6% at the basic scoring level. Seniors scoring at the proficient level dropped 2% over the same time period (Jetton & Lee, 2012). The political demands are becoming more burdensome to improve our children's science literacy (Yore, Hand, Goldman, Hildebrand, & Osborne, 2004). In 1988 it was estimated that only 5% of the United States population was considered to be scientifically literate (Glynn & Muth, 1994).

Becoming scientifically literate involves mastering many literacy and science processing skills including; computational, estimating, manipulation, observation, classifying, predicting, inferring, interpreting data, communication and critical response skills (Glynn & Muth, 1994; Padilla, 1990). According to *Science for All Americans* a scientifically literate person:

> "…is one who is aware that science, mathematics, and technology are interdependent human enterprises with strengths and limitations; understands key concepts and principles of science; is familiar with the natural world and recognizes both its diversity and unity; uses scientific knowledge and scientific ways of thinking for individual and social purposes" (Glynn & Muth, 1994, p. 1057)

Most educators agree that writing is critical to the learning process. That being said, writing is underused in secondary science classrooms. Instead, the focus is on activity-based/hands-on/inquiry learning activities. When writing is completed in high school science classes, it is more note-taking than note-making or completing a worksheet that goes along with an activity which is likely to be discarded by many students shortly after the lesson. As a result, students lose out on the opportunity to deepen their thinking about and learning science through writing. Writing creates a situation in which learning becomes a "minds-on" activity and deepens learning (Glynn & Muth, 1994). By the time students reach high school the majority of them find science to be dull, difficult and meaningless (Glynn & Muth, 1994); hands-on activities are helpful with engaging students in science, writing is then needed to strengthen and solidify learning.

Science teaching reform has advocated for student-centered/student-driven instruction. When students are engaged in note-making they become the directors in their learning. They begin to take ownership in their notes, thus enhancing motivation, engagement and learning in science. Furthermore, when students are writing they become engaged in metacognition as they are organizing, revising and rethinking the information which they are writing about. When students revise their writings and review their notes to write reflections, often times they will see the information differently and possibly change their thinking. Writing activities have shown to help clarify misconceptions. Another advantage to writing in science is students often engage in conversations with their peers resulting in deeper understandings of the topic, clarifies misconceptions, brings out new ideas or questions, all of which enhance learning (Zwiers & Crawford, 2011).

A goal of this project is to design lessons rich in literacy, specifically writing. Whether through note-making or full length writing tasks, students will be writing in each lesson. Studies have shown that teachers often lack pedagogical skills incorporating some aspects of science literacy (Sampson & Blanchard, 2012). When using literacy strategies in the classroom, to be effective, teachers need to be vigilant with the placement of the strategy within the lesson and their choice in strategy which they use (Dew & Teague, 2015). The four writing strategies this project focuses on are; science writing heuristic, RAFT, Interactive Notebooks, and Cornell Note-taking. Ultimately, this project strives to provide high quality lessons which will assist students to be successful with writing about science topics in various genres, with the goal of providing teachers with ideas of how to implement and use these specific strategies.

Significance of Project

The Common Core State Standards and the Next Generation Science Standards have given priority to increasing literacy in all disciplines. As more states implement the new standards there is an increase in demand on teachers to have strong literacy based lessons. Written language is a vital component of science literacy. It is through writing that scientists communicate their research and understandings and argue or persuade an audience to support a particular view of a social issue at hand (Yore et al., 2004). When writing in science, students become engaged in metacognition which studies have shown to deepen understanding. As students write about science topics they clarify their thinking, engage in conversation and discover new ideas (Glynn & Muth, 1994). As new curriculums have emphasized hands-on activities, forms of writing appear to have taken the sidelines in science classrooms. Researchers have found that as little as 19% of writing assignments collected from students in the study consisted of an extended paragraph, the remaining writing pieces were fill in the blanks and short

answers. Another study surveyed high school teachers across the nation and found 36% of science teachers in the study did not require a multiple paragraph writing assignment within a grading period (Kohnen, 2013). Writing in secondary science should involve more than filling in blanks on guided notes or on a worksheet following along in an activity.

Many studies in the nation have observed teachers to have little to no pedagogical skills with writing in science; this is said to be due to the lack of or minimal training and/or lack of successful experience (Kohnen, 2013). A survey of science teachers found approximately 60% believe they were not prepared to teach writing in high school science (Kohnen, 2013). This project focuses on adding to science teachers' box of tools for incorporating writing activities in the Earth Science curriculum.

Definition of Terms

Writing-to-learn (WTL): Instructional and learning strategies which are focused on the process of organizing thoughts, evaluating supporting ideas, and revising written thoughts. Students have the opportunity to reflect on their own thoughts and deep their understanding. (Balgopal & Wallace, 2013)

Writing-to-communicate (WTC): activities/strategies that focus on the final written product and the method through which it conveys a message. The three most common WTC essays in science classrooms are; expository, narrative and persuasive essays. (Balgopal & Wallace, 2013)

Metacognition: The awareness and control of all cognitive processes (Glynn & Muth, 1994)

Schema (schemata (plural)): interconnected categories within the memory (Quintus, Borr, Duffield, Napoleon, & Welch, 2012)

Chapter II: Literature Review

Introduction

From the water we drink to the air we breathe, science is in all aspects of our daily life (Griffin & Ramachandran, 2010). As the world becomes progressively more connected socially and economically, there is an increasing necessity to be scientifically literate. As scientific information is increasingly being exposed to the public, it is critical to be able to read and interpret this information to make informed decisions as a consumer and an educated citizen (Glynn & Muth, 1994; Griffin & Ramachandran, 2010). Students who do not have good scientific literacy skills are at a great disadvantage as they enter the collegiate world (Zucker, Staudt, & Tinker, 2015).

Our children are falling further and further behind in science. Between 1992 and 2009 the scores of our seniors on the NAEP have dropped 6% at the basic scoring level. Seniors scoring at the proficient level dropped 2% over the same time period (Jetton & Lee, 2012). The political demands are becoming more burdensome to improve our children's science literacy (Yore et al., 2004). In 1988 it was estimated that only 5% of the United States population was considered to be scientifically literate (Glynn & Muth, 1994).

When No Child Left Behind was passed, focus of instruction shifted to strengthen reading and math skills of all children in school; science and other subjects took the sidelines for some time, by losing class time (Pearson, Moje, & Greenleaf, 2010). As standardized testing became the norm students were tested with multiple choice exams which tested memorization of facts. It became difficult for teachers and educators to make progress with inquiry based teaching when students were not being assessed on this way of learning (Pearson et al., 2010).

Unfortunately, this way of assessing has resulted in most teachers teaching content facts (Pearson et al., 2010). With the implementation of the Next Generation Science Standards and Common Core State Standards, literacy in science is taking a step into the spotlight as the country is seeing the dire need for its citizens to become scientifically literate. As these new standards are being accepted by more states, it is pointed out by Pearson et al. (2010) that inquiry activities are advanced in their meaning through incorporating reading and writing tasks into the inquiry based activity. When participating in "hands-on" and "minds-on" science students gain deeper understanding of the content beyond just rote memorization of facts.

Becoming scientifically literate involves mastering many literacy and science processing skills including; computation, estimating, manipulation, observation, classifying, predicting, inferring, interpreting data, communications and critical response skills (Glynn & Muth, 1994; Padilla, 1990). According to *Science for All Americans* a scientifically literate person:

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Most educators agree that writing is critical to the learning process. In 1995, Connely stated the value of learning science through writing is in 'enabling the discovery of knowledge" (as cited in Yore et al., 2003, p. 700). However, the use of writing for the purpose of developing student understanding is rarely considered in schools (Yore, Bisanz, & Hand, 2003). Instead, the focus is more activity-based/hands-on/inquiry learning activities. When writing is completed in high school science classes, it's more note-taking than note-making or completing a worksheet that goes along with an activity. As a result, students lose out on the opportunity to deepen their thinking and learning science through writing. Writing creates a situation in which learning

becomes a "minds-on" activity and deepens learning (Glynn & Muth, 1994). By the time students reach high school the majority of them find science to be dull, difficult and meaningless (Glynn & Muth, 1994); hands-on activities are helpful with engaging students in science, writing is then needed to strengthen their learning.

When students are shown a demonstration, do an experiment, listen to a lecture or read a text book, to gain a deeper understanding and comprehension it is beneficial for them organize their thoughts and new information into a form that makes sense to them (Yore et al., 2004). The interactive notebook and Cornell note-taking are strategies which provide an opportunity for students to reflect on the lesson/activity and put the information into a form that works for them to learn the material. This reflective process turns note-taking into note-making.

As science and technology continue to rapidly evolve they enter our lives more and more each day. The need to have the skills to interpret, analyze, read and comprehend science information is vitally important. The students of the United States are continuing to fall behind other countries in the world. It has been pointed out to continue to make advancements in science and technology we need to reform science education. Students need to have science literacy skills to become informed citizens and be able to make educated decisions about social issues throughout their lives. Science teachers can help students gain the skills they will need to become lifelong learners by creating a literacy rich learning environment with literacy rich lessons.

This literature review focuses on strategies to increase writing in the science classroom and turning note-taking into note-making. The framework is centered on two categories of learning through writing; writing-to-learn and writing-to-communicate. Writing-to-communicate

will include two strategies; science writing heuristic and R.A.F.T. The strategies discussed under the writing-to-learn category are; the interactive notebook and the Cornell note-taking method. To conclude this literature review there is a brief discussion on the difficulties faced with writing in the classroom and lastly implementation of the above mentioned strategies into a science classroom.

Science Literacy

Throughout literature there are many definitions of science literacy. Griffin & Ramachandran (2010) sites an international definition of science literacy from the Organization for Economic Cooperation and Development (OECD);

> "Science literacy is the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity." (Griffin & Ramachandran, 2010, p. 328)

The National Research Council states:

> "A scientifically literate person can ask, find or determine answers to questions derived from curiosity about everyday experiences. It means that a person has the ability to describe, explain, and predict natural phenomena. Scientific literacy entails being able to read with understanding articles about science in the popular press and to engage in social conversation about the validity of the conclusions." (Saul et al., 2012)

All definitions of science literacy have one main goal for students; to be able to effectively read, write and communicate science (Krajcik & Sutherland, 2010). The American Association for the Advancement of Science emphasizes the importance of science literacy in order to make informed decisions and participate in a global society (Krajcik & Sutherland, 2010). With the importance of having scientifically literate citizens to obtain a strong democracy, science literacy has been a primary focus of reform in science education for the past 20 years (Pearson et al., 2010). Researchers are concerned with students developing the

necessary skills to successfully engage in science inquiry activities (Pearson et al., 2010). Science writing activities play a critical role in science inquiry. The learning opportunities made possible through science inquiry can be advanced with the supplement of literacy activities (Pearson et al., 2010).

Writing in science

Before 1980 there was little research conducted of reading and writing in science education (Yore et al., 2003). During this time educators strongly promoted a shift in science education from textbooks and worksheets to hands-on activities; this move resulted in writing to be greatly diminished in the science classroom. During the 1980s, research in science education increased and researchers began to look into the effectiveness of hands-on activities. This new research conducted several meta-analyses finding hands-on activities not to be as effective as initially promoted, unless the activity was supplemented by a minds-on (writing) task (Yore et al., 2003). Writing tasks are needed to fill the learning gap of hands-on activities and solidify learning (Glynn & Muth, 1994). Studies found students were spending a lot of time interacting with apparatus and little time interacting with ideas (Keys, Hand, & Prain, 1999). To make sense of data collected in laboratory activities students need to process information, this can be and is effectively accomplished through discussion and writing (Keys et al., 1999). When producing a written product, students have an authentic opportunity to improve their vocabulary, grammar, spelling, patterns of argumentation, and technical writing used in the sciences (Yore et al., 2003). It is through metacognition that students gain a deeper understanding of science concepts; writing activities provide the opportunity for students to engage in metacognition processes promoting deeper thinking and thus increasing conceptual understanding (Glynn & Muth, 1994; Nam, Choi, & Hand, 2011).

Writing and in-class discussions combined were found to result in deeper understanding of scientific issues (Balgopal & Wallace, 2013). Written language is a vital component of science literacy. It is through writing that scientists communicate their research and understandings (Yore et al., 2004). Students obtain information on inquiries, procedures and science concepts through written language (Yore et al., 2004). Whether it is detailed notes or a text book, printed text provides students with ideas before, during and after an experiment or research (Yore et al., 2004). Since printed text can be revisited numerous times and does not rely strictly on memory, it is found to help students overcome misconceptions better than any other material (Shanahan, 2012). Demonstrations and labs are a one shot deal; if students do not remember the demonstration accurately they can form new misconceptions. Printed text allows students to revisit the details of what occurred and clarify any questions or misunderstandings. Written text provides students with an external storage of information and their ideas which is important as there is usually a large time frame between lecture and assessment (Faber, Morris, & Lieberman, 2000; Quintus et al., 2012). Granted, today we have several means of recording demos and activities; however students do not always have access to a computer to review the recordings. With this said, Glynn et al (1994) states that when students write they will often form new sensible misconceptions, which is part of the writing-to-learn process. As students write and become engaged in metacognition they will discover new ideas, challenge their thoughts and clarify their thinking (Glynn & Muth, 1994). When students are engaged in writing tasks during class, they will often fall into conversations with their peers. Science based conversation will frequently lead to the enlightenment of ideas, thus clarifying student misconceptions or securing their thoughts.

Research studies have found that students who write in science gain greater conceptual knowledge than those who do not (Baker, 2004). Writing activities are viewed as a learning tool in which students consolidate and integrate their knowledge to produce the end product (Yore et al., 2003). Baker (2004) further states the impact writing has on learning depends on the degree to which students already understand the information. If students understand the content well, then writing will not be as beneficial to their learning as when they are unfamiliar with the content (Baker, 2004).

Along the lines of students' prior knowledge of a topic falls students' interest level in the topic. Faber et al. (2000) found that interest level in the material played a role in students' success with note-taking. The researchers found scores of students who were instructed in a note-taking method to be significantly higher than students who did not receive note-taking instruction. This difference was in part attributed to the interest level of the material given to students. When students read material of high interest (expository passages of student choice) the researchers noticed few sets of notes used the instructed Cornell note-taking method, many students did not take any notes. The researchers recognized the possibility that students did not see much value in taking notes on high-interest material, pointing out the possibilities that students may have thought the material was not 'school' reading. Conversely, when students were faced with low interest passages (text book), half of the students used the instructed method and the other half were either inconsistent with their style of notes or used their choice of note taking. Nonetheless, the study found a significant difference between the scores of students who did and did not take notes. Those students who did take notes scored higher than those that did not. (Faber et al., 2000)

The writing strategies discussed in this paper have unique approaches to writing in science; they can greatly enhance science literacy skills and learning science, all the while striving to bring deeper meaning to science activities. Science Writing Heuristic (SWH) provides teachers and students a framework for writing an argument as a result of a laboratory or research activity; thus facilitating more detail and better organized writings. The RAFT writing strategy attempts to generate a creative aspect to science writing through placing students in different roles as writers who then write to various audiences. The interactive notebook is a tool that gives students the opportunity to engage in writing-to-learn, transforming note-taking into note-making through personal reflections. Another strategy that provides students with the opportunity for reflection of their notes is the Cornell note-taking method.

Theoretical Framework: Learning through Writing

Learning through writing is theoretically supported by information processing and schema theory. Quintas et al. (2012) and Glynn et al. (1994) describe information processing as having three stages; perception, working memory and long-term memory. To begin processing information one must obtain the information through visual, auditory and/or tactual means (Glynn & Muth, 1994). This information is received by the sensory memory (Quintus et al., 2012). If the person who receives this information finds it interesting and purposeful then the information will move into the working memory (Quintus et al., 2012). The working memory can hold information for a brief time (average is about 20 seconds) and works with the information to transfer it to long-term memory (Quintus et al., 2012). If the person does not see the need to keep the information then it will be lost. Long-term memory stores information until it is needed again. In order to store a large amount of information, long-term memory places the new information with old and organizes it to make sense. Schema Theory is the framework of

how information is organized and stored in long-term memory. It is well known in the education field that when students can relate a topic to prior knowledge they will retain and learn the information easier; this is due to schemata. Schemata are formed as students are taught information; these schemata are then built upon as students learn new information. Putting information into long-term memory relies on students' ability to make sense of information in a meaningful way. Building upon previously formed schemata results in information being more easily stored in long-term memory (Quintus et al., 2012).

Writing Strategies to Promote Learning

Writing-to-Communicate Strategies

SWH Writing in science leads students to developing evidence supported arguments (Balgopal & Wallace, 2013). Through writing an argument students become familiar with forms of reasoning that are unique to science (Yore et al., 2004). Students will gain skill in questioning, interpreting data, making claims and providing evidence to support their claims (Yore et al., 2004).

Keys, Hand, Prain & Collins (1999) conducted a study to learn if using the science writing heuristic tool promotes learning in laboratory activities. The science writing heuristic (SWH) was designed to be used as a framework for teachers and students to create meaning of laboratory investigations. The framework focuses on guiding students in reasoning and thinking about how evidence supports claims. There are two templates that make up SWH; a teacher template and a student template (Table 1). The SWH was originally set up to be used with a laboratory in which students performed an experiment and collected original data or a lab in which the outcome was not obvious. As more teachers use the SWH templates they may find

how to successfully use the SWH to guide an argument based research activity. After students gather data, research, make claims and discuss their ideas with peers they will produce personal meanings of the data/research. At the end of the activity, students should be assigned a specific writing task to communicate their understandings. Another possible ending to the activity is a class debate in which the SWH would act as a framework for the students' argument. (Keys et al., 1999)

Generating meaning of laboratory activities, using evidence to support claims, metacognition, and conceptual change were all goals of a study conducted by Keys et al. (1999). During this study SWH supplemented hands-on activities. The results of the study showed considerable evidence that SWH enhanced connections between laboratory exercises, observations and inferences made by the students. It was not clear as to whether students gained conceptual change from the activities and should further be tested in other areas; in this study it was only investigated for one science topic. Keys et al. (1999) suggest further research is needed to determine the types of laboratory activities that will work well with SWH.

Teacher template	*Student template*
Pre-Laboratory Activities: Teacher engages students to elicit pre-knowledge and gain understanding of the scientific context into which the aboratory is situated. Teacher may design pre-laboratory investigations such as brainstorming, developing questions about the topic, or expressing prior knowledge.	Questions: What are my questions?
Participation: Teacher encourages students to engage in an inquiry/laboratory investigation.	Test and Collect Data/Observation: What did I do? What did I see?
Negotiation I: Teacher guides students to think about the meaning of their data through journal writing.	Claims: What can I claim?
Negotiation II: Teacher encourages students to negotiate their understandings of the data with their peers. Students are encouraged to make knowledge claims to state explanations for their data.	Evidence: How do I know? Why am I making these claims?
Negotiation III: Teacher assists students to compare their ideas to textbook and on-line encyclopedia.	Reading: How do my ideas compare with others?
Negotiation IV: Teacher encourages students to communicate their current understandings of the investigation in a more polished form, i.e., writing a poem, letter or report, or creating a presentation or poster.	
Exploration: Teacher engages students to bring reflection to their understanding of the laboratory concepts.	Reflection: How have my ideas changed?

Table 1: SWH Template for Teacher and Student.

Left side of table describes the framework for the teacher during each phase of preparation for the final SWH product. The right side of the table is the framework for students. The student template should be written out and given to the student as a guide in their writing. Table obtained from (Nam et al., 2010)

Nam et al. (2011) conducted a study of 8th graders in three different low socioeconomic level schools in Korea. Korean science classes were largely lecture based in the past due in part to their culture. Recently they have greatly pushed forward and required a more hands-on activity based curriculum. This study performed by Nam et al (2011) wanted to see how successful these students could be in inquiry based activities. These activities were focused on oral and written arguments using SWH as the framework. It is important to note that students in this study had no experience with argumentation prior to the study. The results showed that the students involved in inquiry activities were able to successfully develop arguments and scored significantly higher in the categories of argument and writing than the control group. Nam et al.

(2011) suggests the success of SWH heavily relies on high-quality implementation by the teacher. In an argument based inquiry activity the SWH approach can greatly enhance the arguments made by students and increasing the effectiveness of the activity.

R.A.F.T. RAFT is a well-known strategy in education. This strategy is used to help students create a writing product. RAFT stands for Role (of the writer), Audience (to whom one is writing), Format (form of the writing), Topic (what are you writing about) (Buehl, 2001). Table 3 shows a template of the student graphic organizer of the RAFT strategy. When students actively write in different genres they are required to think about information in different ways and will therefore learn information from a different perspective (Nam et al., 2011). Nam et al. (2011) discuss a few different genres and what type of learning is associated with each. Analytical writing assignments will lead to reformulating content which relies on higher order thinking of the material. When students are asked to create short-answer writing, they search for information in the text book or other reference material and transcribe it onto the paper; low level thinking is taking place. A summary exercise will steer students to review all information. Students' science knowledge is seen to increase during a summary writing task because the students are activing interacting with their prior knowledge of the topic and the new information. During problem-solving activities, accompanying writing tasks will aid in students progressing through the problem to reach their goals for the task. Audience was also found to have an impact in the quality of student writing. Research found when writing tasks were focused on a peer audience, students performed significantly higher than when the writing was being written for the teacher.

The RAFT strategy can be useful in helping students understand the various genres of writing in science. The following table (Table 2) lists several ideas for different categories of writing: (Shanahan, 2012).

Table 2 R.A.F.T. This table lists a few examples for different roles, audiences, and formats for student writing. Information in this table was found in Shanahan (2012).

Role	Audience	Format	Topic
Scientist	Source of funding	Grant proposal	Any
	Another scientist	Log of lab results Discussion of findings	Any
journalist	Public	Basic explanation of findings	Any
	Publishers of journal article	Formal report of experiment	Any

Table 3: Student R.A.F.T. Template: This template can be used by students for organizing and preparing a writing task. Template developed by author with ideas from http://www.adlit.org/strategies/19783/

ROLE: 1.) As the writer I am …. (a scientist, science journalist, news reporter etc.) 2.) My task is….. 	
AUDIENCE: Who am I writing to? 	
FORMAT: 1.) What form is the writing? (Journal, letter to editor, news article, comic, poem etc.) 2.) What are important features or sections of the form of writing I should include?	
TOPIC: 1.) What is the writing about? 2.) Questions to be answered? 3.) My Point of View (if needed) 4.) Questions I have for future research	

Writing-to-Learn Strategies

Note-making With all of the teaching strategies on the market, Balgopal and Wallace (2013) along with many others, have found incorporating writing-to-learn (WTL) activities into science lessons has had great success in helping students increase their science literacy and science content knowledge. Glynn et al. (1994) states, "what students construct determines what they learn." Connolly (1989 as sited in Yore et al., 2003) proclaims writing-to-learn "…is about the value of writing 'to enable the discovery of knowledge.'" In writing-to-learn, one will discover their knowledge and place new information into a form in which they can understand. Writing-to-learn has a personal starting point at which the person is becoming more knowledgeable themselves, finding what the information means to them, and ultimately, through other writings or orally, being able to communicate this information to others (Yore et al., 2003).

Effective notes serve as a summary of a lecture/activity as well as a permanent record of learning and information gathered (Quintus et al., 2012). Through good note taking students will have a record of new information over a time which they can reflect on, add to and progressively connect ideas (Krajcik & Sutherland, 2010). During note taking students are engaged in multiple senses in processing the material; sight, sound and touch. Most educators are aware that hands-on learning helps students gain a better understanding of material. The same is true for note-taking. Students who generate their own notes are more likely to retain the information than if they were simply given the notes (Quintus et al., 2012).

Most students take some form of notes throughout their science classes. The question is, how effective are their notes in learning? For notes to become effective learning tools there needs to be a personal touch and connection to the information. As students begin to interact with notes instead of simply writing what the teacher tells them to, they engage in "note-making"

instead of "note-taking" and learning begins. The key to transforming "note-taking" into "note-making" is students' reflections and personal connections to the information. The process of making connections between prior knowledge and new information will facilitate comprehension of the material (Quintus et al., 2012). A teacher will know when students have adapted note-making; students will begin to show in their notes an increase in questions, drawings, reflections, comments, connections etc. (Young, 2003). Effective notes are difficult for students to create, mostly due to the fact most students have never been taught how to make meaningful notes (Quintus et al., 2012). Note taking has been thought by some to not be effective in science comprehension, however it is noted this could be due to the lack of instruction of how to take effective notes (Faber et al., 2000). When teachers take the time to instruct students in note-taking strategies, many find that the students' comprehension and scores greatly increase (Donohoo, 2010; Faber et al., 2000).

Interactive notebooks and the Cornell note-taking method are two strategies which provide students the opportunity to transform note-taking into note-making, resulting in their notes being more meaningful and deepen their understanding of science concepts. When students are actively taking notes they engage in self-questioning which results in organization of the material in a meaningful way and information is stored in long-term memory (Faber et al., 2000).

Cornell-note taking Cornell notes are designed with three columns; right column is for new information, the left column is where students write questions, main topics, cues or connections; the bottom couple of inches of the page is reserved for students to summarize the notes on the corresponding page (Quintus et al., 2012).

Quintus et al. (2012) conducted a study to investigate what impact Cornell note-taking had on high school students. Two groups of students were selected by the researchers; the groups were made of sophomores, juniors and a couple of seniors who were enrolled in a childhood development class. One group of students was randomly selected to take notes with their choice of method. The second group was taught the Cornell note-taking method and was instructed to use the method during the course. Each group of students was given the same unit exams throughout the semester. The results showed that the student-choice group scored higher than the Cornell note taking group; although the raw scores were slightly higher, the difference was not statistically significant. The researchers concluded the study supported a null hypothesis; there was no difference found in student performance between those who had choice in note style and those who used the Cornell note-taking method. The researchers took notice of several confounding variables that could have affected the results. One variable was student attitude towards note-taking. The researchers observed several students were resistant to note-taking, however they did participate. With the lack of positive attitudes the likelihood these students put a lot of effort into their notes is low. The authors suggested in future studies a third study group should be included; the third group should not take any form notes, thus forming a control group. Also, the student choice group was not a true student choice; as many students would have chosen not to take notes. Not knowing whether students used their notes to study was another unknown factor, which could have affected the exam scores. (Quintus et al., 2012)

On the other hand, Donohoo (2010) reports a teacher having different results than Quintas et al (2012) after implementing Cornell note-taking in her 9th and 10th grade science classes. The first attempt the teacher made implementing Cornell notes students showed great resistance; they were confused and did not know what information to include in their notes. The

teacher quickly learned that the students needed modeling and scaffolding which incrementally gave students more responsibility. With the assistance of a literacy coach, the science teacher modeled and used scaffolding to implement Cornell notes. At the end of the semester the students were taking notes on their own using the Cornell note-taking method. In this case, the class showed an improvement of 10-12% in the class average from the previous semester without Cornell notes.

Interactive Notebooks The interactive notebooks have been in education since 1970 when it was introduced by a teacher, Lee Swenson in California. Lee Swenson developed the interactive notebook in collaboration with history teachers. Later on, the Teacher's Curriculum Institute of History Alive © adopted and adapted the Interactive Notebook. Recently this strategy of note-making has expanded into math and science. (Mallozzi & Heilbronner, 2013)

The interactive notebook provides students a way to make notes instead of take notes. The interactive notebook is a notebook which students interact with information and ideas instead of simply writing information down and then not reviewing it until just before an exam. The structure of the interactive notebook comprises of an input and an output page. The right side page of the notebook is dedicated to 'input,' which is information given to the student by the teacher or an activity/lab. The left side page of the notebook is the output page. This page 'belongs' to the student per say. The left side is the space where the students make their notes their own; through the process of review, summarizing, connecting, questioning etc. Students work with the newly gained information to make sense of it in their own way; this could be through drawings, poems, songs, the opportunities are endless. The left page is also the area in which the teacher begins the class with a bell ringer activity, for example, to introduce the topic or a brainstorm activity. Table 4 shows examples of activities that can be incorporated into the

interactive notebook. (Butler & Nesbit, 2008; Chesbro, 2006; Marcarelli, 2010; Waldman & Crippen, 2009; Young, 2003)

Table 4 Contents of Notebook: Activities that can be incorporated in interactive science notebooks are endless. Here are some examples that teachers have used. It is important to note that teachers should customize the notebook to fit their teaching style. What make the interactive notebook different from a standard science notebook is the interactive left side, where students make meaning of their notes on the right side. Source: Waldman, C., & Crippen, K. J. (2009). Integrating interactive notebooks. *Science Teacher*, *76*(1), 51–55.

Left side	**Right side**
Examples of student-directed *in* and *out* activities:	Examples of teacher-directed *through* activities:
• A drawing, photo, or magazine picture that illustrates a new concept or idea	• Lecture, discussion, or reading notes
• Questions, opinions, and personal reflections about the new information	• Laboratory procedure or rough draft
• Predictions, contradictions, or quotations relating to the *through* activity	• Film, video, and documentary facts or notes
• Practice problems or inquiry activities	• Small- or large-group discussion notes
• Metaphors, analogies, acronyms, poems, songs, or cartoons that capture the new information or issue	• Collaborative group process summary
• Connections between the information, and the student's life, another course, or the world	• Excerpts of a news or journal article
• Reflections on and summary of activities	• Vocabulary exercises
	• Worksheets and activities

The question may be asked, "why are interactive notebooks important?" There are many benefits to the interactive notebooks. First, this style of note-making resembles the way scientists record information and make sense of their data (Young, 2003). Second, it provides a great resource for review for students as everything is in one place (Young, 2003). The interactive notebook can provide a means of communication between student, teacher and parents (Young, 2003). Students have the opportunity to connect science material with other disciplines, form personal connections, express values and feelings (Waldman & Crippen, 2009; Young, 2003). Science writing skills are enhanced with the interactive notebook as well as enforcing self-regulation of learning (Butler & Nesbit, 2008; Waldman & Crippen, 2009; Young, 2003). Furthermore, the interactive notebook can provide the teacher with an authentic assessment of student progress in the class (Young, 2003). In addition, the interactive notebook

is flexible in its format; teachers are encouraged to adapt the interactive notebook to fit their teaching style (Chesbro, 2006).

Chesbro (2006) experienced students taking ownership of their notebooks and making them personal, thus transforming note-taking into note-making which deepens understanding and learning. Similarly, Waldman & Crippen (2009) found that students treasured their interactive notebooks because of the personal connections and reflections they made in the books. The powerful aspect of the interactive notebook is the reflection (Waldman & Crippen, 2009). "Written reflection is essential to promote children's explorations of their own thinking and learning processes," (Shepardson and Britsch, 1997, pg 15, as cited in Butler, 2008, pg 137). As stated earlier, students need to interact with information more than is currently taking place. It is through this interaction students process information into a form that works for them.

In a study, Quintus et al. (2012) suggested a confounding factor with note-making to be students' different learning styles. Quintus et al. (2012) suggested students may benefit from different styles of writing and note-taking. During their study, one group of students were required to use the Cornell note-taking method which some students may not have learned well from, thus skewing the results. Interactive notebooks provide students more flexibility in their style of taking notes, creating an advantage over a specified note-taking method such as Cornell Notes.

Research has been conducted on traditional note-taking techniques, however there is little or no research on the impact of interactive notebooks on student learning (Mallozzi & Heilbronner, 2013). A study was recently conducted by Mallozzi & Heilbronner (2013) to determine if science process skills of 7th graders would be influenced by metacognitive strategies

embedded in an interactive notebook. The findings of the study showed the interactive notebook along with metacognitive strategies greatly developed students' science process skills more than traditional science instruction. The impact of interactive notebooks on students' science process skills can be largely due to the metacognitive strategies of thinking, reflecting, and applying their knowledge through inquiry activities. The interactive notebook is a tool for students and instructors to use to learn and enhance these skills. (Mallozzi & Heilbronner, 2013)

Difficulties with Writing

Teachers and students often become frustrated with writing tasks, especially in science (Buehl, 2001). A majority of students view writing in science as difficult and time consuming (Buehl, 2001) thus they are not motivated to do the assignment and do not put much effort into the writing. The lack of effort by students results in teachers receiving writing that is brief, lacking in detail, and poorly organized (Buehl, 2001). More often than not, writing involves reading of some form of science text. Science text has been shown to be very difficult for high school students. Science texts are dense, highly technical, contain nominalizations, embedded phrases, and are impersonal (Fang, 2012). High school science texts are unlike any textbook or reading material students encountered in grade school (Jetton & Lee, 2012). If students have trouble reading and comprehending texts which are examples of what they should be writing, then logically they will have difficulty and lack of motivation to write in a similar form.

Effective note-taking can be helpful in assisting students in dredging through science texts and gain comprehension. This being said, note-taking comes with its difficulties as well. Quintus et al. (2012) discuss many difficulties teachers and students face when taking notes. Note-taking is dependent on working memory (short-term); which causes difficulty as students try to hold onto the information in their working memory long enough to write it down. As

students continuously receive information they are concurrently trying to obtain, represent and understand the information while at the same time attempting to connect the new information to their prior knowledge. This intricate process poses many problems for students. Quintus et al. (2012) goes on to explain how students have to balance listening and writing at the same time. Often times, students get so involved with writing ideas they begin to tune out the teacher and miss a lot of information. As discussed earlier, students often have difficulty creating meaningful notes that are useful at a later date; which has been found to be partially due to lack of instruction in note-taking.

Another issue with taking notes is the speed at which students write. The average speed of handwriting is 0.2-0.3 words per second compared to the speed of speech of 2-3 words per second. Teachers often have to stop and wait for students to catch up in writing. This causes a loss in instruction time and students attention. Many teachers have gone to guided notes in part because of this problem with speed. (Quintus et al., 2012) One other issue that arises with taking notes is handwriting itself. Educators often gripe about the poor quality in penmanship of students. With the technology students have today there is very little need to have legible handwriting because written communication is mostly in typed form.

Another concern for teachers is language. As the world continues to change and the United States becomes more diverse, the language barrier in schools will continue to strengthen. Yore & Treagust (2006) discuss three language barriers students have to overcome; home language, instructional language and science language. Science has a unique language of its own. Words that students use in everyday language could very well have a different meaning in science (Jetton & Lee, 2012). This is difficult enough for English speaking students, when a teacher considers the multiple languages students may have in the classroom; now we have a

difficult situation. Research suggests English learning students learn science in their native language first then transition to English (Webb, 2010). If a student speaks a language other than English it is important for that student to have a solid understanding of one language before transitioning and learning a second language. If they are forced to learn a second language too early they will not have develop either language sufficiently which will weaken their learning (Webb, 2010). This home language barrier can be very difficult for the science teacher to overcome, especially if he/she does not speak the student's native language. Students would be better served if their teacher would allow them to use their native language first to make sense of the information and to write their assignments, then use a program to translate their work into English to be turned in (Webb, 2010).

From students to teachers, both have their own difficulties with writing in science. Teachers' pedagogical skills play an essential role in incorporating writing in the science classroom. Kohnen (2013) discusses how teachers lack successful experience with implementing writing in their science classrooms and/or lack the pedagogical skill to teach science writing. Along the same lines, Pearson et al. (2010) explains how teacher preparation programs often separate literacy and science courses. This isolation of literacy and science often results in teachers developing the misconception of reading and writing are basic skills which students have learned in elementary school (Pearson et al., 2010). New teachers often do not consider the need in teaching reading and writing in their science classes. However, the importance of teaching these skills in high school science is now well known, as students enter high school and are not able to comprehend science texts (Pearson et al., 2010). Some teacher preparation programs do indeed give teacher candidates a literacy toolkit to promote ideas for helping students with literacy. In spite of having the tools in hand, teachers do not know how to

successfully implement these strategies in science to promote deep thinking and analyzing investigations and texts (Pearson et al., 2010).

Scaffolding techniques can be used to help students through a writing assignment, however this is another area in which teachers feel ill prepared (Baker, 2004). Scaffolding and modeling play critical roles in successful implementation of literacy strategies, especially if students are not familiar with them. Modeling by the teacher and effective feedback to the students will enhance students confidence and learning these new strategies (Donohoo, 2010; Yoon, Bennett, Mendez, & Hand, 2010).

One of the greatest concerns about implementing a new strategy in class is the amount of time it will take to plan and to complete the task in class (Baker, 2004). Teachers would be required to change their way of planning and teaching to incorporate strategies like the SWH and interactive notebooks. In the case of the interactive notebooks and Cornell Note-taking, time must be allotted for students to create summaries or connections to the information received during class. When a writing assignment is being planned the teacher needs to be certain to take into account the variety of student abilities; some students will take much more time to complete a stage of writing than others. Saul, Kohnen, Newman & Pearce (2012) mentions a key to planning a writing task is to know the goals of the task. The goal of the task will help plan for the time needed in each phase of the writing (Saul et al., 2012). Of course those students who finish early are always encouraged to help those who could benefit from some peer assistance or can further their work into deeper research (Saul et al., 2012).

Another difficulty teachers are faced with when implementing writing tasks is the overarching state exams at the end of the year (Pearson et al., 2010). Since these assessments are

given in a multiple choice format they are geared towards testing memorization of facts. The majority of science teachers find it a struggle to teach inquiry-activity-based science when this is not how the students are assessed (Pearson et al., 2010); thus resulting in teachers returning to lecture style teaching.

There are several variables that affect teachers bringing writing into the classroom; from the training teachers receive in college to the attitude and abilities of students themselves. Writing in science is not popular. With increased support from teachers students can greatly benefit from writing in science. There are many hurdles teachers need to overcome to be able to help students. Also lingering in the thoughts of teachers is simply the students' physical ability to write and take notes. Some notes could be typed but this will not help students with incorporating hand drawn sketches. For the most part, the strategies above can successfully be implemented into the classroom with great success. As described by some, there are set backs but with guidance teachers make it work and students gain in their knowledge of science. More research is needed to conclude and recommend the ideal classroom environment, instructional context and teaching strategies needed for science achievement (Yore & Treagust, 2006).

Implementation

During a time period when there is great emphasis on hands-on science learning, it is important to remember students need to have their minds-on science as well. Hands-on activities alone are not enough to gain deep understanding of science. Students need to reflect on their learning through various types of writing to gain the most from the learning experience. To enhance science literacy students need to have opportunities in science class to write a variety of genres; narrative, descriptive, explanations, instruction and argumentation (Yore et al., 2003). There are a multitude of opportunities and possibilities throughout the curriculum for students to

be involved with these writing tasks. In practice, scientists write their ideas in forms such as; personal notes, memos, diagrams, graphs and reports (Yore et al., 2004), these ideas can be forwarded to the classroom. It is still in debate of which genres are important for secondary science educators should include in their curriculum (Keys et al., 1999), however it is agreed upon that students need to be exposed to and practice writing different variations. When implementing a writing task, no matter what genre it is, it is critical to students success that teachers clearly define the purpose of the writing task (Yore et al., 2004).

Students need to be comfortable in their classroom and understanding of the teacher's expectations of them, thus creating a comfortable learning environment is a fundamental key to student success. Starting the first day of school a teacher sets the tone for learning in the classroom. When students engage in writing often times they also engage in conversation either with peers or the teacher. The learning environment set by the teacher needs to be of such that students are comfortable to learn in. An effective learning environment may be characterized as; having an encouraging mentor, collaborative peers, engaging activities, control over the learning tasks and time to reflect upon the activity. Ideally, students would exhibit mutual respect, equality, and genuine interest in helping one another achieve their goals. (Yoon et al., 2010) Factors influencing the learning environment which the teacher has some control over are; the ground rules, student-teacher support, and the teacher's maintenance of student dialogue (Yoon et al., 2010).

From a lesson planning stand point, creating a literacy rich learning environment requires two key planning components; intentional selection of literacy strategies and purposeful placement of literacy strategies (Dew & Teague, 2015). Placement of a literacy strategy is important because depending on where it is placed in the lesson will determine the information

the teacher can gain from the strategy. A strategy placed at the beginning of the lesson will give the teacher an indication of what the students currently know, acting as a preassessment. At the end of the lesson a strategy may be used to determine the amount of student understanding of the material. Some strategies used at any time may be chosen to elicit misconceptions of specific ideas being discussed. (Dew & Teague, 2015)

As science reform continues to progress, teachers need to be aware of what their students know from other disciplines. Depending on the school and curriculum some of the above mentioned writing strategies may be a regular practice through elementary and middle school. If this were the case, by the time a high school earth science teacher has these students in class, the students will be familiar with them and the implementation will be seamless. On the other hand, some students may never have heard of these strategies and the teacher will have to scaffold the strategies for successful implementation. A successful scaffolding method for writing and note-taking is modeling (Donohoo, 2010; Saul et al., 2012). When students see what is expected and how to do a task, they will better understand and are better able to mimic what they saw than if they did not have any examples. Another technique for scaffolding writing is to perform "edit-alouds" (Saul et al., 2012). In this technique the teacher will edit a student's writing in front of the class following the prepared rubric. This helps the students to understand the thinking behind the teacher's rubric, how and what the teacher is looking for, and gives examples of errors and strengths in writing. Of course, edit-alouds should be done without any indication of whose work the teacher is editing. For the purpose of this project it will be assumed the teacher has provided ample instruction and scaffolding to introduce students to these techniques of writing and note-taking.

Some suggestions for implementing long writing assignments, like news report articles, are given by Saul et al. (2012). As stated above, with any writing assignment, setting clear and concise goals are key to the success of writing. A tool to help a teacher in supporting students with their progress with a writing task is to keep a log/table of what steps the students are at. Teachers also need to be flexible with time frames. This being said, there does indeed need to be a firm deadline set for the final project or, as we all know, students will simply keep procrastinating. Saul et al. (2012) discuss how students move through the steps of writing at different paces. Some may get stuck on the pre-writing (brainstorming) stage while others may be stuck in the final draft stage. The teacher needs to be flexible in the timing throughout the project to help students create the final product.

One last suggestion Saul et al. (2012) makes is in helping the teacher grow in his/her pedagogical skills, is for a teacher to create a log or notebook of the various writing assignments. This log/notebook should consist of the various writing tasks with detailed descriptions of what has worked well and what did not work well for the task at hand. A teacher's reflection will be of great benefit to strengthening his/her pedagogical skills in implementing writing in their classroom.

In creating lessons with a writing task another key planning feature teachers need to consider is assessment of student writing. For the most part when assessing a piece of writing a teacher is going to revert to a rubric. Students are also encouraged to self-assess their work before submitting it to the teacher. Self-regulated learning can lead to success in school and prepare students to become life-long learners long after school when they do not have a teacher in front of them guiding their learning (Zimmerman, 2002).

There are multiple ways in which the student notebooks can be assessed. From a daily check for completeness to an in-depth assessment for accuracy and content, the possibilities of assessing notes are completely dependent on the goals the teacher has for the notebooks and the students learning. Young (2003) gives an example of a 6 point rubric for a quick completeness check for students' notebooks. Chesbro (2006) gives an example where the notebooks are collected twice a marking period for an extensive check. Assessing notebooks greatly depends on the teaching style of the teacher. In the case of the interactive notebook, the work inside is promoted to be personal to the student; it is important for the success of this strategy and student learning that they are indeed creating a meaningful notebook. Completeness and accuracy of facts recorded are probably the two key components to assessing this type of notebook.

When creating a lesson, there are many considerations a teacher will need to attend to. Setting goals for the lesson is, of course, one of the first steps. What sets the lessons of this project apart from the typical lesson plan is that these lessons set goals specifically for the writing portion of the applicable lesson. In this project there will be a separate line item for the focus of the writing incorporated in the lesson or projext. The specified goals of the writing tasks(s) will keep the teacher and students focused on the task. As stated earlier the goals of the specific writing task will also guide the teacher with time management.

Summary

Science literacy has become a major topic in science education reform. As the students of the United States continue to fall behind other nations of the world, educators are trying to implement curriculums to change these trends. There is an urgency for citizens of this country to be scientifically literate. Advancements in science are occurring every day and citizens are faced

with having to make decisions based on science facts and data presented to them. Reading, writing and comprehending science text is crucial to making informed decisions. By the time students reach their senior year in high school, it is vitally important they have the skills to educate themselves on the social science issues at hand. Being scientifically literate does not mean one knows every fact about each science discipline, rather it means they have the skills needed to look at information, analyze, research and make an educated decision. Learning science in school has taken a shift from textbook and teacher centered to being student centered and activity based learning. Although this activity based learning does not mean teachers should eliminate textbook readings and writing assignments. On the contrary, research has shown that activities without reading and writing are just fun activities and do not promote metacognition or deep learning. Reading and writing tasks have actually been found to enhance the effects of hands-on activities. This review has looked at four strategies for writing in science. Two strategies focus on guiding students with writing to communicate their ideas; RAFT and SWH. The purpose of the other two strategies is to deepen learning of the science content; Cornell note taking and interactive notebooks. All these strategies result in students' learning science to a deeper extent. Research has suggested students will benefit most from exposure to various styles of writing. Writing is important to science as it has shown to increase metacognition, clear up misconceptions, increase conversation among students, and ultimately deepening understanding of science concepts.

Chapter III: Lesson Plans

Overview

The following chapter comprises of several lessons and projects integrating writing in the Earth Science curriculum. A focus of this project has been on using the interactive notebook for teaching science at the high school level (particularly 9th grade Earth Science). Each lesson in this project incorporates the interactive notebook. Several projects have been designed using the writing strategies discussed in the above the literature review which include; RAFT, SWH (science writing heuristic), Interactive notebooks and Cornell notetaking.

Lesson Plan outline

The following pages of this project contain lessons, projects and rubrics for ninth grade Earth Science. The lesson plans are designed for a 50 minute class period, unless otherwise noted. The projects created are thought to take place over the course of a complete unit or just a few days. The projects are not meant to take a entire class to complete; they are intended for students to work on outside of class. The projects can certainly be worked on in class. Writing skills of students will determine the length of time needed. These projects do not specifically state whether they should be completed in groups, with partners or individually; this is at the discretion of the teacher. Small group discussion is always encouraged to promote deeper thinking.

Each lesson and project lists the corresponding learning standards from the Next Generation Sunshine State Standards retrieved from cpalms.org (Florida), the Next Generation State Standards retrieved from nextgenscience.org and Common Core State Standards for Science (CCSS). The Common Core State Standards are listed by reference number in each lesson and project plan. The reader is referred to the end of the lesson sequence for a complete

list of CCSS Literacy Standards with descriptions. Writing standards are denoted by 'WHST' in the referenced number, while reading standards are denoted by 'RST'. On the reference page writing standards appear first as they do in the lesson plans.

Each lesson also contains outlines for notebook entries. These outlines are not intended to be worksheet handouts for students, they are a visual for the teacher to plan and vision what he/she is looking for in a student produced notebook. The right column represents the right side (input) of the notebook and the left column represents the left side (output) of the notebook; which are discussed in more detail in the above literature review. The majority of the lessons in this project begin with brainstorming (brain warm ups). All brainstorming is expected to result in students writing/expressing their thoughts in their notebooks, this is not explicitly stated in the lessons however, it is expected and will be practiced by this teacher. Students are free to use any style which they determine works best to express their thoughts; whether it be pictures, concept maps, words, paragraphs, charts (K-W-L or similar) etc. In some instances a specific format is suggested.

Rubrics have been designed for projects and are included with the corresponding project. The last section of the developed lessons and projects contains rubrics to be used for any or all projects. There are two rubrics designed for the notebooks; one designed for the presentation of the notebook; what does it look like? And the second rubric was designed to be a more in-depth analysis of the writing aspect of the notebook. A short summary of the day's lesson is important for writing to be successful in advancing students' learning and science literacy. A peer review rubric is also included in this section.

The final template included at the end of the lesson sequence is of a vocabulary sheet. Students will be filling out this sheet for new vocabulary words throughout each unit. These sheets were designed for continuous use and reflection; allowing students to interact with the words and make connections to other topics throughout the year.

Unit	Lesson Topic	Time to complete	Writing
Weather	Intro to Weather Unit	(1) 50 min class period	Setting up notebook for the unit, personal reflection
	Project: Weather Briefings and Log	Up to 5 mins at Beginning of each class	Analyze data, notes
	Project: Weather Log Analysis	(1-1 1/2) 50 min class periods for writing report	Formal Lab Report
	Heat Transfer	(1) 50 min class period	Lab notes, summaries, annotated diagrams, reflection of activities
	Heating of the Earth: Solar Radiation	(1) 50 min class period	Notebook, written connection to everyday life, annotated diagrams
	Greenhouse	(1-1 1/2) 50 min class periods	Informative Letter
	Project: Severe Weather Project	(2-3) 50 min class periods plus one period for presentations	Informative project, RAFT, project proposal, final written report
Climate	Project: Daily News Brief	Up to 5 mins at beginning of each class	Summary of news story, Notebook (get the gist)
	Climate Regions	(1) 50 min class period	Interactive Notebook, Cornell note taking, Trading cards (summarizing)
	Climographs	(1) 50 min class period	Using data to support a claim in writing
	Climate Change	(1) 50 min class period	Summarizing, formulate research question
	Project: The Great Climate Debate	Up to (4) 50 min class periods plus one day of debate	SWH template and written report, Classroom debate
Ocean	Intro to oceans; waves	(1) 50 min class period	Annotated Diagrams, notebook entries
	Ocean Chemistry	(1-2) 50 min class periods	Lab work and report
	Surface Currents vs. Deep water Currents	(1) 50 min class period	Cornell notes; news article research proposal

	El Niño (lesson)	(1) 50 min class period	Summary, annotated diagram, research questions
	Project: El Niño	(1) 50 min class period	Infographic, RAFT, summarizing, informative writing
	Project: Ocean News Research; Problems in the Ocean	(3) 50 min class periods	SWH or RAFT, written news article and Poster or PowerPoint presentation

Additional Teaching Materials	
Rubrics	Peer Review of writing assignments
	Notebook Presentation
	Notebook Writing
Vocabulary Sheet	Template of a vocabulary sheet to enhance literacy and connections between units
CCSS	Common Core Literacy Standards with descriptions

Weather Everyday

Weather Unit: Outline		Writing Focus
Lesson Introduction to weather unit	An introduction to the Weather unit. After a brainstorming weather and discussion of what students hope to learn about weather, they will develop a target question(s) for the unit. The introduction to weather forecasts and weather briefings will also be discussed. Students will begin creating weather logs, read about the layers of the atmosphere and create an annotated diagram of the atmosphere.	Notebook, Students will write a reflection of how weather affects their lives and what they hope to learn.
Project:	*Weather Briefings*: A brief weather summary, similar to the weather segments on the news, will be presented by a group of students. This will be done each day at the beginning of class during the weather unit. The briefing should only take about 3 mins, unless the class gets into a discussion.	Analyzing data, notes on weather highlights
Project:	*Weather Log Analysis*: This project will be introduced to the class the first day of the weather unit. Students will be collecting weather data for a couple of weeks. Near the end of the unit they will analyze their data and write a report using their data to support their findings and knowledge about weather phenomenon.	Formal lab report
Lesson: Heat Transfer	A series of three activities complied to demonstrate the transfer of heat; convection, conduction and radiation. Opening with brainstorming of heat and temperature changes, followed by activities. Concluding with summarizing the activities, students should walk out of class with a strong understanding of three ways heat is transferred.	Taking notes during lab, summaries, reflections, annotated diagrams
Lesson: Heat transfer Part II: Solar Radiation	Students will be learning about the heat budget. Drawing diagrams will help students visualize what happens to the sun's energy when it reaches Earth's atmosphere. We will discuss the greenhouse effect and why it is important. At the end of the lesson students will watch and analyze a weather segment from a news broadcast.	Note making during lecture and readings, connections to life, annotated diagrams, Analyze a weathercast
Lesson: Greenhouse Effect	Students will investigate the internal workings of the greenhouse effect. Through research and writing they will gain further understanding of the connection between Earth's systems as well as an understanding that the greenhouse effect is not all about Carbon Dioxide.	informative letter
Project:	*Severe Weather Project:* This project will go along with lessons about severe weather. Students will be conducting an interview with a teacher or staff	Informative, perform an interview, use RAFT outline, written

	member at the school to find out how the school is prepared for weather related emergencies. They will also add a personal touch to how their family is prepared. The time frame of this project is dependent on how much class time is devoted to writing.	proposal to teacher describing their choice in final project, written report

Lesson Plan: Introduction to Weather
Unit: Weather

Grade Level/Course: Earth Science 9th grade
Time Period: 50 min

Summary: This lesson provides an introduction to the Weather unit and projects to be completed. After brainstorming about weather, how it affects our lives and discussion of what students hope to learn about the weather, students will develop a target question(s) for the unit. The introduction to weather forecasts and weather briefings will also be discussed. Students will begin creating weather logs, read about the layers of the atmosphere and create an annotated diagram of the atmosphere.

Writing focus/purpose: The writing in this lesson will be focused on student's notebooks.
Students will write a reflection of how weather affects their lives and what they hope to learn.

Activity:
Organize notebook for Weather Unit
Read and take notes on Layers of the Atmosphere

Material/management and safety issues:
* Weather Logs
* Weather Briefing

Content Objectives:
- At the end of this lesson students will be able to label the layers of the atmosphere
- Students will be able to describe the important features of each layer of the atmosphere

Content Standards:
Next Generation Sunshine State Standards
None specifically, this is an introduction lesson to the unit
Next Generation Science Standards:
Science and Engineering Practice: Asking Questions and Defining Problems
ESS2.D: Weather and Climate
Common Core State Standards for Literacy in Science:
CCSS.ELA-Literacy.WHST.9-10.4
CCSS.ELA-Literacy.WHST.9-10.10

Academic Language Demands: New Vocabulary
Atmosphere
Troposphere
Stratosphere
Ozone layer
Mesosphere

Guiding Questions:

What is the structure of the atmosphere?
What is weather?
What creates weather?
How does heat transfer from the sun to Earth?

Time	Learning Activities:	**Writing: Notebook Entries** Left side (L) Right Side (R)
5 mins	- Opening Thoughts: What is Weather? While students settle in they will begin thinking about what is weather	(L) Brainstorm ideas
3 mins	Class Discussion/brainstorm: What is Weather?	(L) Notes, Record ideas
1 min	What questions do you have that you would like to answer during this unit about weather?	Add to Questions page at beginning of unit
10 min	Handout Weather Log - discuss activity - fil in the first rows for current conditions	Weather log
15 min	Read text book - chapter 15 section 1 The air around you - chapter 15 section 4 Layers of the Atmosphere Using Cornell Note-taking records notes in your notebook	(R) Create an illustrated diagram of the atmosphere
End of day thought	What happens to the energy from the Sun when it encounters the Earth's atmosphere? (access prior knowledge)	(L) Brainstorm
Remainder of time	Begin vocabulary note sheets	Vocab book

Resources:

Exline, J. D., & Prentice-Hall, I. (2001). *Earth science*. Needham, Mass.: Prentice Hall.
Marcarelli, K. (2010). *Teaching science with interactive notebooks*. Corwin Press.

Student Project: Weather Briefing and Analysis
Unit: Weather

Grade Level/Course: Earth Science 9th grade
Time Period: up to 5 mins at beginning of class, (1 -1/2 class periods) for analysis and writing

Summary: A brief weather summary, similar to the weather segments on the news, will be presented by a group of students. This will be done each day at the beginning of class during the weather unit. The previous day's weather, current weather and forecast will be presented. The briefing should only take about 3 mins, unless the class gets into a discussion. Students are responsible for filling out their weather log with the proper data presented in the briefing.

Writing focus/purpose: There is not a specific writing focus for this activity. This activity was designed to enhance other science literacy skills; speaking, analyzing data, explaining patterns, answer questions.

Material/management:

* computer with projection and internet connection

Objectives:

- At the end of this lesson students will be able to recognize and describe the various symbols on a weather map
- Discuss how the features on a weather map will affect the weather for various areas
- predict future weather conditions based on trends seen in weather observations
- describe the limitations and uncertainties of weather predictions

Standards:

Next Generation Sunshine State Standards:

SC.912.E.7.5 Predict future weather conditions based on present observations and conceptual models and recognize limitations and uncertainties of such predictions.

Next Generation Science Standards:

ESS2.D: Weather and Climate

Common Core State Standards for Literacy in Science:

Reading: CCSS.ELA-Literacy.RST.9-10.4
CCSS.ELA-Literacy.RST.9-10.7

Speaking and Listening Anchor #2: Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

Speaking and Listening Anchor #5: Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

Academic Language Demands: students are encouraged to accurately use vocabulary terms relevant to the weather unit.

Guiding Questions: What was yesterday's weather? (Hi & Lo temps, precipitation, any storms?)
What is today's weather pattern map?
What is the forecast for tomorrow or the weekend?

Time	Learning Activities:	Students Writing: Notebook Entries
Up to 5 minutes	Create groups of 3 students - one group will be assigned the weather briefing each day	Students choose (or teacher assigns) one of 3 jobs 1. Past: previous day's weather (high, low, precip) 2. Present: Today's weather map 3. Future: Forecast for tomorrow
	Student of Weather Past: will inform the class of the High, Low temperatures and amount of precipitation (liquid equivalent if in NY winter) of the <u>previous day</u> *Student of Weather Present:* Will describe the current weather pattern on the weather map and provide students with current weather observations to be written on the weather log *Student of Weather Future*: Will inform the class of the next day's forecast, weekend and/or tropical weather	Class will record the data presented in their notebooks' weather log
	Grading: 3 points for participation towards Weather log final grade	

For the Student: tape into notebook for reference

Student of Weather Past: Informs the class of the High, Low temperatures and amount of precipitation (liquid equivalent if in NY winter) of the previous day

Student of Weather Present: Describes the current weather pattern seen on the weather map and provide students with current weather observations, to be written on their weather log

Student of Weather Future: Informs the class of the next day's forecast, weekend and/or tropical weather

Student Project: Weather Log Analysis
Unit: Weather

Grade Level/Course: Earth Science 9th grade
Time Period: (1 -1/2) 50 min class periods for analysis and writing

Introduction: There are several variables used to describe the weather. These variables include; temperature, dew point, relative humidity, pressure, wind, sky condition and precipitation. Changes in these weather variables are used by meteorologists to produce weather forecasts. In this lab students will graph the variables collected during weather briefings. Students will analyze the graphs and explain trends seen between weather variables. The trends seen in variables will then be correlated to changes to weather conditions.

Objective:
Explain the trends seen in weather variables and how these trends relate to the weather experienced day to day. Make a forecast for the next day based on the trends seen in the previous few days' weather.

Materials: Completed weather logs
Student handout describing writing task
Computers with excel and word

Standards:
Next Generation Sunshine State Standards (NGSSS): retrieved from CPalms.org
- SC.912.E.7.5 Predict future weather conditions based on present observations and conceptual models and recognize limitations and uncertainties of such predictions.

Next Generation Science Standards:
Science and Engineering Practice: Analyzing and Interpreting Data
Once collected, data must be presented in a form that can reveal any patterns and relationships and that allows results to be communicated to others. Because raw data as such have little meaning, a major practice of scientists is to organize and interpret data through tabulating, graphing, or statistical analysis. Such analysis can bring out the meaning of data—and their relevance—so that they may be used as evidence. Obtained from
Common Core State Standards for Literacy

CCSS.ELA-Literacy.WHST.9-10.2
CCSS.ELA-Literacy.WHST.9-10.3
CCSS.ELA-Literacy.WHST.9-10.4
CCSS.ELA-Literacy.WHST.9-10.7

CCR Speaking and Listening #2: Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

Weather Log Analysis

(To the Student)

Introduction: There are several variables used to describe the weather. These variables include; temperature, dew point, relative humidity, pressure, wind, sky condition and precipitation. Changes in the weather variables are used by meteorologists to produce weather forecasts. In this lab you will graph the variables you collected in your weather log. You will then analyze the graphs and explain the trends you see in the variables and correlate these trends to each other as weather as the changing weather conditions.

Objective:
Explain the trends seen in weather variables and how they relate to the weather we experience day to day. Make a forecast for the next day based on the trends seen in the previous few days.

Procedure:
1) Work with a partner
2) Enter data into excel
    - Data columns to include
        - temperature (Fahrenheit)
        - dew point (Fahrenheit)
        - pressure (millibars)

3) Create a meteogram with the following:
    - temperature
    - dewpoint
    - pressure
    - wind direction (will have to manually add)
4) Print meteogram → one for each person

5) on your graphs mark times of high and low pressure
    - pressure max = H
    - pressure min = L

6) Can you find any fronts which have passed through the area? What conditions did you use to find frontal passages?

7) On your meteogram draw the symbols for each front that passed through the area

8) Write a formal lab report (individually turned in). Include the following information:
    - Introduction and purpose
    - Procedures: What did you do? Be sure to include any problems you had collecting the data
    - Results: what does your data show? Are there any correlations between variables?
        Do you see trends between variables and the weather observed?
    - Conclusion
    - Personal Reflection

Weather Log

Name:

DATE	High Temperature	Low temperature	Precip Amount	CURRENT Pressure	CURRENT Wind Direction	CURRENT Wind Speed	CURRENT Sky Condition

Use this rubric to assess the written report of the Weather Analysis project

Category	5	4	3	2	1	0
Data collection	Neat, accurate, dated, no data missing	Neat, accurate, dated, missing 1 or 2 entries	Neat, accurate, dated, missing 3 or more entries	Illegible, entries made are accurate, missing 3 or more	Illegible, entries are mixed up or inaccurate, missing more than 50% of data	No effort, illegible and very few entries
Introduction	Introduces the project and purpose in detail	Introduces the project and purpose but could have more detail	Introduces the project but does not discuss the purpose	Inaccurately introduces the project and purpose	Introduction and purpose are not accurate	No introduction and purpose
Procedures	Presents all steps followed including the units used for the data	Presents all steps in the data collection, does not have as much detail	Presents most of the steps with no details	Has some steps or are inaccurate	Missing several steps	Does not include procedures
Graphs	Includes all required graphs and marks the graphs with the required symbols	Includes all the required graphs and includes most of the symbols	Includes most of the graphs but missing some symbols	Missing some graph and symbols	Missing several symbols and graphs	No graphs are included
Results	Accurately discusses the graphs and relates the trends in variables to each other and the weather	Accurately discusses the graphs and some of the trends/correlations between variables	Discusses the graphs with some inaccuracies. Does not discuss correlations between variables	Does not discuss the graphs accurately, nor mentions the trends/correlations between variables	Needs a lot of improvement discussing the graphs	Missing section
Accuracy	All symbols are accurate	Most of the symbols are placed accurately	Some symbols are inaccurate	Several symbols are inaccurate	Majority of symbols are inaccurate	Missing all symbols
Summary	Accurately summarizes the project with all of the main ideas	Accurately summarizes the project with most of the main ideas	Summarizes the project but misses some ideas	Short summary misses main ideas	Needs improvement.	Missing summary or is irrelevant
Reflection	Describes skills and knowledge the student has learned, very thoughtful and personalized with examples	Describes skills and knowledge the student has learned, gives an example	Discusses some ideas that the student have learned, no examples given	Does not reflect on the learning of the student, no examples given, gives a short assessment on their work	Does not reflect on ones learning or assess their work	Missing personal reflection

Lesson Plan: Heating the Earth (part 1)
Unit: Weather

Grade Level/Course: Earth Science 9th grade
Time Period: (1 – 1 ½) 50 min class period

Summary: Students will complete three activities to demonstrate the ways heat is transferred; convection, conduction and radiation. Understanding how heat can be transferred will provide students background knowledge for understanding the heat budget, weather formation and global climate circulations. The students will begin this lesson with brainstorming about heat and temperature changes. After the activities the students will have an understanding of the difference between the three processes of heat transfer.

Writing focus/purpose: Writing for this lesson is focusing on taking notes in notebooks during lab experiments/demonstrations, writing results and observations of the three types of heat transfer. Students are expected to carry out the investigations in their notebooks and respond to them through summaries and reflections as well as making connections to previous units. An example; convection in atmosphere is similar to the convection cells studied during the unit, "Structure of the Earth." At the end of the lesson, students are expected to write a comparison discussing how heat is transferred through convection, conduction and radiation and how the demonstrations showed these.

Activity:

- Don't Melt my Chocolate
- Convection Chimney
- Ouch, how did that get so hot?

Preparation:

- set up lamps, place chocolate in shade, sun and under two lamps with thermometers next to chocolate at each set up
- set up convection chimneys
- set up conduction station
- print handouts (directions for each station) for each student

Safety Issues:

- Heat gloves for handling hot pot
- Caution to be used around light bulbs (if used)

Objectives:

At the end of this lesson students will be able to:

- list three ways heat is transferred
- differentiate between the three ways heat is transferred by describing how heat is transferred, in each process, resulting in a temperature change
- differentiate between conduction and convection in terms of how Earth's systems are heated
- label a diagram with the proper examples of heat transfer
- relate temperature to molecular activity

Content Standards:

Next Generation Sunshine State Standards:

SC.912.P.10.4: Describe heat as the energy transferred by convection, conduction, and radiation, and explain the connection of heat to change in temperature or states of matter.

Next Generation Science Standards:

Core Ideas:

ESS2.D: Weather and Climate: The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-2)(HS-ESS2-4)

Cross Cutting Concepts:

- Energy and matter: the total amount of energy and matter in closed systems is conserved.
- Energy drives the cycling of matter within and between systems

Science and Engineering Practice: Constructing Explanations and Designing Solutions: Asking students to demonstrate their own understanding of the implications of a scientific idea by developing their own explanations of phenomena, whether based on observations they have made or models they have developed

Common Core State Standards for Literacy in Science

CCSS.ELA-Literacy.WHST.9-10.4
CCSS.ELA-Literacy.WHST.9-10.10

CCSS.ELA-Literacy.RST.9-10.3:

Academic Language Demands: New Vocabulary

Conduction Insolation
Convection Insulation
Radiation

Guiding Questions:

How do objects heat up?
Where is the heat coming from?
How is radiation different from convection? How is convection different from conduction? How is radiation different from conduction?

Time	Learning Activities:	Writing: Notebook Entries
3 mins	Take notebooks out: warm up- Teacher will do a notebook check	(L) Answer the following: What layer of the atmosphere does weather occur? Where is the ozone layer? Why is Ozone

		important?
2 mins	With your side partner quietly discuss the following question: in what ways have you experience/felt heat?	(L) In what ways have you experienced/felt "heat"
	Look out the window: How does the sun heat Earth?	(L) how does the sun heat Earth?
30 mins	Heat Transfer Activities - group students into teams of 3-4 - each group gets "don't melt my chocolate" activity - set up two sets each of convection and conduction: Rotate groups through these stations	Record: (R) Station Set up, Observations, collect data, draw and annotate diagrams
Between Temperature readings	- Students will be drawing diagrams and annotating the processes being observed. - Read textbook Chapter 16 Weather Factors, Section 1- Energy in the Atmosphere Section 2 Heat Transfer Take notes in your notebook using Cornell notes	(R) - draw and annotate diagrams (R) - Cornell note taking
Remainder of time	Big group discussion of what students observed	(L) Add the type of heat transfer to the ways you feel heat…discussed in warm up (L) Write a reflection about the activities…how can you relate to the three heat transfers? How do you think this relates to heating the earth by the sun?
	Students will submit a written report of these activities	Turn in to teacher Separate paper: Write a detailed summary discussing the three ways heat is transferred, how are they different?

Textbook:

Exline, J. D., & Prentice-Hall, I. (2001). *Earth science*. Needham, Mass.: Prentice Hall.

(Outline of Notebook Entries)

What I know happens to energy from the Sun:

What I learned about the Sun's energy from reading

Text book Chapter 16 Weather Factors, section 1 & 2

Key ideas/ questions	Notes

Questions I have about this activity:

Response to this activity: may be typed and taped in on the last page of this activity

How might you solve the problem of melting chocolate in the sun? Can you prevent chocolate from melting?

If you were to design a container to attempt to prevent your chocolate from melting what might it be like? Describe your container and why you would design it the way you choose

Heat Transfer: Radiation, Convection, Conduction

Radiation: "Don't Melt My Chocolate"

(drawing of set up with detailed descriptions and collected data)

(continue with summary/reflection)

Convection: Convection Chimney

(drawing of set up with detailed descriptions and collected data)

Conduction: Hot handle

(drawing of set up with detailed descriptions and collected data)

Ouch, How did that get so hot?

Conduction is the process by which heat energy is transferred through collisions between adjacent molecules.

An example: an electric stove or burner, as in this demonstration. Does the stove/burner heat the pan when you hold it above the heating element? No, it might slightly but your arm would get tired from holding it before the temperature of the pan increases. An electric stove/burner heats a pan by conduction. Have you ever left a spoon in a pan or touched the handle of a pan after it has been on the stove for a time period? How does the spoon or handle feel when you touch it? Let's see…..

What you need to do:

1) Draw and describe the demonstration in your notebook.
2) CAUTION: The pan on the burner should already be **hot** so be careful. Take a spoon and set it in the pan
3) Wait 3 mins and then gently touch the spoon…DO NOT grab it with your entire hand
4) Record your observations
5) What other examples of conduction can you think of?

Don't Melt My Chocolate (Place at the station)

During this activity you will observe the effects the sun has on chocolate. While gathering data think about; *What is happening to the chocolate? Why does it melt?*

Procedure and Expectations:

* In your notebook, draw the four different stations with details of the set ups.

* Create a table with each drawing to record your data and observations

> **!!! Do not move any part of the sets, only touch the chocolate through the bag, do not open it**
>
> **!!!!! CAUTION: Light bulbs are 100 watts (record this value) they will get very hot. Make wise choices with your movements…do not touch!!!!!**

* Record conditions every 5 mins

* At the end of the experiment write a summary and conclusion in your notebook or on the computer and then attach to the last page of the activity in your notebook. As you write your conclusion be sure to reference your data.

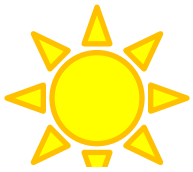
* Extra data to collect: calculate rates of heating, find the elevation of the sun given the date and time to enhance your claims, measure the distance and angel of the lamps to the chocolate.

* What is happening to energy/heat during these activities?

* If I asked you to design a container to prevent my chocolate from melting would this be possible? If not, why? If yes then describe the container you would create?

* write a reflection of this activity in your notebook

Ex:



Sunlight

Chocolate

Time	Temp	Condition of Chocolate
0 mins	28°C	Solid, firm

CONVECTION CHIMNEY

Introduction: This activity will show you how convection currents occur in the air. Convection plays a large role in the development of weather and is a large contributor to heat transfer across the globe. It is important to understand how this circulation develops and transfers heat. Convection acts at all scales from the small scale (the size of a room or in this activity a box) to large scale (global).

Procedure:

1) Tape or draw the diagram given into your notebook.
2) Hold the burning end of an incense stick over the opened plain chimney (not above the water chimney)
3) Then describe what you see happening in the demonstration
4) Try different variations: be sure to write what you do in your notebook along with the results: some possibilities to try;
    a. hold the burning stick over the other chimney
        i. Describe what happens
    b. Remove the water then hold over incense over a chimney
        i. Describe what happens
5) Write or type (and tape) a summary in your notebook

!! **Note**: if the water has cooled inform your teacher to warm it up

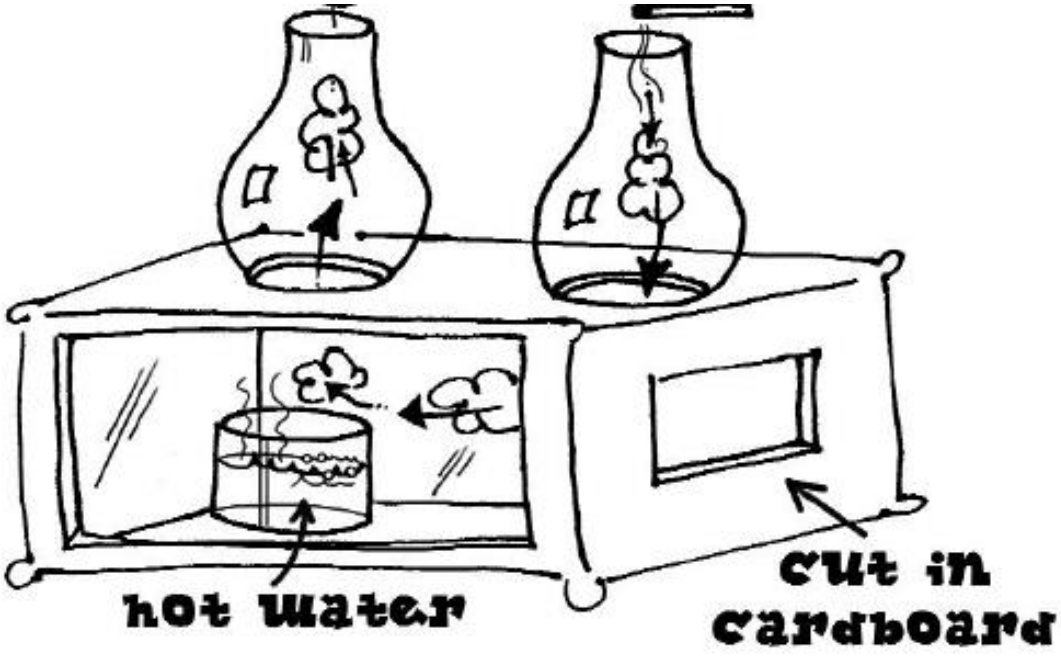


Diagram retrieved from: http://sciencediscovery.colorado.edu/wp-content/uploads/2012/02/Convection-Connection.pdf

Lesson Plan: Heating the Earth (part 2)
Solar Radiation
Unit: Weather

Grade Level/Course: Earth Science 9th grade
Time Period: 50 min

Summary: During this lesson students will be learning about the heat budget. Drawing diagrams will help students visualize what is happening with the sun's energy when it reaches the atmosphere. We will discuss the greenhouse effect and why it is important. At the end of the lesson students will watch and analyze a weather segment from a news broadcast.

Writing focus: Writing during this lesson is focused on the notebook with taking notes during reading and lecture. There are many opportunities for students to make connections to previous lessons and life. Students will be creating diagrams of the heat budget which are expected to be developed as an informative tool; containing descriptions and definitions if needed.

Activity:

Read textbook, note taking
Watch weather segment on news: analyzing what is in a weather forecast? what do the broadcasters show and discuss during the weather segment?

Material

- blank computer paper
- crayons or colored pencils
- straight edges

Safety issues: points on pencils

Objectives:

- At the end of this lesson students will be able to
    - Distinguish between insolation and insulation
    - Describe and draw the heat budget
    - Explain how the sun's energy transfers heat and heats up the troposphere
    - Create an illustration of the Sun's energy entering the atmosphere

Content Standards:

Next Generation Sunshine State Standards:

SC.912.P.10.4: Describe heat as the energy transferred by convection, conduction, and radiation, and explain the connection of heat to change in temperature or states of matter.

Next Generation Science Standards:

Core Ideas:

ESS2.D: Weather and Climate: The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-2)(HS-ESS2-4)

Cross Cutting Concepts:
- Energy and matter: the total amount of energy and matter in closed systems is conserved.
- Energy drives the cycling of matter within and between systems

Common Core State Standards for Literacy in Science:
CCSS.ELA-Literacy.WHST.9-10.10
CCSS.ELA-Literacy.RST.9-10.2:
CCSS.ELA-Literacy.RST.9-10.4
CCSS.ELA-Literacy.RST.9-10.5
CCSS.ELA-Literacy.RST.9-10.7

Academic Language Demands: New Vocabulary

Absorption	Heat Budget
Insolation	Reflection
Insulation	Albedo

Guiding Questions: Main ideas for lesson
What happens to the energy coming from the sun when it reaches the atmosphere?
What is the greenhouse effect? Why is it important?
Has the atmosphere always been the way it is today?
How and why has it changed? Will it continue to change?

Time	Learning Activities:	Writing: Notebook Entries Left Side (L) Right Side (R)
Warm up	Label the Diagram (at front desk) with the appropriate types of heat transfer	Label diagram
3 mins	Weather Briefing	Record info in weather log
Brainstorm	What happens to the Sun's energy when it reaches the Earth's atmosphere? - students may talk with elbow partner - if students read text book in previous lesson they will have a good idea	(L) Brainstorm
Finish from previous day	If students did not have time to read the sections in the textbook during the previous lesson then start the lesson with reading, note taking and small discussions	(R) Record notes and prepare for discussion
	Begin whole class discussion about the heat budget and what happens to Sun's radiation Differentiate between insulation and insolation How is the troposphere heated? During the melting chocolate activity you recorded the	(R) Take notes Draw diagrams on computer paper to turn in and later be taped in notebook (R) Give examples

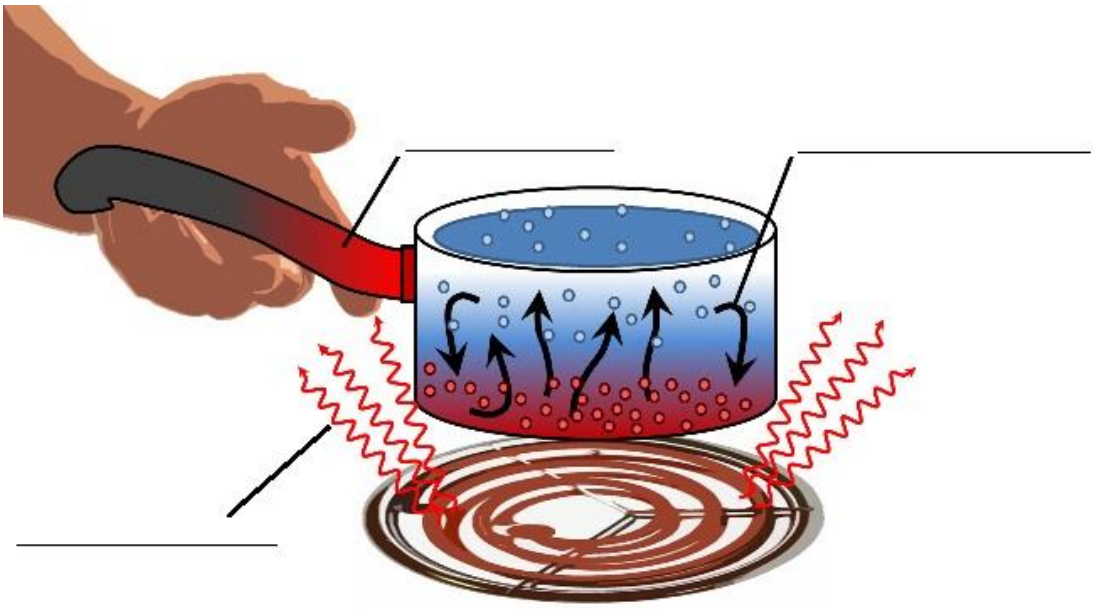
	time of day and the date. Do you think the results would have been different if the day and time were different? If so how would it be different and why?	(R) Discuss questions in small groups: write questions and solutions in notebooks
Guiding questions for the lesson	What are the three forms of radiation that reaches Earth from the Sun? (visible light, infrared radiation and UV radiation) What can happen to the energy when it reaches the atmosphere? (it can be reflected or absorbed by the atmosphere…question taken from textbook) What role do clouds play in the heating of the earth? Discuss the Greenhouse Effect (detailed in a future lesson) How would the temperature be different if there was not a greenhouse effect? (from textbook) Does water and land heat at the same rate? Should all surfaces be treated equally when it comes to heating?	(R) Take notes Add details to drawing of heat budget throughout the lesson
Vocab card	Work on Vocabulary Sheets	
End of lesson Question	If one part of the heat budget was altered, would it cause a problem? If so what would happen? Be sure to state what part of the heat budget you are thinking about (i.e. increase in clouds, or increase in CO_2)	Students write a prediction discussing what would happen if a change were to occur in the heat budget. They may discuss ideas with a partner
Remaining time: lead into next lessons	Practice vocabulary encountered so far Watch a weather broadcast - What features does the weather person talk about? - What variables are in the forecast? - What does the broadcaster show to support his forecast?	Take notes about what the forecaster discusses during his/her weather segment on the news.

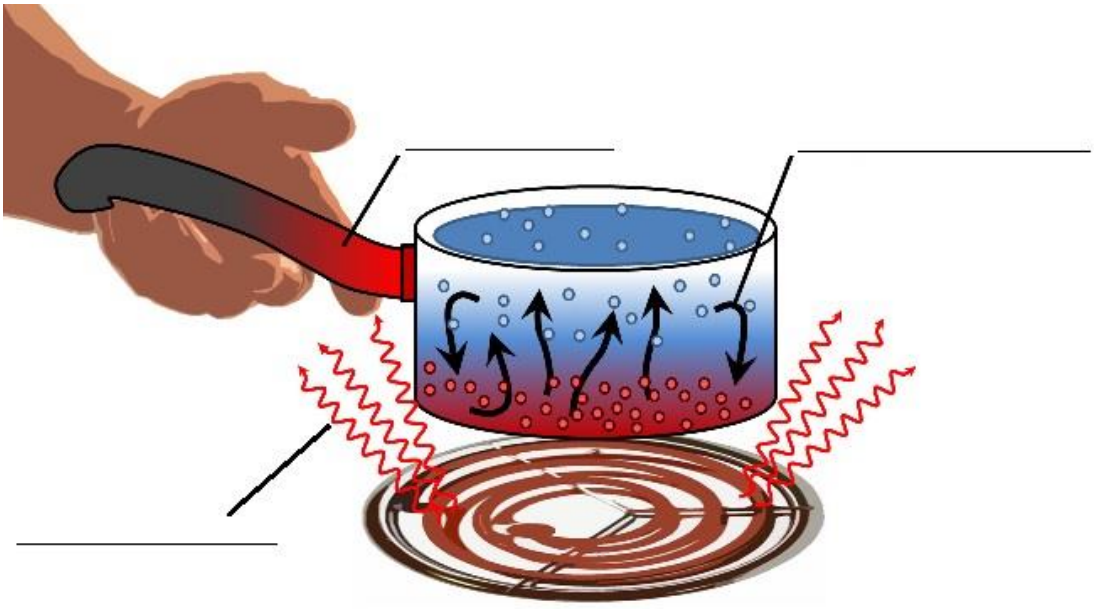
Textbook:

Exline, J. D., & Prentice-Hall, I. (2001). *Earth science*. Needham, Mass.: Prentice Hall.

Diagrams retrieved from google images, source site is

https://shroudofturinwithoutallthehype.files.wordpress.com/2013/11/conduction-convection-radiation.jpg





(Outline of Notebook Entry)

Brainstorm:

What happens to Sun's energy when it reaches the atmosphere?

Examples of Radiation, Conduction and Convection that I have encountered

In my own words (summary of today's lesson):

Thinking question: if one part of the heat budget was altered, would it cause a problem? If so what would happen? Be sure to state what part of the heat budget you are thinking about (i.e. increase in clouds, or increase in CO_2)

(Annotated Diagram of Heat Budget)

Lesson Plan: Greenhouse Effect under Investigation
Unit: Weather

Grade Level/Course: Earth Science 9th grade
Time Period: (1 – 1 ½) 50 min classes

Summary: The greenhouse effect is important to Earth because it is this process that helps keep Earth warm. However, it seems lately this process is out of control and is heating Earth at an alarming rate. During this lesson students will investigate the internal workings of the greenhouse effect. Through research and writing they will gain further understanding of the connection between Earth's systems as well as an understanding that the greenhouse effect is not all about Carbon Dioxide which appears to be the most popular greenhouse gas in the media. Once the students find the sources of various greenhouse gases they can deepen their knowledge with developing plans/ideas of how to reduce, if possible, the emissions of the various gases.

Writing focus/purpose: Write an informative letter to your parents/guardians or person of choice (with teacher approval) discussing the greenhouse effect. Students will choose a source of these gases which the person they are writing to contributes to daily (via car or farming etc.). In this letter students will describe the greenhouse effect, the gases involved, sources of the gases and how the person may be able to lessen the amount of gases emitted by this particular source. Students are encouraged to peer review each other's letter and editing/revising before submitting to the teacher.

Activity:

* Research focused on students learning about the different gases involved in the greenhouse effect, the sources of these gases and what this all means for climate change.
* Students will be researching online for information
* Read Text book Chapter 18 section 4: pages 623-626 Greenhouse effect

Material/management and safety issues:

* Internet connection
* Computers/tablets for each student

Objectives:

- At the end of this lesson students will be able to
  - List all of the major greenhouse gases
  - Describe in writing the importance of each greenhouse gas
  - Develop a plan to personally reduce greenhouse emissions
  - Write a letter describing the greenhouse effect
  - Identify sources of each greenhouse gas
  - Develop a detailed diagram of the greenhouse effect including the many sources of these gases

Standards:

Next Generation Sunshine State Standards:

SC.912.E.7.7 Identify, analyze, and relate the internal (Earth system) and external (astronomical) conditions that contribute to global climate change

Next Generation Science Standards:

ESS2.A: Earth materials and Systems

ESS.2D: Weather and Climate
Connections to Science and Engineering Practices:
Developing and using models
Cross Cutting Concepts: Stability and Change

Common Core State Standards for Literacy:

CCSS.ELA-Literacy.WHST.9-10.2
CCSS.ELA-Literacy.WHST.9-10.3
CCSS.ELA-Literacy.WHST.9-10.4
CCSS.ELA-Literacy.WHST.9-10.5
CCSS.ELA-Literacy.WHST.9-10.7
CCSS.ELA-Literacy.WHST.9-10.8
CCSS.ELA-Literacy.WHST.9-10.10
CCSS.ELA-Literacy.RST.9-10.1
CCSS.ELA-Literacy.RST.9-10.2
CCSS.ELA-Literacy.RST.9-10.4
CCSS.ELA-Literacy.RST.9-10.6
CCSS.ELA-Literacy.RST.9-10.7

Academic Language Demands:

Greenhouse Effect reflection
Absorption longwave radiation shortwave radiation

Time	Learning Activities:	Writing: Notebook Entries
Brainstorm	Tap prior knowledge: What do I know about Greenhouse Effect? How do I know it? (what are my sources)	(L) Brainstorm in your notebook; create a KWL chart about the greenhouse effect
Class time	Team up with a partner and research the greenhouse effect; discovering the various greenhouse gases Read Text Book 623-626 take notes Greenhouse Effect	(R) Research and take notes on the greenhouse effect and the gasses involved
	What are the sources of the particular gases?	(R) Encouraged to create a chart including greenhouse gasses and their sources
	Annotated diagram	(R) Create a diagram of the greenhouse effect and how it works in the atmosphere
	Write a letter to your parents/guardian or person of choice (teacher approved). In this letter describe the Greenhouse effect, what gasses are involved and the sources of the gasses. Make suggestions to this individual how they can help reduce the amount of these gases (or particular gas specified) being emitted	(L) Write a letter. Have a peer edit it before turning it in

Textbook:

Exline, J. D., & Prentice-Hall, I. (2001). *Earth science*. Needham, Mass.: Prentice Hall.

Student Project: Severe Weather Preparedness
Unit: Weather

Grade Level/Course: Earth Science 9th grade
Time Period: (2-3) 50 min class periods

Summary: This project is designed to have students understand the potential hazards of severe storms, gain knowledge with severe weather warnings and advisory terminology. Students will learn the dangers associated with certain weather phenomenon. They will discover what actions they should take and how they can help other children at the school or home get to safety and prepare for severe weather. Schools spend time preparing students for a potential fire through several fire drills throughout the year. Some schools in the Midwest prepare students for potential tornadoes or earthquakes. This activity will prepare students for several types of severe weather; flash floods, thunderstorms, tornadoes, and hurricanes. Not only will students learn about the potential threats of these storms they will also learn about their school's procedures for these storms. Students will interview a teacher or other school staff to learn the school's procedures. They will also research how to prepare for and react to severe weather at home. Students will choose how to present this information to their intended audience.

Writing focus/purpose*:*

Writing during this project is intended to be a form of communicating information about severe weather to an audience of classmates and/or other grade levels. Students will be interviewing teachers and/or the principal to gather information. During the interview students will take on the role of a science journalist. Students will learn how to write notes during an interview and what questions they should ask to get information they need. Students will be using the RAFT outline to help guide their writing and project. They can choose from a variety of forms for delivery of their information they gather. However, students will turn in a written proposal explaining what they would like to do and the approach they plan to take. They need to have a plan and it needs to be approved by the teacher. Final reports will be posted to the class webpage.

Objectives: At the end of the project students will be able to:

- Differentiate between watches, warnings, and advisories of severe weather
- Describe severe weather storms and their individual threats
- Decide on a plan of action when severe weather is headed for the school or home
- Identify the economic impacts a severe storm could have
- Present their project

Standards:

Next Generation Sunshine State Standards:

SC.912.E.7.6: Relate the formation of severe weather to the various physical factors

Next Generation Science Standards:

HS.ESS2.D: Weather and Climate

Science and Engineering Practice: Constructing Explanations and Designing Solutions; Asking students to demonstrate their own understanding of the implications of a scientific idea by developing their own explanations of phenomena, whether based on observations they have made or models they have developed, engages them in an essential part of the process by which conceptual change can occur.

Common Core State Standards for Literacy in Science:

CCSS.ELA-Literacy.WHST.9-10.2
CCSS.ELA-Literacy.WHST.9-10.3
CCSS.ELA-Literacy.WHST.9-10.4
CCSS.ELA-Literacy.WHST.9-10.5
CCSS.ELA-Literacy.WHST.9-10.6
CCSS.ELA-Literacy.WHST.9-10.7
CCSS.ELA-Literacy.WHST.9-10.8
CCSS.ELA-Literacy.WHST.9-10.9
CCSS.ELA-Literacy.WHST.9-10.10

CCSS.ELA-Literacy.RST.9-10.1
CCSS.ELA-Literacy.RST.9-10.2
CCSS.ELA-Literacy.RST.9-10.4
CCSS.ELA-Literacy.RST.9-10.5
CCSS.ELA-Literacy.RST.9-10.7

CCSS Speaking and Listening Anchor #4: Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

Stage 1	Handout and discuss project Decide on type of final project and type of storm
Stage 2	Write up a proposal to teacher describing the approach you are going to take for this project. Use RAFT to help organize your project
Stage 3	Proceed with development of project
Stage 4	Revise and Edit
Stage 5	Turn in project
Stage 6	Presentations in class
NOTE:	Time will be set aside in class to assist students with their project. Most of time spent on this project will have to be outside of class

Rubrics needed:

1) Self-assessment of progress
2) Writing Rubric (can also be used by peers)
3) Project Rubric (depending on the project chosen)
4) Self-assessment Reflection (complete at the end of the written report)

Project Details Severe Weather Project

(teacher plans)

Students may work alone or with 1 partner

Students will:

- Choose a grade level as their audience
  - Elementary, middle or high school

- Design an informative project discussing severe storms development and their threats to humans.
  - Choices of project may include but limited to:
    - Brochure
    - Placemat or table cover
    - Presentation/PowerPoint
    - Booklet or coloring book for little kids
    - Story
    - Video
    - Other ideas: seek teacher approval

- Choose one type of storm to go into detail (approved by teacher)
    - Describe the formation of the storm
    - What are the threats of the storm
    - Discuss the environmental conditions which will 'kill' the development of the storm
    - Describe the environmental conditions which will continue storm development
    - Highlight economic concerns of the storm
      - Example: floods will drown cattle causing a blow to the beef industry…, In 1980 a flood caused $XXXXX of destruction…
- Interview School personal
  - What are the school's procedures if a _____ warning were issued for the area?
  - How is the school prepared for a _____? (Food? Supplies?)
  - What should the teachers do? What should students do if in school?
  - Questions you may have for the school

- What would you do at home? Do you have a plan at home for certain storms?
- Write a proposal to your teacher including the type of storm you want to research and the type of project you want to create
- Present your project to the class
- Present your project to a class in the grade level you chose (optional, extra points)
- Turn in a written report about your project

Student Project Due Date:_____

It's Coming!!!

(student handout)

Your mission: You are the severe weather expert from our science classroom. Your mission is to create a project that will inform students about how to prepare and react to severe weather while at school or at home. To accomplish this task you will need to focus on a particular grade level, choose a storm, research the storm, use your knowledge of science, and interview a staff member at the school. Here are the details;

- Choose a target grade level for your audience
  - Elementary, middle or high school

- Design an informative project discussing severe storm development and their threats to humans.
  - Choices of project may include but limited to:
    - Brochure
    - Placemat or table cover
    - Presentation/PowerPoint
    - Booklet or coloring book for little kids
    - Story
    - Video
    - Other ideas see teacher approval
- Choose one type of storm to go into detail (approved by teacher)
    - Describe the formation of the storm
    - What are the threats of the storm
    - Discuss the environmental conditions which will 'kill' the development of the storm
    - Describe the environmental conditions which will continue storm development
    - Highlight economic concerns of storm
      - Example: floods will drown cattle causing a blow to the beef industry, In 1980 a flood caused $XXXXX of destruction
- Interview School personnel
  - What are the school's procedures if a _____ warning were issued for the area?
  - How is the school prepared for a _____? (Food? Supplies?)
  - What should the teachers do?
  - Questions you may have for the school
- Write a proposal to your teacher including the type of storm you want to research and the type of project you want to create
- Present your project to the class
- Present your project to a class in the grade level you chose (optional, extra points)
- Turn in a written report about your project

Written Report about Storm Readiness

Your written report should include:

- Introduction to your type of storm
- Description of the storm's development
- Discuss the dangers of the type of storm
- Interview school personnel
- What plans do you have at home for these dangers? Interview your parents/guardians
- If you do not have any plans this is a great time to develop them
- Summary of your project: what did you create?
- Reflection of what you learned and how you think you did (self-assessment)

**** Write a draft, have a classmate edit and assess for you before turning in.

** Reminder: rewrites are always possible after receiving a grade

Use a RAFT outline to help you stay organized.

ROLE: 1.) As the writer I am …. (a scientist, science journalist, news reporter etc.) 2.) My task is…. 	
AUDIENCE: Who am I writing to? 	
FORMAT: 1.) What form is the writing? (Journal, letter to editor, news article, comic, poem etc.) 2.) What are important features or sections of the form of writing I should include?	
TOPIC: 1.) What is the writing about? 2.) Questions to be answered? 3.) My Point of View (if needed) 4.) Questions I have for future research	

Self-assessment: Where am I at? for Severe Weather Project

Name: _____

Have I completed……	Yes	Almost, I have questions	No
Completed RAFT template			
A proposal and turned into teacher?			
Received teacher approval?			
Notes/Outline			
* Description of storm			
- description of the formation of storm			
- included conditions that will decrease intensity (if applicable)			
- included conditions that will enhance strength			
* Describe the threats/dangers of storm			
* Economic concerns			
Interview			
* Include name and title of person			
* Obtain school procedures for particular threats			
* Obtain information on how school is prepared			
* Do I know what the students should do?			
* Are there specific plans for teachers?			

This rubric is designed for the written report of the Severe Weather Project. Students are encouraged to use this rubric to assess each other's reports before submitting to the teacher.

Category	5 points	4 points	3 points	2 points	1 point	0 points
Proposal	Turned in and well outlined	Turned in, needs some adjustment	Turned in, needs more thought	Turned in with minimal effort	Turned in with a lot of information missing	Did not turn in
Graphic organizer (RAFT)	RAFT was correctly completed and detailed	RAFT was completed	RAFT was minimally completed	RAFT was missing information	RAFT was missing a lot of information	RAFT was not completed
Organization	Information is organized with well-constructed paragraphs and subheadings.	Information is organized with well-constructed paragraphs and subheadings.	Information is organized with well-constructed paragraphs.	Information is organized, but paragraphs are not well-constructed.	information appears to be disorganized	No effort. Information is not relevant to topic
Vocabulary (where possible)	Correctly use vocabulary from this unit	Correctly uses most of the vocabulary from this unit	Correctly uses some of the vocabulary from this unit	Tries to use vocabulary but some places are incorrect	Attempts to use vocabulary but incorrectly does so several times	Does not use vocabulary or does not use it correctly
Knowledge	Subject knowledge is excellent	Subject knowledge appears to be very good	Subject knowledge is ok	Several errors in facts	Needs a lot of corrections to facts	Shows no knowledge of content
Information	Contains all information required and goes beyond	Contains most of the information	Missing some pieces of information	Missing more than half of the information	Missing more than 75% of the required information	Missing Most of the information
Mechanics	No grammatical or spelling errors	Very few grammatical or spelling errors	Several grammatical or spelling errors	Many grammatical or spelling errors	Frequently makes grammatical or spelling errors	No effort.
Internet Use	Used suggested credible websites and cited those used	Used mostly suggested credible websites and cited those used	Used some suggested websites but did not cite those used	Did not use suggested websites	Did not cite websites used	Did not use and did not cite websites

Climate Today and in the Future

Climate Unit: Outline		Writing
Project:	*Daily News Brief*: Students are encouraged to find current news articles related to climate change. Up to 5 mins at beginning of class a student will present a short summary and discussion on a science news article. Some sources are provided.	Every students will write a "Get the Gist" in their notebook (page for news) for the story being presented. The reporting student will turn in a lengthier (paragraph or two) summary of the chosen news story
Lesson: Climate Regions	Introduction to the various types of climate regions. Students will explore the various climates around the world and describe the various characteristics of the climate regions. In their summaries students will also discuss the factors which play a key role in the climates being observed in certain areas. Students will take this information and crate trading cards.	Notebook, Summarizing, Cornell Notetaking on textbook reading, creating trading cards
Lesson: Climographs	Students will work with climographs. After completing climographs students will analyze the data and determine the type of climate being represented by a specified graph.	Use data to support a claim, in written form
Lesson: Climate Change	A precursor to students creating an argument about climate change/global warming. They begin watching a video from Bill Nye about global climate change and discuss the main ideas in small groups. By the end of the lesson students will have created their position on climate change and questions they will research. This lesson and the research will produce a foundation for students to participate in the great debate at the end of the unit about climate change.	summarizing, brainstorming, formulating questions
Project:	*The Great Climate Debate*: Designed to give students experience with science argumentation and debate. Students will be researching their questions to support their position on climate change. Research will be based on students' personal interest and will be in support of one of the 3 opinions listed in the outline. For the debate students will be part of a larger group based on the opinion they chose. Students will participate in a class debate.	SWH template for guidance through the writing process, writing an argument based research paper

Student Project: Daily News Brief
Unit: Climate

Grade Level/Course: Earth Science 9th grade
Time Period: up to 5 min at beginning of class
Note: This activity can be used for any unit in the Earth Science Curriculum

Summary: The purpose of this activity is to increase students' awareness of and involvement in the science community. Students will also improve their public speaking skills. Everyday students will search for science in the news which they will then share with the class. A list of topics/stories will be kept by the students and the teacher to be drawn upon for further research. Summaries will be downloaded to Science in the News folder on the class website.

Writing focus/purpose: Summarizing a news story.

Objectives: Students will:

* Be able to Search for science in the news and critique the validity and credibility of the article
* Compile a list of topics and/or questions they may be interested in for further research.
* Recognize how science is involved in many aspects of life
* Be able to Summarize a science news story
* Develop public speaking skills

Standards:

Next Generation Sunshine State Standards: will depend on the unit this activity is used for and the topics picked by the students

Next Generation Science Standards: will depend on the unit this activity is used for and the topics picked by the students

Common Core State Standards for Literacy:

CCSS.ELA-Literacy.WHST.9-10.2
CCSS.ELA-Literacy.WHST.9-10.3
CCSS.ELA-Literacy.WHST.9-10.4
CCSS.ELA-Literacy.WHST.9-10.6
CCSS.ELA-Literacy.WHST.9-10.10

CCSS.ELA-Literacy.RST.9-10.1
CCSS.ELA-Literacy.RST.9-10.2
CCSS.ELA-Literacy.RST.9-10.4
CCSS.ELA-Literacy.RST.9-10.6
CCSS.ELA-Literacy.RST.9-10.8
CCSS.ELA-Literacy.RST.9-10.10
CCR Speaking & Listening Anchor #1
CCR Speaking & Listening Anchor #2

Academic Language Demands: Vocabulary found in articles

Resources: list provided to students
Assessment: Participation Points, Rubric for written summaries

Time	Learning Activities:	Writing: Notebook Entries
5 mins	Presentation of News story by assigned student	
	For this unit, students are encouraged to find articles/current stories regarding climate/climate change.	
	Students will present the science news to the class and turn in a short written paragraph summary of the news article	Summary of news story
	Students are encouraged to keep a log of topics/stories and questions in their notebooks. Students will draw upon this list later in the school year to write a news article	Log of topics/stories including title and source as well as main points/issues presented
Expectations	* All students participate * All students recognize the vast ways science takes part in our daily lives * All students will turn in a written paragraph summarizing the news story and citing the resource * Students will post summaries onto the class Edmodo Site for future reference	
Scaffolding	This scaffolding procedure will increase the student's individual responsibility. As students get to know each other, as well as the teacher and her expectations, they should be more comfortable taking part in classroom discussions and ultimately the leader there of.	
	♣ To begin the year, the teacher will demonstrate/model through read-a-louds. (approximately the first week)	
	♣ Group students (4-5 in group with no more than 5 students in a group). One student in the group will be assigned daily to look for a science story and report the science news story to their group. (1-2 weeks, give students time to become comfortable with the routine and gain participation)	
	♣ Next step: Students will present their science news to the whole class	
	♣ Students will tape the expectation sheet in the front of their notebooks for reference	

Student News Brief

On your assigned day:

1. Find a news story involving science
2. A list of resources has been given to you, with teacher approval you may use a source not listed. You must be able to determine the credibility of the website/source
3. Lead a discussion among your group/class about the article
    a. What? Where? Who says? What does this mean for you?
4. Write and turn in a short summary of the news story (minimum of a paragraph)
5. Graded on participation and quality of your summary

Summary outline; What to include in your news summary

1. Your name
2. News article title
3. Source of information
4. Brief summary of the main points or perspectives of the story. Is there more than one side to the story?
5. Did you search anywhere else for more information on this story's topic?
6. Questions you have?
7. Use correct grammar
8. Post summary to Class WebSite

Total points: 10 pts

The Daily News Briefing Resources

Retrieved from SciJourn.org

www.sciencedaily.com

www.enn.com

http://science.nasa.gov/science-news/
http://www.nasa.gov/index.html
http://www.nasa.gov/today/#.VfXZCZcwAQs

Nasa science news. Space images of the day from Hubble and much more. Great source for satellite usage and pictures

www.nytimes.com/pages/science *Daily science news updates with headlines and summaries. Comprehensive and entertaining!*

www.space.com/news *Headlines and stories about space. Also includes links (with headlines) to Live Science and Space News. Excellent photo gallery at bottom of page.*

www.news.google.com *Lots of tech news with the science.*

www.news.yahoo.com/science
In addition to headlines and ledes, an array of science slide shows are included. Examine the photographs and the extended captions.

www.sciencenews.org/ *Higher level mix of latest science stories. Includes a multi-media section containing an array of short raw video footage.*

www.news.sciencemag.org/ *Published by AAAS*

www.esciencenews.com/

www.usnews.com/science *Current updates on science news with a large selection of science videos.*

www.aolnews.com/category/science/ *Quick and basic source of science headlines and stories.*

www.scienceagogo.com *Published in Australia - interesting science news, research tidbits and science discussion.*

www.scitechdaily.com

other possible sources: science issues at school or in a community

Lesson Plan: Climate Regions
Unit: Climate

Grade Level/Course: Earth Science 9th grade
Time Period: 50 min

Summary: This lesson will introduce students to the various types of climate regions. Students will explore the various climates around the world through readings and describe why places experience the climate that they do.

Writing purpose/focus: Writing in this lesson is geared toward summarizing important facts about climate regions and creating trading cards. Students will be writing summaries of each type of climate region to go along with pictures of each region. The summaries are to be short, to the point and informative. Summaries will include the climate regions characteristics and what global/environmental features result in the specified climate conditions.

Activity:

* Research climate regions around the globe
* Write a description of climate regions and reasons why they are where they are

Material/management and safety issues:

* Access to internet and printer

Objectives:

- At the end of this lesson students will be able to
  - List the various types of climate
  - Identify the climate regions around the globe
  - Describe the characteristics of each climate region and what geographic features result in these characteristics

Standards:

Next Generation Sunshine State Standards:

SC.912.E.7.4 Summarize the conditions that contribute to the climate of a geographic area, including the relationships to lakes and oceans

Next Generation Science Standards:

ESS.2.D Weather and Climate

Common Core State Standards for Literacy:

CCSS.ELA-Literacy.WHST.9-10.5
CCSS.ELA-Literacy.WHST.9-10.6
CCSS.ELA-Literacy.WHST.9-10.9
CCSS.ELA-Literacy.WHST.9-10.10

CCSS.ELA-Literacy.RST.9-10.1
CCSS.ELA-Literacy.RST.9-10.2
CCSS.ELA-Literacy.RST.9-10.5
CCSS.ELA-Literacy.RST.9-10.7

Academic Language Demands:

Climate zones	Desert
Rain shadow	Savanna
Rainforest	Steppe
Humid continental	Mediterranean
Humid Subtropical	Subarctic
Tundra	Wind belt
ITCZ	

Time	Learning Activities:	Writing: Notebook Entries
3 mins	News Brief:	(L) "Get the Gist"
10 mins	Read text book Chapter 18 Climate section 2 Climate Regions 606-615	(R) Take Cornell notes
	Look at a global view of climate regions - do you see any patterns of global climate regions? - What may be causing these differences? Why are climate regions found where they are? Use internet to search various climate regions or places of interest Northeast States data from Cornell	
	What climates are found in the United States?	(R) investigate the various climates found across the U.S.
	Vocabulary Worksheets	Complete vocab worksheets for new words

Textbook:

Exline, J. D., & Prentice-Hall, I. (2001). *Earth science*. Needham, Mass.: Prentice Hall.

Climate Trading Cards

* Read Text book pages 122-131 about Climate Regions
* Take notes using Cornell Notetaking
* Write summaries of each climate region (due in 3 days)
    1. name of region
    2. where it is found
    3. major characteristics
    4. why do these areas see this type of climate
    5. find a picture representing the climate regions
    6. put all information together to create a trading card of each region

* notebook entry
    - Do you see patterns to the global climate regions? If so, what could be causing them? Why are the climate regions found where they are? (i.e. why are tropical rainy climates found in South America and Central Africa?)

Lesson Plan: Climographs
Unit: Climate

Grade Level/Course: Earth Science 9th grade
Time Period: 50 min

Summary: During this lesson students will work on identifying climate regions based on their knowledge and information gained from analyzing a climograph. Students will complete climographs for various cities by adding the monthly precipitation given in the raw data. After completing the graphs students will analyze the data and determine which type of climate is represented by the graph and selecting the city which they represent (a list of cities are given to choose from). Students will write an explanation of why they chose that city and graph combination.

Writing purpose/focus: Use data to support a claim

Activity:

* Complete and analyze climographs

Material/management and safety issues:

* Worksheets with climographs and raw data

Objectives:

- At the end of this lesson students will be able to
  - Identify the various climate regions around the U.S.
  - Distinguish between climate regions in the U.S. from interpreting a climograph
  - Use data to support their decision on what city is represented by a specific climograph

Standards:

Next Generation Sunshine State Standards:

SC.912.E.7.4 Summarize the conditions that contribute to the climate of a geographic area, including the relationships to lakes and oceans

Next Generation Science Standards:

ESS.2.D Weather and Climate

Common Core State Standards for Literacy:

CCSS.ELA-Literacy.WHST.9-10.1
CCSS.ELA-Literacy.WHST.9-10.9
CCSS.ELA-Literacy.WHST.9-10.10

CCSS.ELA-Literacy.RST.9-10.1 Analyzing and Interpreting Data
CCSS.ELA-Literacy.RST.9-10.4
CCSS.ELA-Literacy.RST.9-10.5
CCSS.ELA-Literacy.RST.9-10.7

Academic Language Demands:

Climate zones Desert

Steppe	Savanna
Humid continental	Mediterranean
Humid Subtropical	Subarctic
Rain shadow	Rainforest
Tundra	Wind belt
ITCZ	climograph

Time	Learning Activities:	Writing: Notebook Entries
3 mins	Daily News Brief	"Get the Gist"
	Quick review of Climate Regions	
	Describe how to read a climograph Complete and Analyze climographs with a partner Use internet to search various climate regions or places of interest Northeast States data from Cornell	(R) Analyze climographs, compare/contrast, and answer questions. Use knowledge and data to support a claim (R) analyze graphs and determine which city the graphs represent. Write an explanation why you matched the graphs to the chosen city…see worksheet
	Discuss as a class the topographic and global wind circulations determine types of climate regions	
	Why do we study climate? What impact does it or can it have on humans?	(L) personal connection to climate
	Continue to finish vocabulary sheets	Vocab sheets

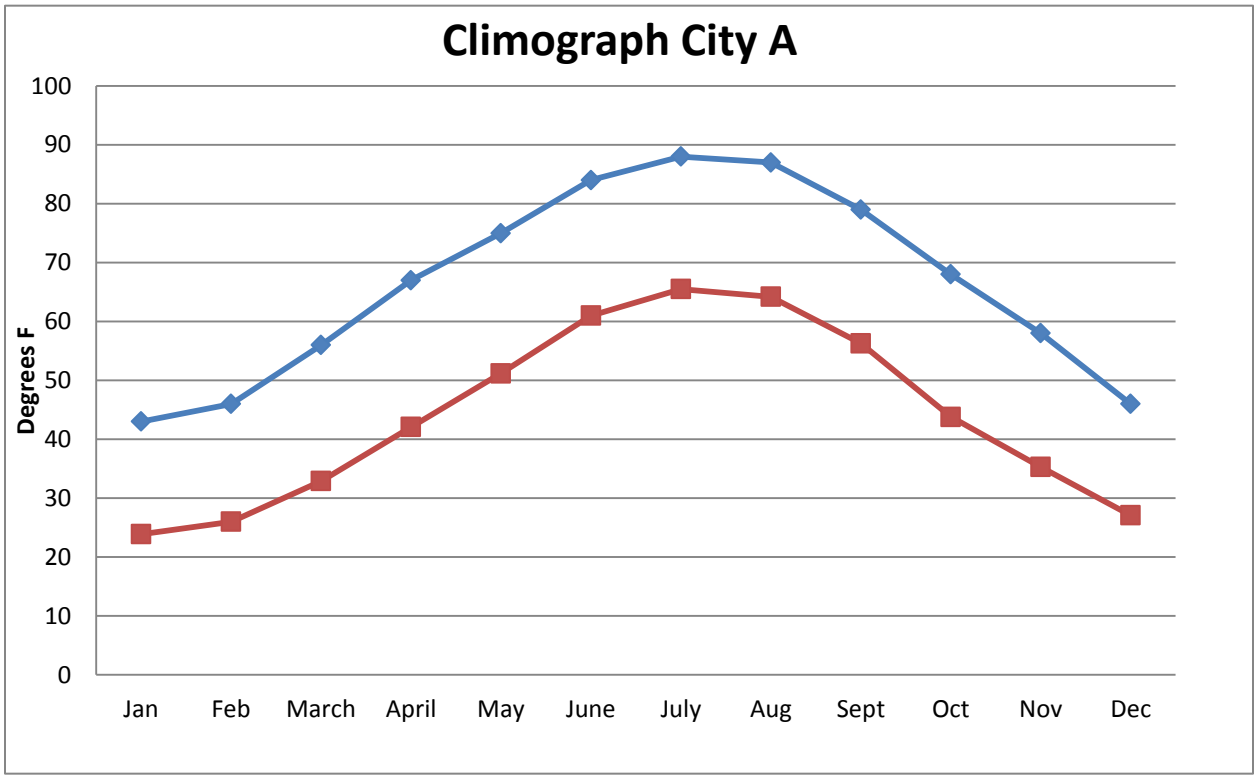
Resources:

Text book: Simons, B.B. (2002) *Science Explorer: Weather and Climate*. New Jersey: Prentice Hall

Teacher: master copy charts												
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Washington DC												
Ave Monthly High Temp	43	46	56	67	75	84	88	87	79	68	58	46
Ave Monthly Low Temp	24	26	33	42	51	61	66	64	56	44	35	27
Monthly Precipitation	2.68	2.74	3.38	3.47	4.55	3.98	3.67	3.53	3.92	3.25	3.41	2.96
Daytona Beach												
Ave Monthly High Temp	68	71	75	79	85	88	90	90	87	82	76	70
Ave Monthly Low Temp	47	50	54	59	65	71	73	73	72	66	57	51
Monthly Precipitation	2.74	2.78	4.24	2.18	3.13	5.83	5.83	6.4	6.96	4.21	2.69	2.63
Orlando												
Ave Monthly High Temp	71	73	77	82	88	91	92	92	89	84	78	72
Ave Monthly Low Temp	50	53	57	62	68	73	76	76	74	68	60	54
Monthly Precipitation	2.74	2.83	3.79	2.49	3.3	8.74	7.1	7.82	6.02	3.29	2.42	2.63
Buffalo												
Ave Monthly High Temp	31	33	42	55	67	75	80	78	71	59	78	36
Ave Monthly Low Temp	19	19	26	37	47	57	62	61	53	43	34	24
Monthly Precipitation	3.18	2.49	2.87	3.01	3.46	3.66	3.23	3.26	3.9	3.52	4.01	3.89
Colorado Springs												
Ave Monthly High Temp	43	45	52	60	69	79	85	82	75	63	51	42
Ave Monthly Low Temp	18	20	26	33	43	51	57	56	47	36	25	18
Monthly Precipitation	0.32	0.34	1	1.42	2.03	2.5	2.84	3.34	1.19	0.82	0.4	0.34
San Francisco												
Ave Monthly High Temp	56	60	62	65	68	71	72	73	74	70	63	57
Ave Monthly Low Temp	44	46	48	49	52	54	55	56	56	53	49	45
Monthly Precipitation	4.19	4.06	2.96	1.29	0.47	0.11	0	0.04	0.17	0.95	2.38	4.03
Reno, NV												
Ave Monthly High Temp	46	51	58	64	74	83	92	91	82	69	55	46
Ave Monthly Low	25	29	34	38	46	52	58	56	49	39	31	25

Temp												
Monthly Precipitation	1.03	1.02	0.76	0.47	0.49	0.51	0.18	0.23	0.35	0.51	0.82	1.03
Phoenix												
Ave Monthly High Temp	67	71	77	85	95	104	106	104	100	89	76	66
Ave Monthly Low Temp	46	49	54	60	69	78	84	83	77	65	53	45
Monthly Precipitation	0.91	0.92	0.99	0.28	0.11	0.02	1.05	1	0.64	0.58	0.65	0.88
Rapid City												
Ave Monthly High Temp	37	40	48	58	68	78	87	86	76	61	47	37
Ave Monthly Low Temp	12.9	15.1	22.9	31.8	42.1	51.2	58.1	56.6	46	34.1	22.1	13
Monthly Precipitation	0.3	0.44	0.93	1.8	3.22	2.53	1.85	1.56	1.29	1.42	0.53	0.42

Climate data retrieved on 9/30/2015 from http://www.nrcc.cornell.edu/wxstation/comparative/comparative.html#
data consists of climate normal over 30 yr period 1981 to 2010


Climograph City A
Degrees F
100
90
80
70
60
50
40
30
20
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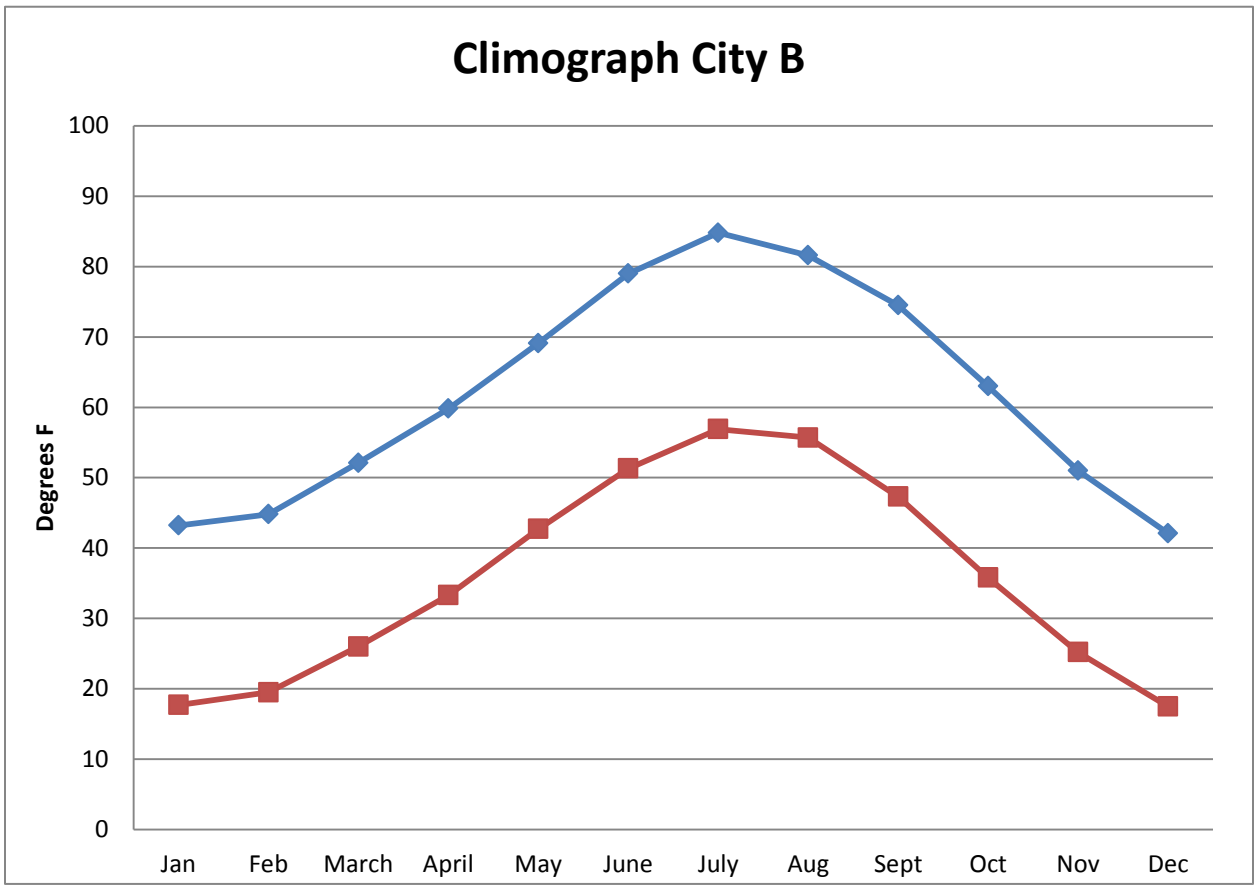
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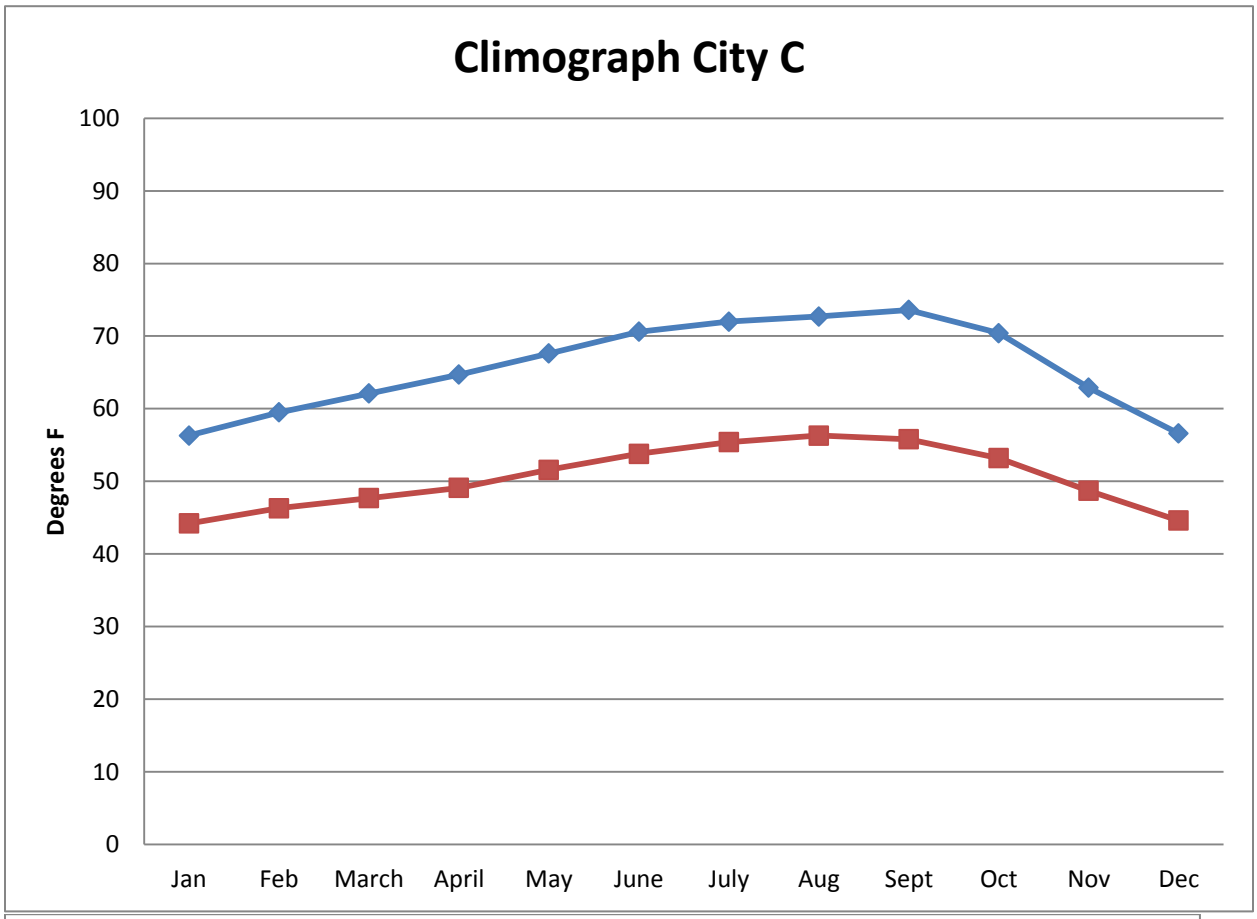
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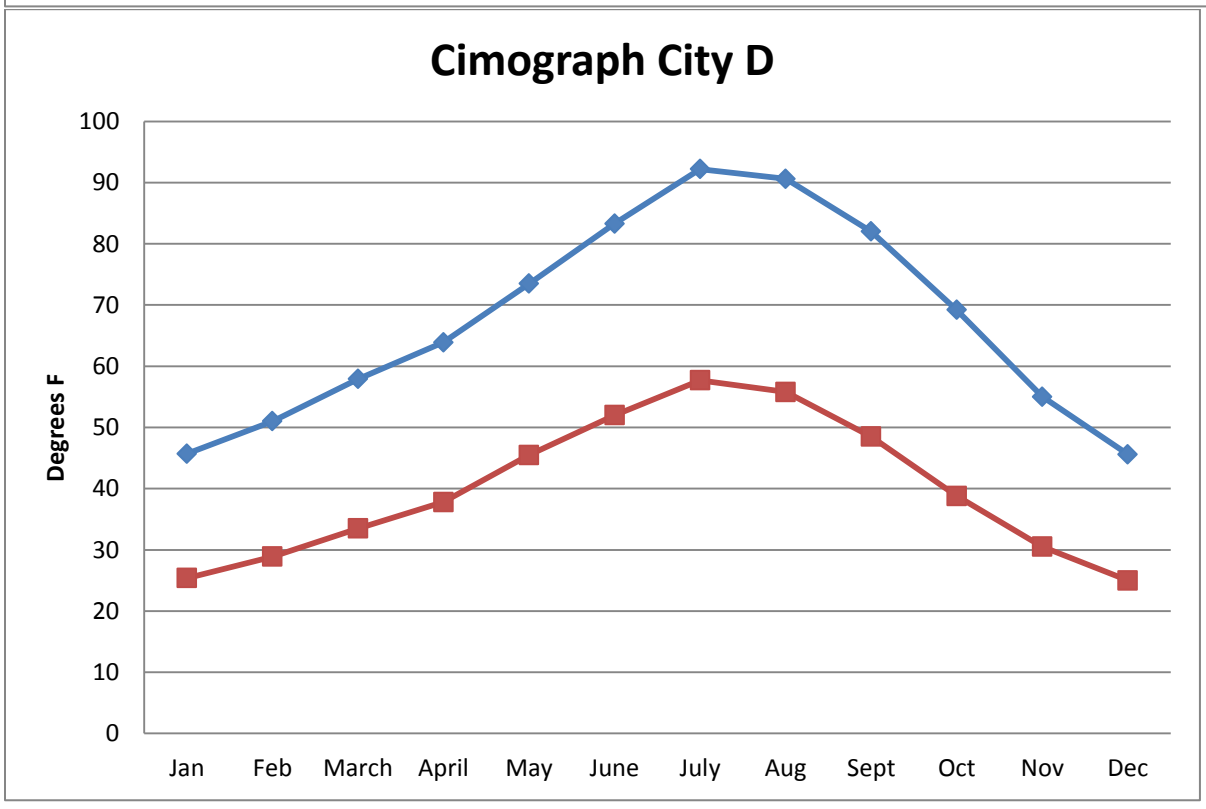
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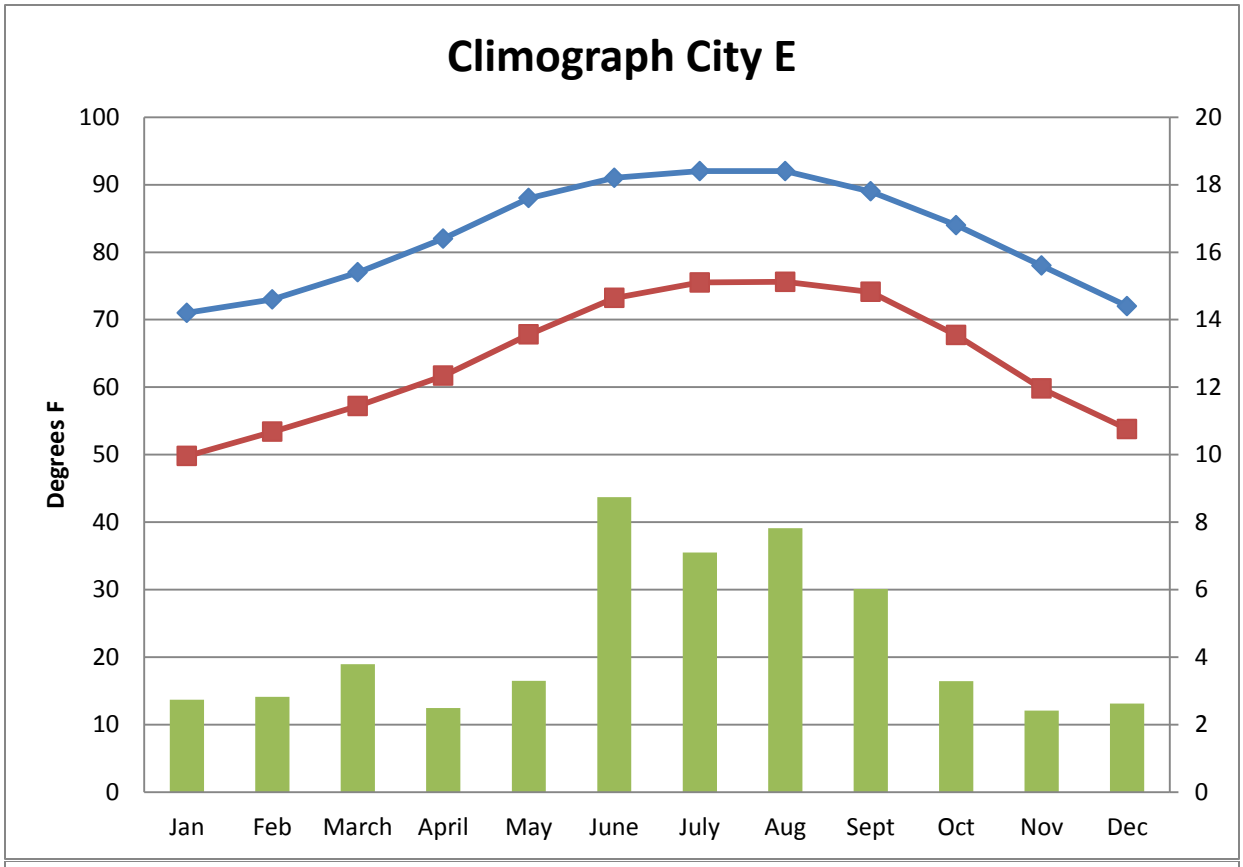
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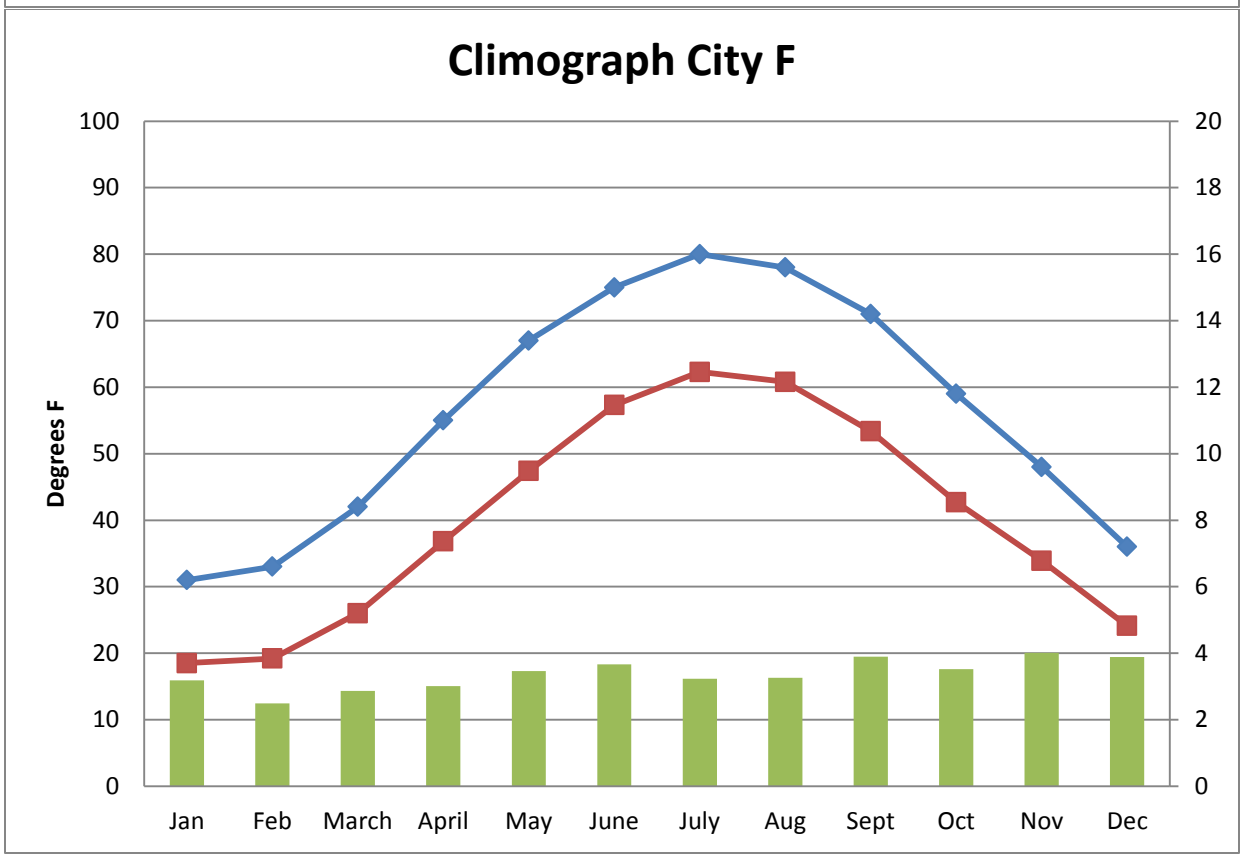
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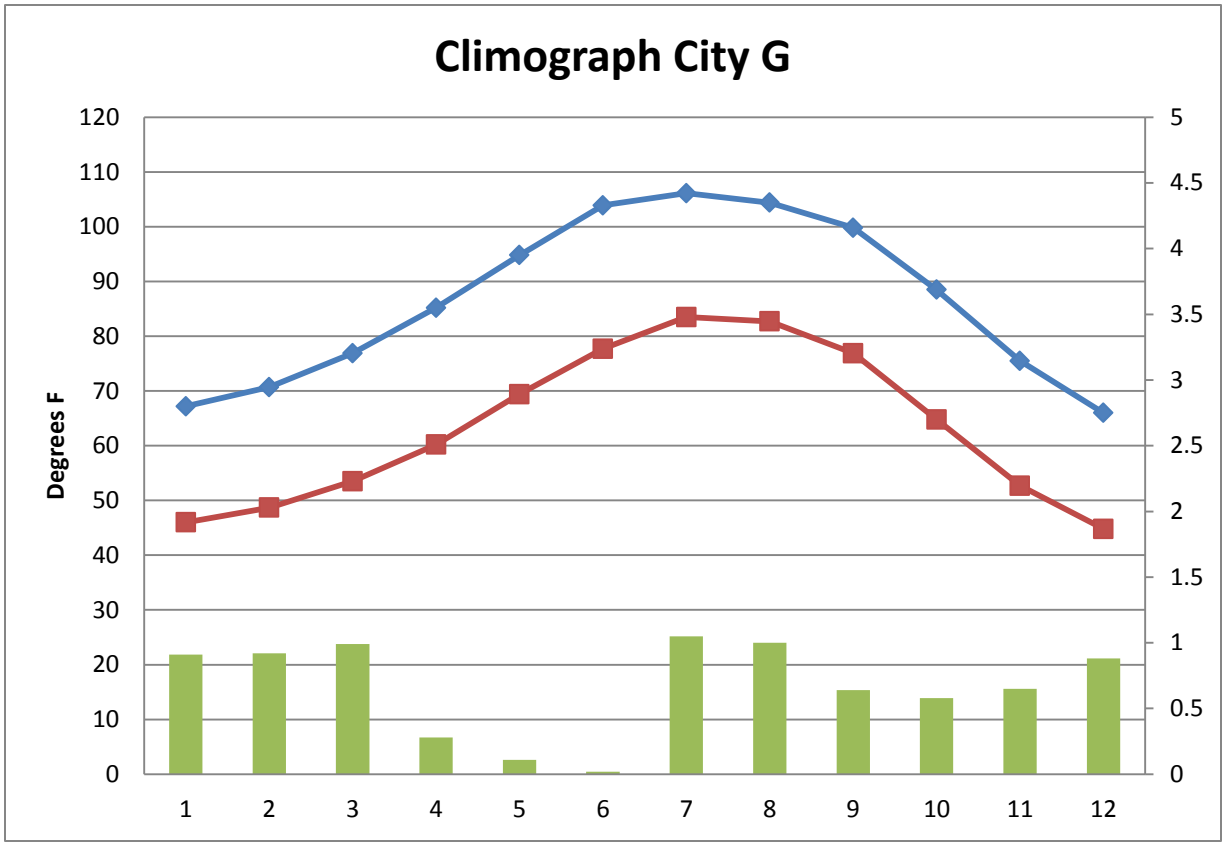
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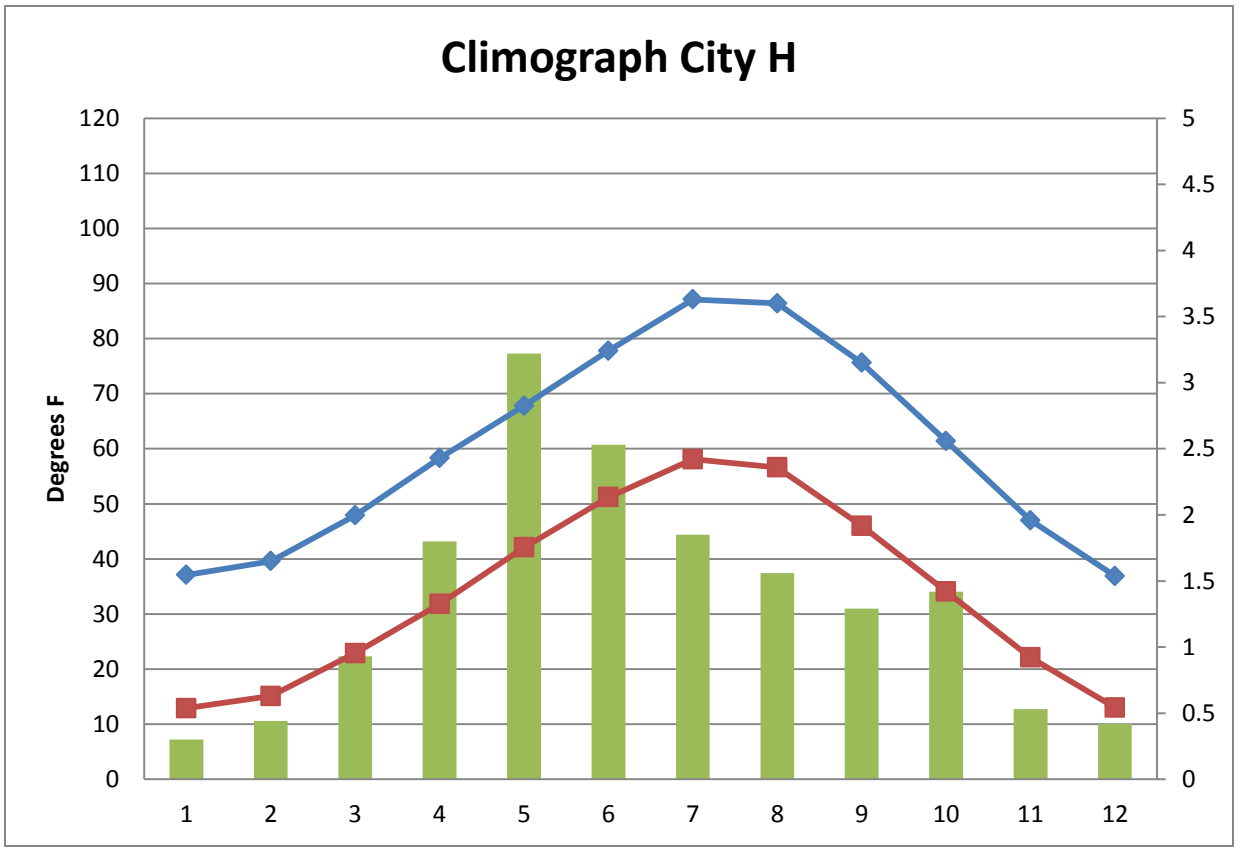
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Raw Data:

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
City A												
Ave Monthly High Temp	56	60	62	65	68	71	72	73	74	70	63	57
Ave Monthly Low Temp	44	46	48	49	52	54	55	56	56	53	49	45
Monthly Precipitation	4.19	4.06	2.96	1.29	0.47	0.11	0	0.04	0.17	0.95	2.38	4.03
City B												
Ave Monthly High Temp	46	51	58	64	74	83	92	91	82	69	55	46
Ave Monthly Low Temp	25	29	34	38	46	52	58	56	49	39	31	25
Monthly Precipitation	1.03	1.02	0.76	0.47	0.49	0.51	0.18	0.23	0.35	0.51	0.82	1.03
City C												
Ave Monthly High Temp	43	46	56	67	75	84	88	87	79	68	58	46
Ave Monthly Low Temp	24	26	33	42	51	61	66	64	56	44	35	27
Monthly Precipitation	2.68	2.74	3.38	3.47	4.55	3.98	3.67	3.53	3.92	3.25	3.41	2.96
City D												
Ave Monthly High Temp	43	45	52	60	69	79	85	82	75	63	51	42
Ave Monthly Low Temp	18	20	26	33	43	51	57	56	47	36	25	18
Monthly Precipitation	0.32	0.34	1	1.42	2.03	2.5	2.84	3.34	1.19	0.82	0.4	0.34

Climate Regions and Climographs Name: _____-

1.) Finish climographs
    a. On the right side of each climograph, create a scale and plot the average monthly precipitation for each city. A bar graph will work best
    b. Using the raw data determine the range in annual temperature for each city.

2.) The following cities are represented by the above charts
    a. Washington DC latitude 39°N
    b. Colorado Springs, CO latitude 39°N
    c. San Francisco, CA latitude 38°N
    d. Reno, NV latitude 39°N

3.) Using Google Earth or Maps find these cities. Take notes about the type of topography near the listed cities.

4.) Analyze the climographs and decide which graph represents which city
    a. Mark on the graph the city it represents

5.) In your notebook, write a summary discussing
    a. why you chose the city for each graph,
    b. the name of the climate it represents
    c. the characteristics of that particular climate region

6.) Discuss how proximity to topographic features effects an area's climate

7.) Now look at climographs E and F, G and H
    a. On the back of the graphs write a few paragraphs discussing the following;
        i. What similarities and differences do you see?
        ii. Determine the type of climate these graphs represent.
            1. why did you choose that type of climate?
        iii. Take an educated guess where these climates might be from (states or region, do not need specific city). Describe why you chose that area.

Lesson Plan: Changing Climate
Unit: Climate

Grade Level/Course: Earth Science 9th grade
Time Period: 50 min

Summary: This lesson is a precursor to students creating an argument about climate change/global warming. They begin watching a video from Bill Nye about global climate change. Students will watch the video and then discuss it in small groups. Students should come up with questions and brainstorm their position on climate change. At the end of the lesson students will have created their position and questions they will research. This lesson and the research will produce a foundation for students to participate in the great debate at the end of the unit about climate change.

Writing Focus/Purpose: summarizing, brainstorming, formulating research questions

Activity:

Movie: Eyes of Nye: Global Climate Change
Small group discussion, brainstorm and notebook entries

Material/management and safety issues:

* Movie
* notebooks
* Textbook Chapter 18 section 3: Long Term Changes in Climate pg 618 through 622

Objectives:

- At the end of this lesson students will be able to
    - Describe how scientists gain information about Earth's paleoclimate from ice cores
    - Discuss how the global climate is changing
    - Develop a topic and question for further research

Standards:

Next Generation Sunshine State Standards:

SC.912.N.1.3: Recognize that the strength or usefulness of a scientific claim is evaluated through scientific argumentation, which depends on critical and logical thinking, and the active consideration of alternative scientific explanations to explain the data presented.
SC.912.N.1.4: Identify sources of information and assess their reliability according to the strict standards of scientific investigation.
SC.912.N.1.1: Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science
SC.912.E.7.4: Summarize the conditions that contribute to the climate of a geographic area, including the relationships to lakes and oceans.

Next Generation Science Standards:

ESS2.D Weather and Climate:

- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.

HS-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

Common Core State Standards for Literacy:

CCSS.ELA-Literacy.WHST.9-10.4
CCSS.ELA-Literacy.WHST.9-10.7
CCSS.ELA-Literacy.WHST.9-10.10

CCSS.ELA-Literacy.RST.9-10.2
CCSS.ELA-Literacy.RST.9-10.6
CCSS.ELA-Literacy.RST.9-10.7
CCSS.ELA-Literacy.RST.9-10.8

CCR Speaking & Listening Anchor #3: Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric.

Academic Language Demands: New Vocabulary

Ice core
Climate change

Time	Learning Activities:	Writing: Notebook Entries
5 min	News Brief: how is climate in the news today? Discuss the Climate Debate	News story page: record title, source and "Get the Gist" presented by students
10 mins	What do you know about climate change? Read text Chapter 18 section 3 Long Term Changes in Climate pg 618 thru 622	Brainstorm: prior knowledge Cornell notes
30 mins	Watch movie: Eyes of Nye: global climate change	Record notes Record questions that arise
Remainder of time	Small group discussion	Record notes: ideas of students, questions brought up
Remainder of time	Writing, formulating research questions	Students will decide on their position on climate change Students will summarize the main ideas discussed today. Students will develop a question/topic they would like to further research regarding climate change

Textbook:
Exline, J. D., & Prentice-Hall, I. (2001). *Earth science*. Needham, Mass.: Prentice Hall

(notebook outline)

Brainstorm:

What I know about Climate change:	How do I know this? (sources of information)

What I now know about Climate Change: (summary of movie and discussions)

Topic/???s	Notes from Textbook page 618-622
Summary	

Topic I would like to research about Climate Change

Question I have about my topic and its role in climate change?

Topic/???s	Notes from Eyes of Nye Climate Change
Summary	

Personal Connections/Summary

Topic/???s	Notes from class discussion
Summary	

Student Project: The Great Climate Debate
Unit: Climate

Grade Level/Course: Earth Science 9th grade
Time Period: Several days, allow for peer review and rough draft

Summary: Many scientists have different opinions about the global climate change, also called global warming. There is a lot of data out there that supports or denies climate change. Students will have completed research throughout the climate unit in Earth Science. During this time students will gain knowledge about factors effecting climate, cycles of the earth, and global climate patterns. They will produce an informed opinion about this topic. After individually researching one aspect of climate change, students will join other students in the class with the same opinion and together as a team they will debate the issue, using their research as evidence to support their opinion of climate change.

Writing focus/purpose: Students will write an argument supporting one of three positions on climate change. Students will be researching a topic of interest, create an argument in writing then use their research in a verbal class debate.

Objectives:

- At the end of this project students will have written an argument based research project paper
- Students will participate in a class debate
- Students will use evidence to back up their claim regarding climate change
- Students will be able to discuss at least one argument supporting humans causing global warming and one argument against humans causing global warming
- Students will recognize how earth's systems work together

Material/management and safety issues:

* The Great Debate worksheets (teacher plans and student plans)

Standards:

Next Generation Sunshine State Standards:

SC.912.N.1.3: Recognize that the strength or usefulness of a scientific claim is evaluated through scientific argumentation, which depends on critical and logical thinking, and the active consideration of alternative scientific explanations to explain the data presented.
SC.912.N.1.4: Identify sources of information and assess their reliability according to the strict standards of scientific investigation.
SC.912.N.1.1: Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science
SC.912.E.7.4: Summarize the conditions that contribute to the climate of a geographic area, including the relationships to lakes and oceans.

Next Generation Science Standards:

ESS2.D Weather and Climate:

- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.

- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.

HS-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

Common Core State Standards for Literacy:

CCSS.ELA-Literacy.WHST.9-10.1
CCSS.ELA-Literacy.WHST.9-10.3
CCSS.ELA-Literacy.WHST.9-10.4
CCSS.ELA-Literacy.WHST.9-10.5
CCSS.ELA-Literacy.WHST.9-10.6
CCSS.ELA-Literacy.WHST.9-10.7
CCSS.ELA-Literacy.WHST.9-10.8
CCSS.ELA-Literacy.WHST.9-10.9
CCSS.ELA-Literacy.WHST.9-10.10

CCSS.ELA-Literacy.RST.9-10.1
CCSS.ELA-Literacy.RST.9-10.5
CCSS.ELA-Literacy.RST.9-10.6
CCSS.ELA-Literacy.RST.9-10.7
CCSS.ELA-Literacy.RST.9-10.8
CCSS.ELA-Literacy.RST.9-10.9:

CCR Speaking & Listening Anchor #1: Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

CCR Speaking & Listening Anchor #3: Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric.

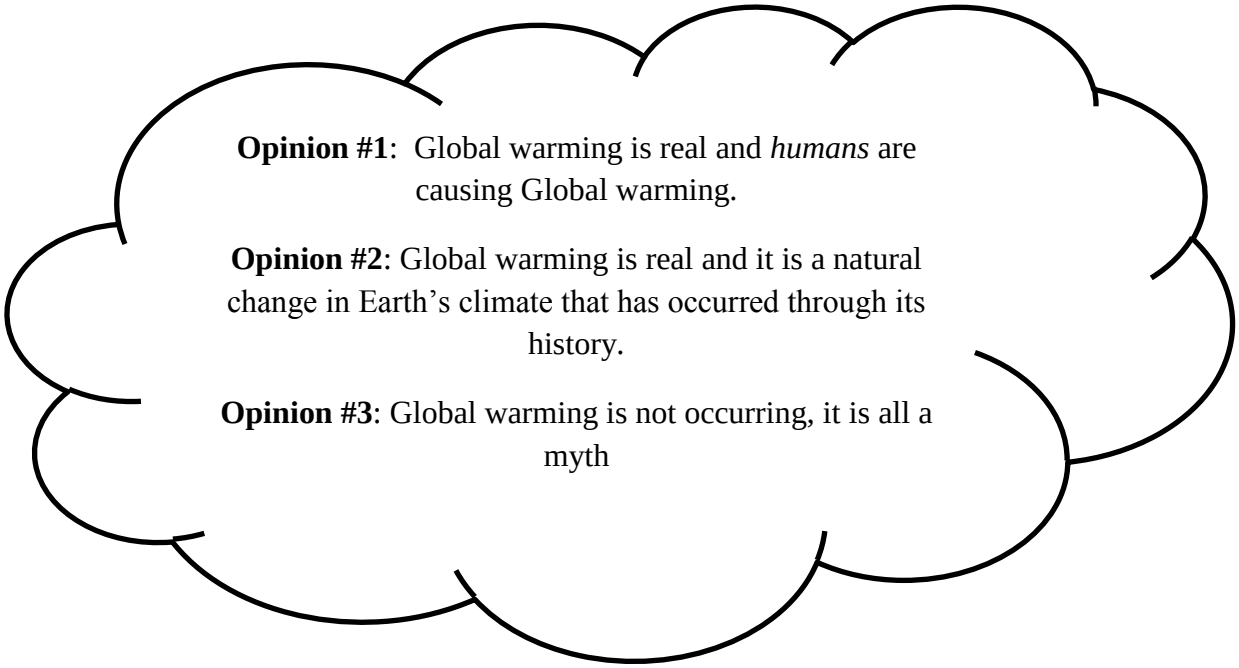
CCR Speaking and Listening Anchor #4: Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience

The Great Climate Debate

Teacher Plans/Notes

Many scientists have different opinions about the global climate change, also called global warming. There is a lot of data out there that supports or denies climate change. Students will have completed research throughout the climate unit in Earth Science. During this time students will gain knowledge about factors effecting climate, cycles of the earth, global climate patterns. They will produce an informed opinion about this topic. After individually researching one aspect of climate change, students will join other students in the class with the same opinion and together as a team they will debate the issue, using their research as evidence to support their opinion of climate change.

* Students must choose one of the three opinions below which they feel they want to support.



* Students will participate in a class debate as a team. Each student will have the opportunity to voice their research in support of their opinion or to dispute another opinion. Other faculty will be invited to watch and listen to the debate. With students' and parents' permission this activity may be video and/or audio recorded.

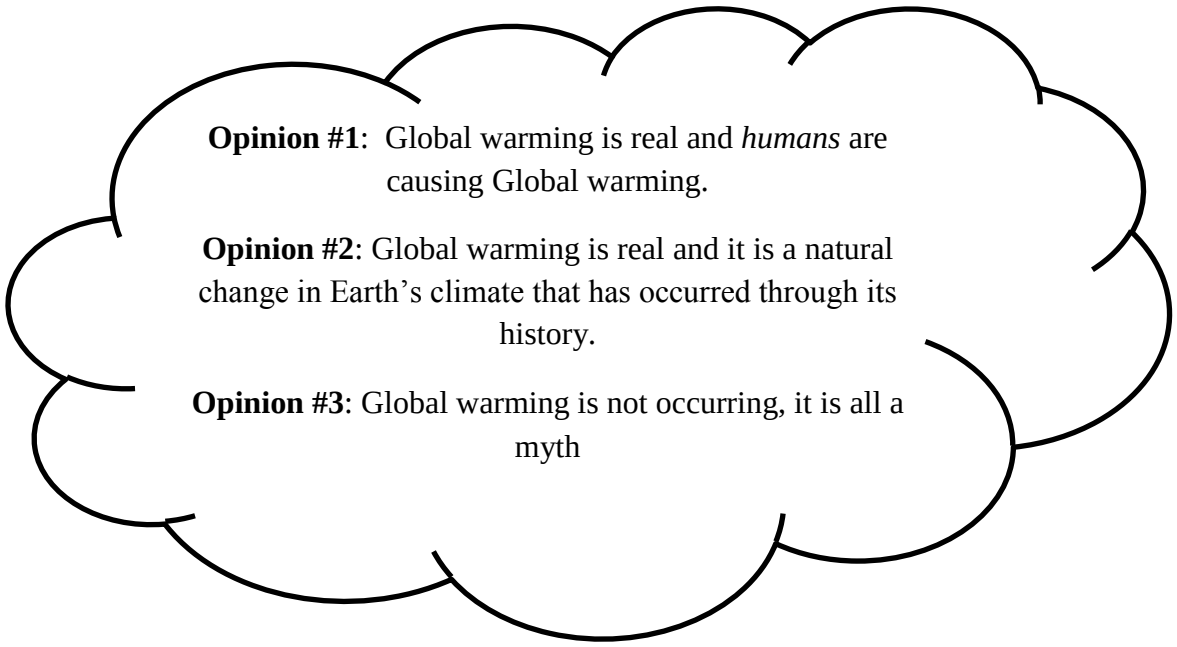
* Creativity is encouraged during this activity. Students are encouraged to create props, i.e. graphs, charts, pictures, posters etc. They will not be allowed to use media recordings/clips. Poster paper and whiteboard will be provided.

SWH Template

Teacher	Student
Pre-research: brainstorm what we know about climate; create a large concept map about climate and climate change Watch Bill Nye video for a starting point with ideas	What questions do I have?
Participation/lab design: Introduce students to various simulations, websites about climate change	Collect data: Find credible sources of climate data
Negotiation I: Guides students to collect data off internet, journal about what the data means to them	Claims: What can I claim?
Negotiation II: Encourages students to discuss data with peers	Evidence: how do I know? Why am I making these claims? Students will get together in groups based on their choice of opinion about climate change and discuss what they have found
Negotiation III: further support students in researching their ideas Debate time	Reading; how do my ideas compare with others? Students will participate in a class debate
Exploration: engages students in reflection of their understandings and results of the debate	Reflection: how have my ideas changed? What is the greatest argument against my data and opinion?

The Great Climate Debate

To the Student: This class is taking part in the great debate about climate change. Throughout the climate lesson you will be learning about the global climate, how the atmosphere works on a global scale and how it is changing…. or is it? At the end of the unit we, as a class, will be putting together a debate about climate change. There are three positions you can choose from:



Using your knowledge and experiences pick a side you believe in and a topic of interest to you. Are humans only to blame? Is it all natural? Or is it a myth?

Research your opinion and topic, collect evidence supporting your opinion. Be sure to use credible sources and cite them.

Use the SWH template to guide your argument.

What you will be turning in and graded on;

- Brainstorming/outline: SWH template
- Written report about your research
- Did you use models? Simulations? If so be sure to describe how you manipulated them and what they showed as results…this is evidence to back your claims
- Reflection about the debate
- Has your research or the debate changed your opinion?

What questions do I have?
Collect data: Find credible sources of climate data….record in your notebook, or type on computer and tape in later
Claims: What can I claim?
Evidence: how do I know? Why am I making these claims? ** get together in groups based on your choice of opinion about climate change and discuss what you have researched. What other claims are your peers making?
Reading; how do my ideas compare with others? What does the textbook lead you to believe? Does it present one side? **Students will participate in a class debate**
Reflection: how have my ideas changed? What is the greatest argument against my data and opinion? What did I learn from the debate
References/websites:

Note: You can use separate pages for this sections of this chart. This is to get you started and guide you with what type of information you need to include along with the progression of the project

Resources for Students for Climate Change Ideas

Climate Change: http://www.pbslearningmedia.org/resource/ess05.sci.ess.watcyc.climatechange/climate-change/

Great Video! Introduces climate change.

Greenhouse effect http://www.pbslearningmedia.org/resource/phy03.sci.phys.matter.greenhouse2/global-warming-the-physics-of-the-greenhouse-effect/

Great 5 min. video about greenhouse effect and emitting carbon dioxide.

A Journey through Climate History http://www.abc.net.au/innovation/environment/cc_timeline.html

Very interesting interactive timeline of climate change during history and events that have occurred from 4.5 billion years ago; has some possible ideas to research.

Earth Viewer: http://www.hhmi.org/biointeractive/earthviewer-online-and-downloadable-version?utm_source=BioInteractive+News&utm_campaign=63d9fadbb7-BioInteractive_News_Vol_527_17_2015&utm_medium=email&utm_term=0_98b2f5c6ba-63d9fadbb7-69145229

Interactive map (can be downloaded on tablet or phone as an app) of how the Earth has changed throughout its history; parameters like temperature, CO_2 levels, Sun's luminosity are shown.

NASA Visualization Studio http://svs.gsfc.nasa.gov/vis/a000000/a003600/a003674/index.html

Images of Five-Year Average Global Temperature Anomalies from 1881 to 2009

Northeast Regional Climate Center http://www.nrcc.cornell.edu/wxstation/comparative/comparative.html

Raw climate date: normal temperature and precipitation for locations across the United States

Video about Milankovitch cycles
http://www.pbslearningmedia.org/resource/ess05.sci.ess.watcyc.naturalchange/natural-climate-change-in-djibouti-africa/

Video produced by PBS about evidence of climate change in Africa. Discusses the Earth's position to sun as a potential cause of climate change

Various Natural Causes of Climate Change https://www.climate.gov/taxonomy/term/3451

Video about Milankovitch Cycles; greater technicality of Milankovitch cycle; has several sources.

Science news websites are a great place for ideas, current research and links to further research

Science Daily News: http://www.sciencedaily.com/news/earth_climate/

Environmental News: http://www.enn.com/topics/climate

Ocean: How does it work? and its importance

Ocean Unit: Outline		Writing
Lesson: Introduction, ocean waves	Students will explore and discover what forces create waves. Three short activities are planned for students to make waves and see the potential destruction caused by waves.	Summarizing, reflections, and recording observations and data
Lesson: Ocean Chemistry	Students will conduct 3 small experiments. The effects of salinity and temperature in the oceans will be seen and discussed.	SWH: written report using data from experiments
Lesson: Surface Currents vs Deep Currents	Students will read textbook reinforcing ideas from prior activities and start researching importance of oceans or problems occurring in the ocean. Students will briefly research what problems are out in the oceans. By the end of the class students should pick a topic for their research paper and write a proposal to the teacher.	Cornell notes on textbook reading, making connections to previous lessons' activities. Write a proposal to the teacher for research paper.
Lesson: El Nino	Students will investigate El Nino and its effects on their region (Florida). Students will analyze two short newscasts focusing on El Niño. While listening to the different news casts students will develop questions, critique what the newscasters say and search for answers to their own questions.	Compare newscasts, research questions
Project:	*El Niño Infographic*: Plans are included with the El Niño lesson plan. Students will research El Niño and create an infographic informing the public of El Niño and its potential effects on Florida.	Informative poster with short descriptive summaries supported by graphics, the RAFT organizer will assist students with organization and thoughts
Project:	*Ocean News Research*: Problems in the Ocean; news article. Students will choose a topic and write a news article about this problem, what is causing it (if known), the potential environmental or economic problems and what could possibly be done to reverse or slow the process. This research is intended to help students understand the importance of the ocean to the health of the planet. There are many different directions students can take this project, they need to choose what is interesting to them.	Research based news article. Students will use SWH or RAFT template to guide their research and writing. Final products include a proposal to the teacher, news article style writing, and multimedia presentation. (presenting is optional)

Lesson Plan: Introduction to Oceans and Ocean Waves
Unit: Ocean

Grade Level/Course: Earth Science 9th grade
Time Period: 50 min

Summary: During this lesson students will experiment with waves in water. This lesson may seem elementary however; this lesson is intended to have students think about the forces involved with creating waves in water as well as the dangers to land. After completing a couple of activities students will have an understanding for the effect ocean waves have on human life.

Writing focus/purpose: Students will be using their notebooks to record observations and actions in creating waves in water. Summaries and reflections will be completed for this lesson.

Activity: each station has directions at the end of this plan to be placed at the station to keep students on track

- Station 1: Create some waves, record observations
- Station 2: Watch videos of ocean waves, record observations
- Station 3: Beach in a box: what do waves do to a beach?
  ** Needs to be prepared before class

Material/management and safety issues:

* large tubs or sinks of water
* safety concerns are slipping due to wet floors. Have several towels or mops available to clean up floor

Objectives:

- At the end of this lesson students will be able to
  - Explain how ocean waves form
  - Distinguish between the different parts of waves by drawing a diagram
  - Describe and draw a rip current and how to escape one
  - Describe longshore drift

Standards:

Next Generation Sunshine State Standards:

SC.912.P.10.20: Describe the measurable properties of waves and explain the relationships among them and how these properties change when the wave moves from one medium to another.

SC.912.E.7.8: Explain how various atmospheric, oceanic, and hydrologic conditions in Florida have influenced and can influence human behavior, both individually and collectively. Describe and discuss the conditions that bring about floods, droughts, wildfires, thunderstorms, hurricanes, rip currents, and tsunamis and how these conditions can influence human behavior (e.g. energy alternatives, conservation, migration, storm preparedness).

Next Generation Science Standards:

HSS-ESS-2.C: The Roles of Water in Earth's Processes

Common Core State Standards for Literacy:

CCSS.ELA-Literacy.WHST.9-10.4
CCSS.ELA-Literacy.WHST.9-10.10

Academic Language Demands: New Vocabulary
Waves: Crest, Trough, Wave height, Wavelength, period
Longshore drift
Rip current

Time	Learning Activities:	Writing: Notebook Entries
3 min video, 1-2 min response discussion	http://www.montereyinstitute.org/noaa/lesson08.html Video discussing the impact of oceans globally Start class with discussion of the importance of the oceans Ask students why they think the ocean is important?	(L) Opening Brainstorming, What does the ocean mean to you? (L) Create a chart: Two columns: (1) What does the ocean mean to me? Why is it important? (2) After this lesson: I now think…..
	Now knowing some importance and basics of the ocean lets further investigate how the ocean works and the effects it has on our Earth	
opening questions	What is one of the first things you think about when you think of the ocean? What questions do you have about the ocean? What do you want to learn about the ocean? What are waves? How are waves created?	(L) brainstorm and discussion
	Station 1: Let's make some waves: have large tub or sink ¾ filled with water. Let students try to make waves. **Without pushing down on the water with your hands! Can you make different waves? What did you do to make waves? What resulted from your actions?	(R) Discuss with a partner how one can make waves Station 1: Go to sink/tub and create some waves….record your observations and what you did to create waves…do not push on the water with your hands Try creating waves with

		different frequencies, heights and periods. How do the forces differ to create these waves? What is so important about waves in the ocean? Brainstorm types of waves
	Station 2: Destruction by waves	Station 2: watch a couple of videos of ocean waves and record your observations
	Station 3: what do waves do to our beaches? Erosion, longshore drift	(R) What do waves do to the beach? Describe what happens when waves hit a beach. Be sure to try different waves and angles to shore
Guiding questions to probe student thinking	Why do we care about waves? (economic destruction on coastlines, dangers to fishing industry) Is there more than one type of wave?	(R) record observations of wave destruction reflect on the threats of waves Is there anything we can do to protect the shores?
Connections	Are there waves on other bodies of water? What do you know about water when it moves?	Brainstorming/writing thoughts
Wave videos	https://www.youtube.com/watch?v=p2RAEp9pObw https://www.youtube.com/watch?v=QNB393ns8Lg https://www.youtube.com/watch?v=3Rjh8pLeoUg https://www.youtube.com/watch?v=JFIiKoANi4Y	
Textbook Reference	Chapter 13 Ocean Motion, Section 1: Wave Action	Take notes
	Summarize what you learned and how you personally can connect to the ocean	(L) summarize and reflect;

	Potential guiding questions for reflection: What did you learn?, what may have surprised you about the ocean, how do you connect to the ocean, do you have any personal experiences with monster waves?	
	Vocabulary sheets	Vocabulary

Resources:

Text book: Simons, B.B. (2002) *Science Explorer: Weather and Climate*. New Jersey: Prentice Hall

BEACH IN A BOX

Preparation for station 3: beach in box
Use a rectangular shallow box or a tin. Put some sand on one side of the box and prop this end up with a book. Put water in the other end just to the edge of the sand: use image below for reference.

Provide students with a cardboard "dock/pier" to enhance longshore drift effect.
Provide students with popsicle sticks or tongue depressor to create waves, or a straw to create wind and thus waves

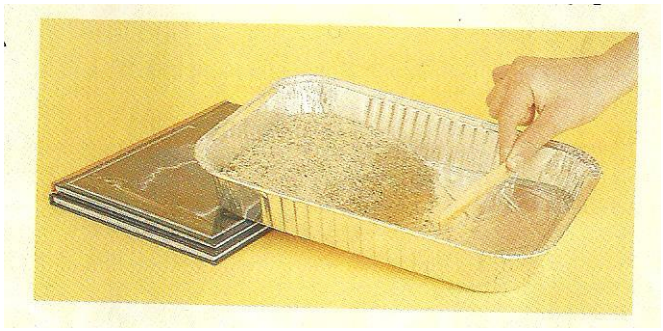


Image and activity retrieved from textbook, page 428
Text book: Simons, B.B. (2002) *Science Explorer: Weather and Climate*. New Jersey: Prentice Hall

(Outline for Notebook)

Brain Warm Up:

What does the ocean mean to me? Why is the ocean important to me? What I think about when I think of the ocean….	After the lesson I now think…..

Date:
Ocean: waves

Station 1: Making waves

Predict: (how can I make waves? Waves with different frequencies? With different heights? Without pushing down on the water with your hands)

Data:

Wave Height	Wave Frequency	How I created

Draw a diagram of waves with labels

Station 2: Monster Waves

Observations:

My reaction:

What are the threats of waves?

Write a summary and reflection of the activities today:

Station 3: What do waves do to our beach?

In the beach box create some waves and see what happens to the beach. Describe what happens:

1) When waves are perpendicular to the shoreline

2) What waves are at an angle to the shoreline

Draw a diagram of longshore drift

What (if anything can be done) to save beaches on the ocean coast?

Station 1: Make some waves

DO NOT push on the water with your hands!!!!

In the box there are a few potential tools for you to use to create waves. Think about the ocean, what forces create waves in the ocean?

Record your results in your notebook

Try different forces; try to create different wave heights and frequencies

How can you relate your actions to those in nature?

Station 2: Monster Waves

Watch a few of the following videos. You do not need to watch the entire video….you will run out of time

https://www.youtube.com/watch?v=p2RAEp9pObw
https://www.youtube.com/watch?v=QNB393ns8Lg
https://www.youtube.com/watch?v=3Rjh8pLeoUg
https://www.youtube.com/watch?v=JFIiKoANi4Y

While watching these videos somethings to think about….

- is there destruction? What are the waves doing?
- are there people in the videos? What do you think about that? Would you go into that environment?
- How are these waves being made?
- If monster waves like these were to hit the Florida coast what do you suppose would happen?

Record all of your observations, thoughts and reactions in your notebook. Be sure to be specific on what is happening.

Station 3: Beach in a Box
What do waves do to a beach?

Use the tongue depressor or straw to gently create some waves towards the beach, try to get the waves as close to perpendicular as possible at first.

Add a pier and record your observations

Now let the water settle. Take the pier out and create waves at an angel to the beach

Are there any differences you see?

Replace the pier and create more angular waves

What is happening?

Record all observations, actions and reactions in your notebook

At the end of all three of these stations, write a summary about waves. Describe the various parts of a wave, how they affect the beach/shoreline and potential threat to humans. How do humans affect the natural flow of waves? Why do you think this is all important?

Lesson Plan: Ocean Chemistry
Unit: Ocean

Grade Level/Course: Earth Science 9th grade
Time Period: (1-2) 50 minute class periods. [1-1 ½ class periods for the activities and discussion, a second class to write the report and further discuss findings].

Summary: Temperature and salinity are key components in understanding deep ocean currents. Deep ocean currents are driven by differences in density caused by temperature and salinity. Surface currents are mostly caused by wind. The ocean and atmosphere are tightly connected to produce the circulations we experience. Students will conduct a series of demonstrations/labs to show the effects of temperature and salinity in water (ocean).

Writing focus/purpose: Students will take part in three activities of how temperature and salinity change the characteristics of water. Students will follow the SWH template and write up a report with evidence from the activities to back up their claim in answering questions.

Activity:

- Temperature difference…What's all the fuss about?
- Does the potato float or sink?
- When fresh water meets salt water….

Safety issues:

* Safety concerns are limited to potential spilling of water; slippery floors and falling.
* Students may want to wear an apron to prevent food coloring from splashing on clothes
* Salt water may get in eyes; although there is no health concerns students may be uncomfortable for short period of time. If salt water does get in eyes, an eye flush will be sufficient

Material/management and

- see activity plans at end of this lesson plan
- The 3 activities listed above will require preset up
- Directions for students: one per group for each activity

Objectives:

At the end of this lesson students will be able to

- Discuss what effects salt has on water properties
- Explain how density differences of ocean water results in currents
- Predict the basic deep water ocean currents around the globe

Standards:

Next Generation Sunshine State Standards:

SC.912.E.7.2 Analyze the causes of the various kinds of surface and deep water motion within the oceans and their impacts on the transfer of energy between the poles and the equator

SC.912.E.7.5 Predict future weather conditions based on present observations and conceptual models and recognize limitations and uncertainties of such predictions

Next Generation Science Standards:

HSS-ESS-2.C: The Roles of Water in Earth's Processes

Common Core State Standards for Literacy:

CCSS.ELA-Literacy.WHST.9-10.1
CCSS.ELA-Literacy.WHST.9-10.2
CCSS.ELA-Literacy.WHST.9-10.3
CCSS.ELA-Literacy.WHST.9-10.4
CCSS.ELA-Literacy.WHST.9-10.7
CCSS.ELA-Literacy.WHST.9-10.10

CCSS.ELA-Literacy.RST.9-10.3
CCSS.ELA-Literacy.RST.9-10.5
CCSS.ELA-Literacy.RST.9-10.7
CCSS.ELA-Literacy.RST.9-10.9

Academic Language Demands:

Salinity
prior understanding of density

Guiding Questions:

What is the difference between salt water and fresh water?
Does salt in water matter?
What does salt in water do? How does it affect the characteristics of water?
Why do we care?
Can salt be taken out of water? How?

Time	Learning Activities:	Writing: Notebook Entries
1 mins	Brain warm up: what is the difference between river/lake water and ocean water? Does it matter?	(L) brainstorm with partner
3 mins	Discuss the three activities that will be completed and the final paper Give an over view of the activities then let the groups work at their own pace Teacher will circulate around to assist students and keep them on track. Time frames should be watched to be sure students finish the activities	Group students (no more than 4 in a group)
10 mins	Activity 1: Temperature difference…What's all the fuss about?	(R) record notes in notebook
10 mins	Activity 2: Does the potato sink or float? this activity could be done as a large class or in small groups (no more than 4 in a group)	(R) perform the activity and record in notebook
15 mins	Activity 3: When fresh water meets salt water…	(R) perform the activity and record in notebooks

	It is recommended to complete this activity in small groups (4 or less) so everyone gets to clearly see the results	
Big class discussion:	discuss what students observed and discovered	Share results Did everyone get the same results?
Application/prediction	Use the diagram of the world to predict how ocean currents move around the globe and deep water. Use the ideas shown in today's lesson.	Diagram: blue = cold water, red = warm This is a prediction How do the characteristics of the ocean discussed in today lesson affect circulation of the ocean?
Textbook reading for support	Chapter 13 section 3 Ocean Water Chemistry	Notes on reading, or use as support in written report
Day 2: writing	Begin the day with a discussion about the 3 activities and what they tell us about the oceans. Assist students in writing	Discuss results and implications from activities. Write a report using the SWH template

Resources:

Text book: Simons, B.B. (2002) *Science Explorer: Weather and Climate*. New Jersey: Prentice Hall

Temperature Difference…What's all the fuss about? Main ideas and activity were drawn from: *Understanding oceans* at http://www.discoveryeducation.com/teachers/free-lesson-plans/understanding-oceans.cfm retrieved on 10/08/2015

Does the potato float or sink? Main ideas of the activity were drawn from: *Potato Float* at http://aquarius.umaine.edu/activities/potato_float.pdf retrieved on 10/08/2015

When fresh water meets salt water… The procedure of this activity was retrieved on 10/15/2015 from http://www.cpalms.org/uploads/Resources/final/71508/Document/33993/SalinityLab.pdf

Teacher's SWH template

Teacher	Student
Pre-research: brainstorm: What is difference between ocean water and river/lake water? Does salt change water? What affect does temperature have on water?	*What questions do I have*? Does salt change the properties of water? How does salt change the properties of water? What does this mean to the ocean? What affect does temperature have on water?
Participation/lab design: Warm vs. cold water (temperature test) Does the potato sink or float (salinity test)	*Tests* – what did I do? (discuss, describe the experiments)
Negotiation I: writing personal meaning for laboratory activity	*Claims*: What can I claim?
Negotiation II: Encourages students to discuss data with peers, sharing and comparing with other groups.	*Evidence*: how do I know? Why am I making these claims?
Negotiation III: compare ideas to textbooks or other resources	*Reading*; how do my ideas compare with others?
Negotiation IV: Individual reflection and writing	*Writing:* communicate your understanding
Exploration: engages students in reflection of their understandings and results	*Reflection*: how have my ideas changed? What questions do I still have or now have? What other experiments could I do to answer my questions? How do models play a role in science? Studying the ocean?

Student guide (SWH template) for final report:

What questions do I have?
Tests and data collection: What did I do?
Claims: What can I claim?
Evidence: how do I know? Why am I making these claims?
Reading; how do my ideas compare with others? What does the textbook and other articles say? What other ideas are in science literature regarding temperature and salinity?
Writing: communicate your understandings
Reflection: how have my ideas changed?

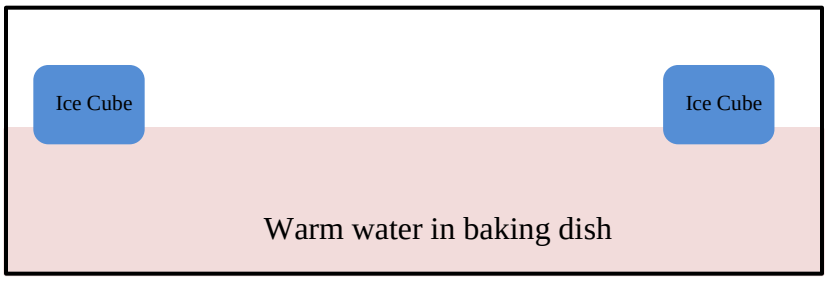
Activity Plan: Temperature difference…What's all the fuss about?
Unit: Ocean

Grade Level/Course: Earth Science 9th grade
Time Period: 10-15 mins

Preparation/Materials:
* Prepare died ice cubes (blue)
* Clear glass baking dishes or clear plastic boxes
* Pitchers of warm water
* Instruct students to draw the initial set up in their notebooks

Initial set up

Warm water does not need to be dyed red; it is in this picture for visualization



Prediction: Have students predict what will happen if you place the ice cubes in the baking dish of warm water (one at each end)

Walk around and be sure each student has a prediction written before they continue on with the experiment.

What do the ice cubes and warm water represent? Why are we putting ice cubes at the ends instead of the middle?

Each group places one ice cube at each end of the dish with warm water

Reaction: As the students watch the ice cubes melt they should be recording their observations and creating drawings of what is occurring.

As the colored ice melts students should observe the cooler water sinking and moving toward the center of the dish, while the warmer water moves towards the ends of the dish near the ice cubes.

Students must record their observations in their notebooks. Discuss as a class group what happened.

Discussion questions:

Why do we use simple models like this?
Can anyone connect this exercise with the real ocean?
What does this mean for the ocean?
How was the water moving?
Did someone push the water? Then why did it move?

Activity Plan: Does a potato sink or float?
Unit: Ocean

Grade Level/Course: Earth Science 9th grade
Time Period: 5-10 mins

Preparation/materials

* Sliced potatoes of the same kind and similar size so each group gets three pieces
* Three Beakers for each group
    - One beaker with tap or distilled water
    - One beaker with salt water
    - One beaker filled with ½ salt water and ½ tap water. Salt water should be placed in beaker first and tap water carefully poured on top. To prevent mixing, pour the tap water down the side of the beaker.

Procedure:

- Ask students to predict what will happen to the potato if it is placed in the beakers with water? Not knowing the difference in the water they will probably say it will sink
- Have students write down their predictions
- Students will place a potato cube in each beaker and record their results; written description and diagram

- Then have students hypothesize why the potato sinks in one beaker, floats in another and becomes suspended in the third.

Activity Plan: When Fresh Water Meets Salt Water
Unit: Ocean

Grade Level/Course: Earth Science 9th grade
Time Period: 15 mins
Note: To save some time, bins of materials could be set up before class

MATERIALS:
- 1 large clear beaker
- clear tap water·
- tap water dyed with blue food coloring
- clear very salty water
- slightly salty water dyed with red food coloring
- very salty water dyed with green food coloring
- masking tape
- 1 beaker
- stirring rod
- two medicine droppers

Part I

1. Fill beaker 3/4 full with clear tap water.
2. Fill medicine dropper with very salty green water.
3. Place one drop of very salty green water into the beaker with clear water.
4. Record observations

Part II

5. Fill beaker 3/4 full with clear salt water.
6. Fill the other medicine dropper with blue tap water.
7. Place one drop of blue tap water into the cup with clear salt water.
8. Record observations

Part III

11. Fill the large beaker half full with very salty green water.
12. Pour clear tap water slowly into 1/4 of the beaker on top of very salty green water.
13. Record observations:

14. Making sure that the dropper is clean, fill the dropper with slightly salty red water.
15. Place the dropper into the layer of very salty green water and squeeze out a drop of slightly salty red water.
16. Record observations:

17. Take the same dropper of slightly salty red water and place it into the layer of clear tap water and squeeze out a drop of slightly salty red water.
18. Record observations:

19. Using the stirring rod, mix the layered water system together.
20. Record observations:

[Outline of notebook]

Brain warm up:
What is the difference between river/lake water and ocean water? Does it matter?

Conclusions that can be made from the experiment:
what does the data tell you? what claims can you make?

Activity 1: Temperature Difference…what's all the fuss about?

Initial set up (drawing)

Prediction:

Result when ice cubes were placed in the dish:
(diagram and description)

(repeat this outline for each activity….initial state, prediction, procedure, observations, results)

Temperature difference…What's all the fuss about?

(Student Handout)

Pre-Activity thinking: Does the temperature of water change anything about the water?

Preparation/Materials:

* Two died ice cubes (blue)
* Clear glass baking dish or clear plastic box
* Pitcher of warm water
* draw the initial set up in notebook

Prediction: what will happen if you place the ice cubes in the baking dish of warm water (one at each end)

Think: What do the ice cubes and warm water represent? Why are we putting ice cubes at the ends instead of the middle?

Go ahead and find out…put an ice cube at each end of the dish and observe what happens

Observations: As the ice cubes melt record your observations and create drawings of what is occurring.

Discussion questions: brainstorm with your group and write down your thoughts

Why is temperature of water important?
What happened between the warm and cold water?
Why do we use simple models like this?
Can anyone connect this exercise with the real ocean?
What does this mean for the ocean?
How was the water moving?
Did someone push the water? why did it move?

Does a potato sink or float?

(Student Handout)

Preparation/materials

* 3 potato cubes
* Three Beakers (A, B, C) already containing liquids

Prediction: What will happen to the potato if placed in the beakers?

Procedure:

- place a potato cube in each beaker, one at a time
- record your results with a written description and diagram

Hypothesis? Make a hypothesis of why you got different outcomes for each beaker. The potato cubes came from the same potato

When fresh water meets salt water

(Student handout)

MATERIALS:

- 2 large clear beakers
- clear tap water·
- tap water dyed with blue food coloring
- clear, very salty water
- slightly salty water dyed with red food coloring
- very salty water dyed with green food coloring
- masking tape
- stirring rod
- two medicine droppers

Part I

1. Fill beaker 3/4 full with clear tap water.
2. Fill medicine dropper with very salty green water.
3. Place one drop of very salty green water into the beaker with clear water.
4. Record observations

Part II

5. Fill beaker 3/4 full with clear salt water.
6. Fill the other medicine dropper with blue tap water.
7. Place one drop of blue tap water into the cup with clear salt water.
8. Record observations

Part III

11. Fill the large beaker half full with very salty green water.
12. Pour clear tap water slowly into 1/4 of the beaker on top of very salty green water.
13. Record observations:

14. Making sure that the dropper is clean, fill the dropper with slightly salty red water.
15. Place the dropper into the layer of very salty green water and squeeze out a drop of slightly salty red water.
16. Record observations:

17. Take the same dropper of slightly salty red water and place it into the layer of clear tap water and squeeze out a drop of slightly salty red water.
18. Record observations:

19. Using the stirring rod, mix the layered water system together.
20. Record observations:

Write a summary of this activity.

Using Red to indicate warm water, blue for cold water and your knowledge of water properties, predict what the ocean currents may look like. Draw them on this map

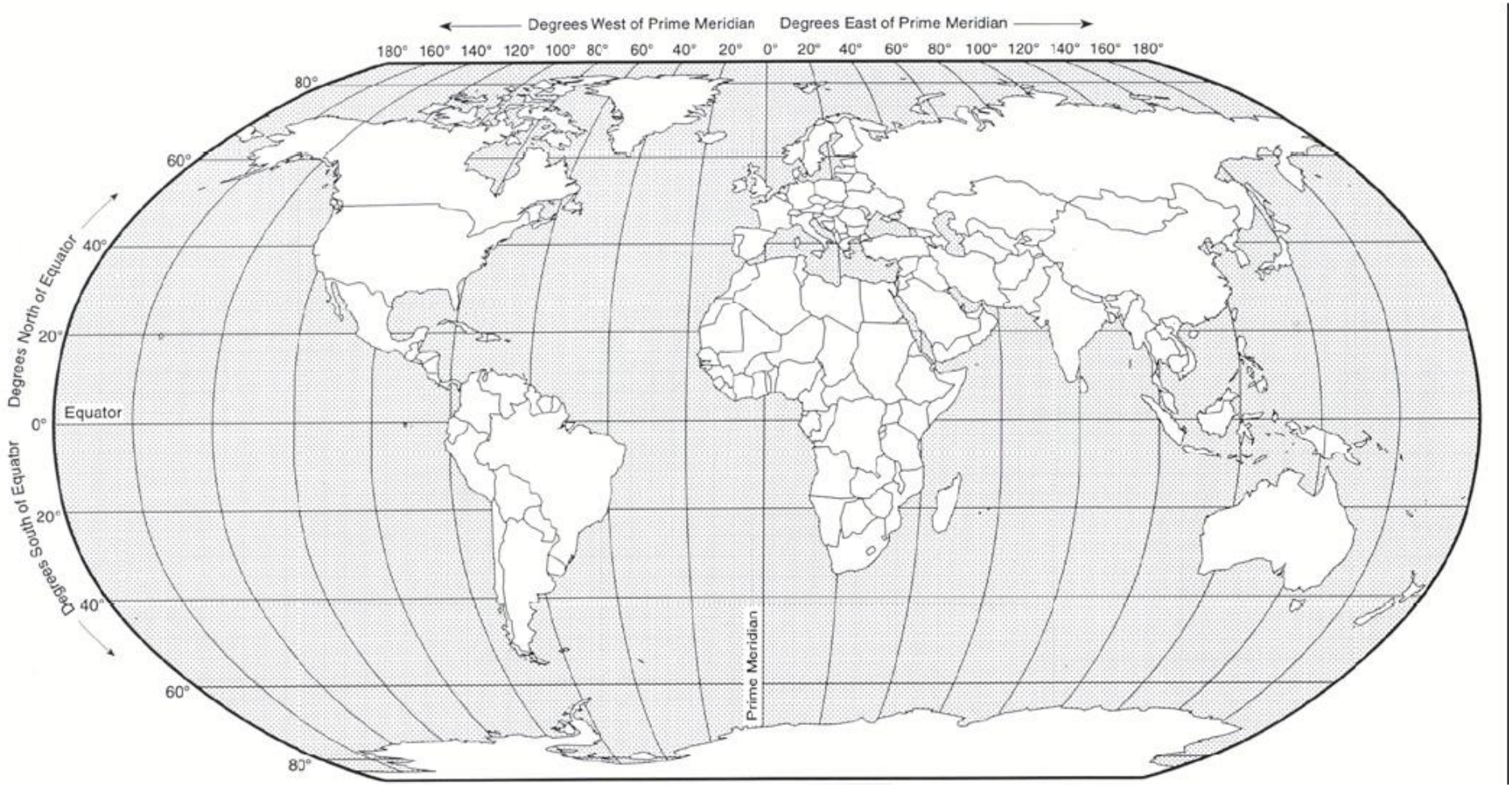


Image retrieved fromhttp://homepage.smc.edu/morris_pete/resources/studyworldmap.jpeg

Lesson Plan: Ocean Currents
Unit: Ocean

Grade Level/Course: Earth Science 9th grade
Time Period: 50 min

Summary: After completing several activities discovering how salinity and temperature affect water and currents during the previous lesson, students are going to read the textbook and start researching threats to our ocean. It is important to study ocean currents since they affect climate, transport food for fish which then feed humans, knowing currents are important if an oil spill were to occur and more. Students will perform brief research during this class of problems in the oceans like acidification, coral bleaching etc. This brief research will lead students to pick a topic for their news article.

Writing focus/purpose: Cornell notes on textbook reading, making connections to previous lessons' activities. Research ideas for news article and write a proposal to the teacher.

Activity:

- text book reading and preliminary research

Material/management and safety issues:

* textbook: Exline, J. D., & Prentice-Hall, I. (2001). *Earth science*. Needham, Mass.: Prentice Hall.
* 3 world maps per student
* Computers with internet connection

Objectives:

- At the end of this lesson students will be able to
    - Create an accurate color coded diagram of the ocean surface currents around the globe on a world map
    - Describe verbally or in writing what effects surface currents and their patterns
    - Explain what El Niño is and why we study it

Standards:

Next Generation Sunshine State Standards:

SC.912.E.7.2: Analyze the causes of the various kinds of surface and deep water motion within the oceans and their impacts on the transfer of energy between the poles and the equator

Next Generation Science Standards:

ESS2.C The Roles of Water in Earth's Surface Processes
ESS2.D: Weather and Climate

Common Core State Standards for Literacy:

CCSS.ELA-Literacy.WHST.9-10.4
CCSS.ELA-Literacy.WHST.9-10.10

CCSS.ELA-Literacy.RST.9-10.2
CCSS.ELA-Literacy.RST.9-10.4

CCSS.ELA-Literacy.RST.9-10.5
CCSS.ELA-Literacy.RST.9-10.6

Academic Language Demands: El Niño, La Niña, ocean currents (surface vs. deep)

Time	Learning Activities:	Writing: Notebook Entries
Brain warm up	What did you learn from the activities in previous lesson? Discuss with class. Have students find their map of their prediction of ocean currents from previous lesson. If they do not have one or did not have time in previous class to complete allow a few mins now Have students put names on the back of their maps, and turn upside down in the center of the table or on the corner of their desk, if desks are not grouped then collect the maps	Write in notebook; concept maps, paragraph writing etc.
10 min	Read text book and take notes Chapter 13 section 4 Currents and climate	Cornell notes
5 -10 mins	Discuss reading and currents, connecting to the activities in the previous lesson	Notes, discussion
Up to 5 mins	Draw/color world map of ocean currents	Draw/color world map of ocean currents, tape into notebook
5 -10 mins	Redistribute the prediction maps How were student's predictions?	Write a comparison between your prediction of currents and the real currents…What was accurate, what was not? Why did you design the currents the way you did? What did you learn?
Remaining time	Discuss Ocean Problems News Article Assist students with beginning search for topic and develop questions	Ask questions, preliminary research
Exit question	What factors influence ocean surface currents? Deep currents?	Answer on scrap paper
		Write proposal to teacher if time allows

Draw the ocean surface currents. Be sure to color code the relative temperature of the currents. Red = warm, Blue = cold ☺

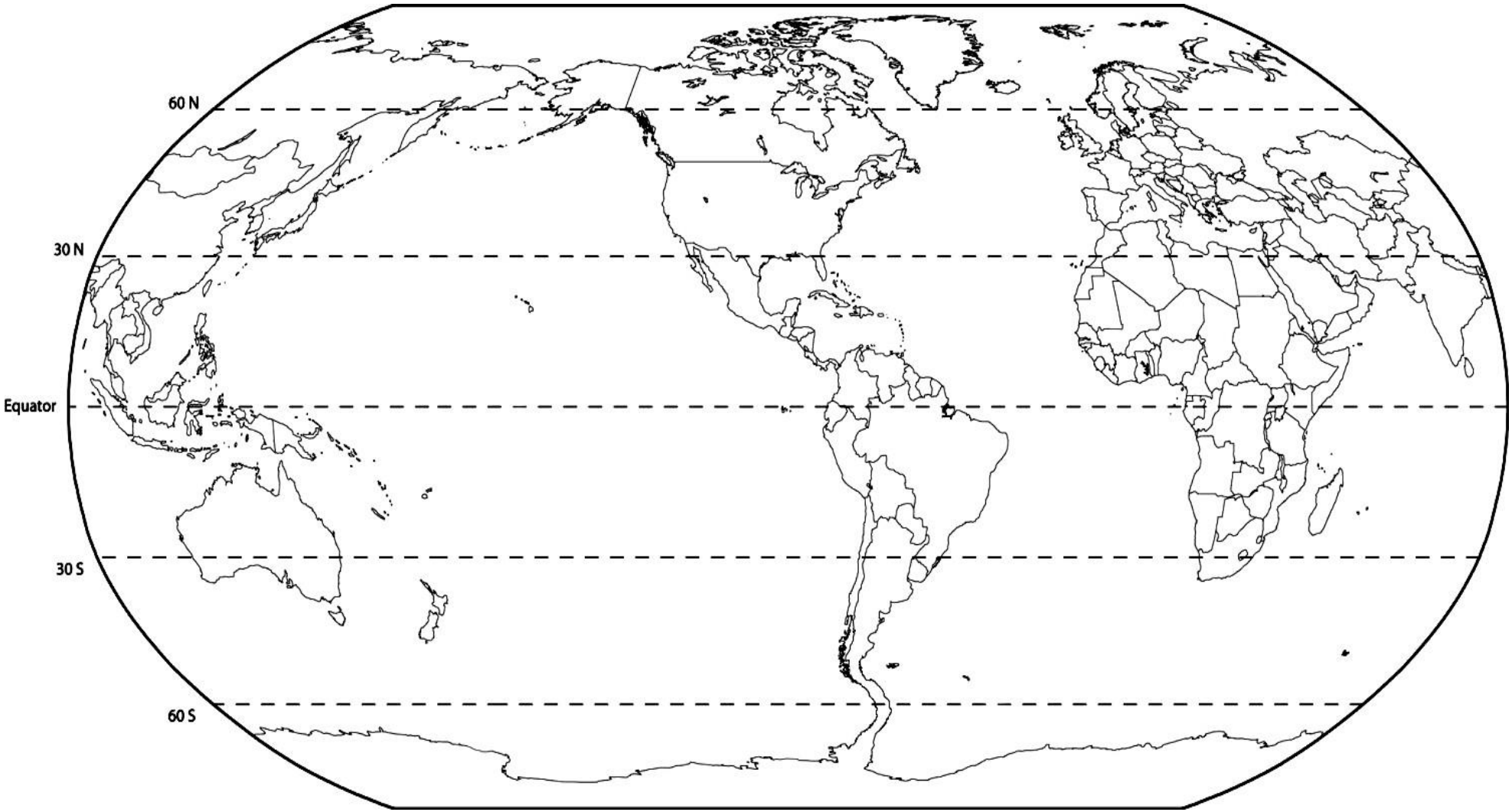


Image retrieved from:
http://p1cdn4static.sharpschool.com/UserFiles/Servers/Server_10640642/File/BuggeD/Oceanography/Ocean%20Water%20Movement/world_no_Drake_Psg.jpg

Lesson Plan: El Niño
Unit: Ocean

Grade Level/Course: Earth Science 9th grade
Time Period: (2) 50 mins class periods

Summary: During this lesson students will learn about El Niño. Several news casts will be shown to encourage students to listen and analyze the information, not just hear the headlines. While listening to the different news casts students will develop questions, critique what is said and look for answers to their own questions. Students will also look into how this weather phenomenon affects their region (Florida).

Writing purpose/focus: Writing will focus on researching students' questions. Students will create an infographic which will contain answers their personal questions and be informative to Florida citizens (students). Students will be posting their infographics on the class website as well as the science wall. Infographics give students the opportunity to act as an advertiser, strengthen summarizing skills, pick out important relevant information and put it all together with graphics to inform the public.

Objectives:

- At the end of this lesson students will be able to
  - describe the conditions of El Niño
  - Draw a diagram of the El Niño circulation compared to normal conditions
  - Critique news casts regarding weather headlines
  - Discuss the potential effects El Niño will have on their local community

Standards:

Next Generation Sunshine State Standards:

SC.912.E.7.2: Analyze the causes of the various kinds of surface and deep water motion within the oceans and their impacts on the transfer of energy between the poles and the equator.
SC.912.E.7.3 Differentiate and describe the various interactions among Earth systems, including: atmosphere, hydrosphere, cryosphere, geosphere, and biosphere.
SC.912.E.7.4 Summarize the conditions that contribute to the climate of a geographic area, including the relationships to lakes and oceans
SC.912.E.7.8 Explain how various atmospheric, oceanic, and hydrologic conditions in Florida have influenced and can influence human behavior, both individually and collectively

Next Generation Science Standards:

ESS2.C: The Roles of Water in Earth's Surface Processes
ESS2.D: Weather and Climate
Crosscutting Concepts:

Energy and Matter: The total amount of energy and matter in closed systems is conserved. Energy drives the cycling of matter within and between systems.

Stability and Change: Much of science deals with constructing

explanations of how things change and how they remain stable

Common Core State Standards for Literacy:

CCSS.ELA-Literacy.WHST.9-10.2
CCSS.ELA-Literacy.WHST.9-10.3
CCSS.ELA-Literacy.WHST.9-10.4
CCSS.ELA-Literacy.WHST.9-10.5
CCSS.ELA-Literacy.WHST.9-10.6
CCSS.ELA-Literacy.WHST.9-10.7
CCSS.ELA-Literacy.WHST.9-10.8
CCSS.ELA-Literacy.WHST.9-10.10

CCSS.ELA-Literacy.RST.9-10.1
CCSS.ELA-Literacy.RST.9-10.2
CCSS.ELA-Literacy.RST.9-10.4
CCSS.ELA-Literacy.RST.9-10.5
CCSS.ELA-Literacy.RST.9-10.7

CCSS Speaking and Listening #2: Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally
CCSS Speaking & Listening Anchor #3: Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric.
CCSS Speaking and Listening #5: Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

Academic Language Demands: New Vocabulary

El Niño
La Niña

Time	Learning Activities:	Writing: Notebook Entries
Warm up	What do you know about El Niño? What is it? Why do we care?	(L) brainstorm, KWL chart
10 min	ABC News NBC News After watching these short videos, have students reflect on them? How do they feel about El Niño? Which news cast best informs the public of the potential weather ahead?	(R) What does the media focus on? How does it grab your attention? How do you feel after watching these news segments?
15 mins	El Niño Introduction The video above focuses on El Niño and how it will effect California, what does it mean for Florida? Or Buffalo NY?	(R) Draw the normal conditions in the Pacific Ocean

		Draw the El Niño conditions
Discussion	Discuss in groups about the interaction between the ocean and the atmosphere	(R) record discussion ideas and points made
Guiding Questions	What data do meteorologists use? What criteria are needed for El Niño to be classified?	(R)
Design Infographic	Provide students with posters, markers, colored pencils, internet access Show students examples on projector/smart board, or use the supplied examples Students may work in groups up to 3. If students work with partners they will need to complete a partner evaluation To step up the seriousness of this project: Create a contest, have a voting box in hallway where students and teachers in the school vote on the posters….two categories: (1) most informative and (2) most creative	(R) use RAFT to organize thoughts on designing infographic
Information resources	http://www.srh.noaa.gov/mlb/?n=mlbnino http://www.elnino.noaa.gov/	

(outline of student notebook)

Brain warm up:

What I know about El Niño:
Why do I care?

What I know	Want to Know	What I learn

Reflection of Lesson:

(What I now know about El Niño?
Did my views or understanding change?)

Comparison of News Casts:

(guiding questions: What did they news casters do to get my attention? What did I learn from the news cast? How do I feel about this news?)

Comparison Drawings of Normal Circulation in the Pacific and an El Niño circulation

Brainstorm:
What is an infographic?

ROLE: 1.) As the writer I am .... (a scientist, science journalist, news reporter etc.) 2.) My task is.... 	
AUDIENCE: Who am I writing to? 	
FORMAT: 1.) What form is the writing? (Journal, letter to editor, news article, comic, poem etc.) 2.) What are important features or sections of the form of writing I should include?	
TOPIC: 1.) What is the writing about? 2.) Questions to be answered? 3.) My Point of View (if needed) 4.) Questions I have for future research	

Name: _____

Information graphics or infographics are graphic visual representations of information, data or knowledge intended to present information quickly and clearly. (Wikipedia)

Your Mission: You need to create an infographic that informs people of El Niño.

a) Inform and educate peers about El Niño and the potential of a strong one this year (what is El Niño? and what are the indicators this year's will be strong?)
OR
b) Inform peers of the potential for a strong El Niño this year and its potential effects on Florida (what are the indicators this year's El Niño will be strong and what does this mean for Floridians?)

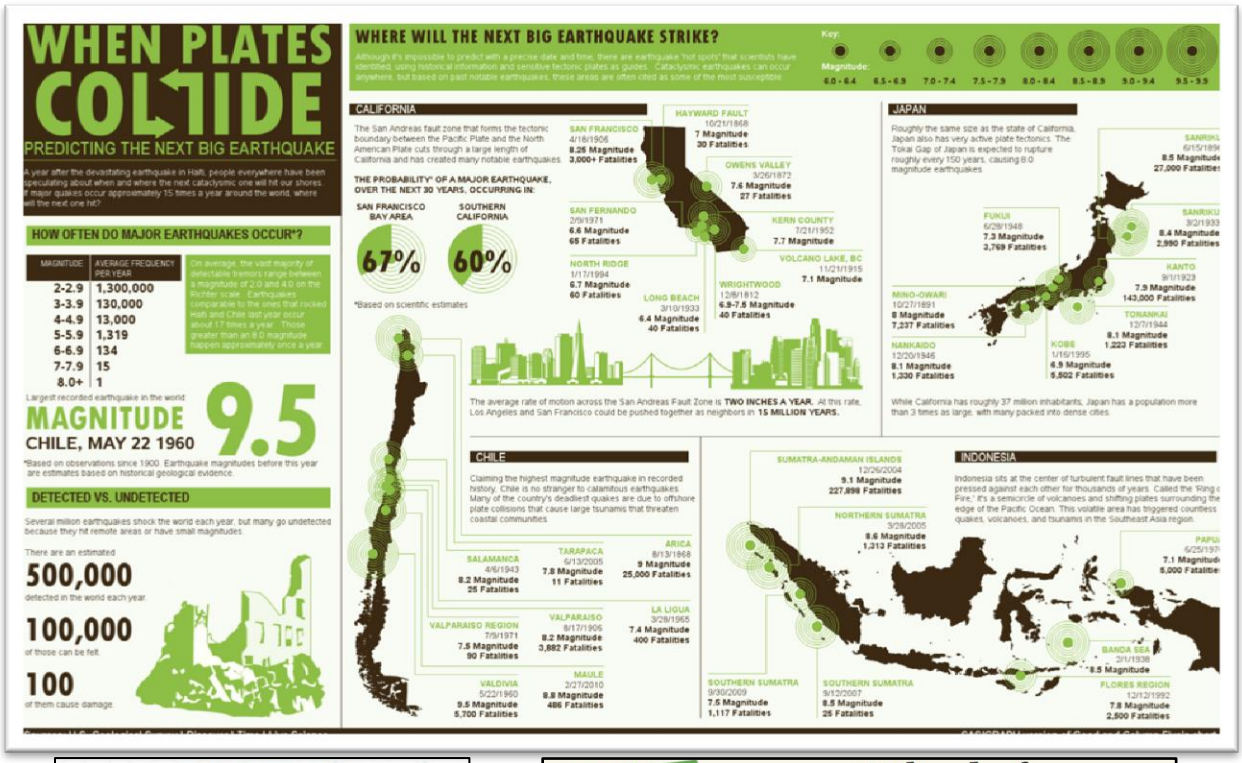
Criteria;

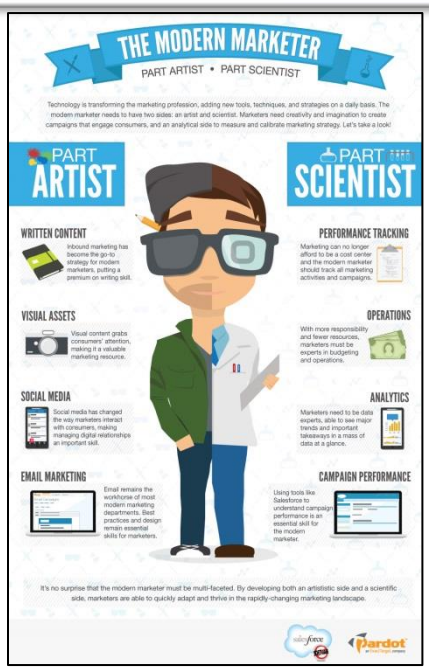
1) Pick (a) or (b) for your focus
2) Create an info graphic on provided poster
    a. You may print and past pictures
    b. You may type and print information
3) Cite sources of graphics and information (no plagiarism, all pictures and information on internet come from somewhere)
4) May work in groups up to 3 in a group
    a. If you choose to work in a group you will complete a partner evaluation
5) Your design needs to be informative to your peers. The final posters will be posted on the Science wall (in hallway) to be voted on: most informative and most creative

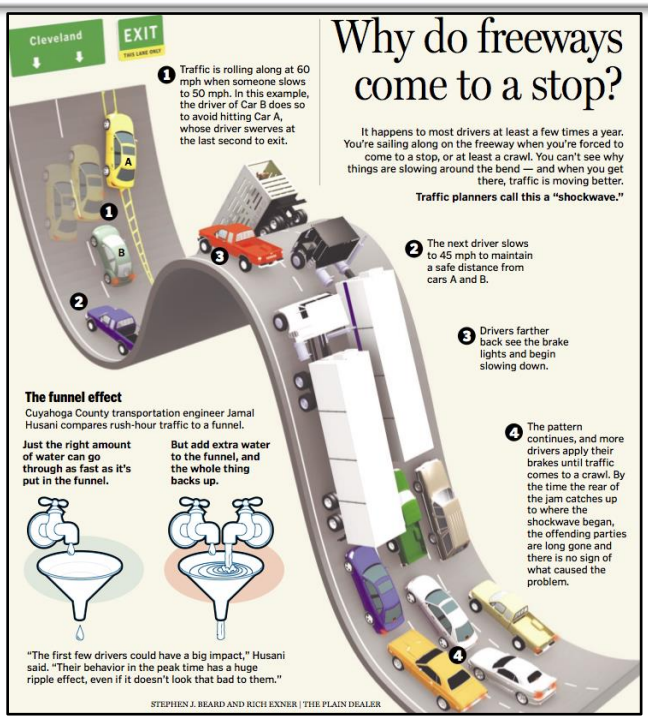
Rubric for El Niño Infographic

	10	8	6	4 or less
Accuracy of graphics	All information and graphics are relevant, accurate and make topic easier to understand. All graphics are cited properly	All graphics are relevant, most of information is accurate. Most graphics are cited properly	Most graphics are relevant and properly cited	Graphics are unrelated to topic, or are not cited
Accuracy of information	Has at least 7 accurate facts	5-6 accurate facts	3-4 accurate facts	Less than 3 accurate facts
Presentation	Makes excellent use of font, color, graphics, effects, etc. to enhance the presentation.	Makes good use of font, color, graphics, effects, etc. to enhance to presentation.	Makes use of font, color, graphics, effects, etc. but occasionally these detract from the presentation content.	Uses of font, color, graphics, effects etc. but these often distract from the presentation content.
Proofreading	There are no grammatical mistakes.	There is 1 grammatical mistake	There are 2 grammatical mistakes.	There are more than 2 grammatical mistakes.
Vocabulary	The authors correctly use several new words and uses words from previous units	The authors correctly use a few new words	The authors try to use some new vocabulary,	The authors do not incorporate new vocabulary.
Organization	Content is well organized and thought out	Content is organized	Organization of ideas is questionable	There is no clear or logical organization of content
Neatness	Takes great care in producing text, graphics etc. Neatly put together. Looks professional	Text is legible and graphics are neat. Neatly organized and put together for the most part	Some text is illegible or too small. Somewhat neatly organized	Text is illegible, not much care or effort has been put into this project

Examples of infographics: these graphics were found during a Google search; individual sites are as follows;
"When Plates Collide" http://blogs.sas.com/content/sastraining/files/2013/04/plates_collide.png
"The Modern Marketer" https://www.pinterest.com/aenzastiga/infographics/
"Why do Freeways come to a stop" http://bloggingbistro.com/5-essential-components-of-a-compelling-infographic/







Student Project: Ocean News
Unit: Ocean

Grade Level/Course: Earth Science 9th grade
Time Period: several days depending on how much class time is allowed and the writing abilities of students

Summary: *Ocean News*: Problems in the Ocean. There are many problems occurring in the ocean or could potentially occur in the ocean like an oil spill. Students will choose a topic and write a news article about how this is a problem, what is causing it (if known), what effects it has on the future health of the ocean/environment and what could possibly be done to reverse or slow the process. Questions to be answered are flexible and dependent on topic. This writing assignment is intended to help students understand the thought that though the ocean is large it plays a vital role in the health of our planet, thus is very important to understand and study. There are many different directions students can take this project, they need to choose what is interesting to them. Time permitting, students may present their paper to the class by creating a PowerPoint (or similar) presentation.

Writing focus/purpose: Proposal and news article writing. Students are required to use a graphic organizer like the RAFT or SWH to guide them through the research. By this time in the year students will have used both RAFT and SWH several times and can pick one to best fit their learning style. Students will be self-assessing and peer reviewing articles. Rewrites are acceptable if student talks to teacher.

Material/management and safety issues:

* computer, notebooks, internet

Objectives:

- At the end of this lesson students will
  - Write a news article focused on a central question developed by the student about a current problem with the ocean
  - Present the problem/question and research with a multi-media presentation
  - Discuss their research with a person outside of the science community

Standards:

Next Generation Sunshine State Standards:

SC.912.N.1.1: Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science, and do the following

SC.912.N.1.4: Identify sources of information and assess their reliability according to the strict standards of scientific investigation

SC.912.E.7.8: Explain how various atmospheric, oceanic, and hydrologic conditions in Florida have influenced and can influence human behavior, both individually and collectively.

Next Generation Science Standards:

ESS2.C: Roles of water in Earths' Surface processes

ESS2.E: Biogeology

Common Core State Standards for Literacy:

CCSS.ELA-Literacy.WHST.9-10.2
CCSS.ELA-Literacy.WHST.9-10.3:
CCSS.ELA-Literacy.WHST.9-10.4
CCSS.ELA-Literacy.WHST.9-10.5
CCSS.ELA-Literacy.WHST.9-10.6
CCSS.ELA-Literacy.WHST.9-10.7
CCSS.ELA-Literacy.WHST.9-10.8
CCSS.ELA-Literacy.WHST.9-10.9
CCSS.ELA-Literacy.WHST.9-10.10

CCSS.ELA-Literacy.RST.9-10.1
CCSS.ELA-Literacy.RST.9-10.2
CCSS.ELA-Literacy.RST.9-10.4
CCSS.ELA-Literacy.RST.9-10.5
CCSS.ELA-Literacy.RST.9-10.6
CCSS.ELA-Literacy.RST.9-10.8
CCSS.ELA-Literacy.RST.9-10.9

CCR Speaking and Listening #5: Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations

Teacher Supported research	Writing: Notebook Entries
Teacher supported research Guide students with questions to focus their research	Most of students' work for this research should be written in their notebooks using various forms of a graphic organizer or note taking
Preliminary Research: find a topic of interest and develop questions Teacher may want to have a list of topic ideas to help students move along. A few are provided with this lesson	Find a topic and develop questions
Assist students in research proposal	Write a proposal to teacher
Talk to students one on one to discuss their proposal and ideas	Teacher conference to discuss proposal
	Research and write article
	Prepare presentation

A few Starter Resources for Ocean Problem Research

Ocean Acidification: NOVA movie, 5 mins

Ocean Methane: http://www.sciencedaily.com/releases/2015/10/151014132455.htm
A very interesting article regarding methane release in the ocean

Oil Spills

Oceanography News:
http://www.sciencedaily.com/news/earth_climate/oceanography/
Good place to start for ideas that are currently being researched by scientists

Environmental News: http://www.enn.com
Type in ocean or specific topic in the search bar

Ocean Conservation: http://ocean.si.edu/gulf-oil-spill
From the Smithsonian National Museum of Natural History. Information about oil spills, overfishing, pollution, invasive species and more. Look at the conservation tab.

NOAA: National Oceanic and Atmospheric Administration: http://www.noaa.gov/ocean.html
Always a great place for data and scientific research

World Wide Fund for Nature (WWF):
http://wwf.panda.org/about_our_earth/blue_planet/problems/
Lists major threats to the ocean.

Daily News Brief articles

Remember to determine if the site and information is credible, you can always cross check information with other sources and you can always ask your teacher or librarian.

Ocean News Article

(To the Student)

Your Mission:

Part #1: As a member of the student science team your mission is to research a problem occurring in our oceans and report it to your peers. This research is wide open for you to design around your interests and questions.

Part #2: Create a PowerPoint (or other multimedia) presentation to your peers.

** These presentations will be posted on the class website for peers to look at. For **extra credit** you may sign up to present your research to the class. You must be prepared for a discussion style presentation not just presenting information.

Part #1 Writing Requirements:

- Write a proposal to the teacher including:
  - Topic
  - A central question as focus of your research
  - How did you learn about this topic? Website? An article? Friend?...
  - Do you want to present to class?

- Use a research **organizer**: RAFT or SWH, Cornell note taking is highly encouraged to keep organized notes from various sources

- **Sources**: at least 3 credible sources

- L**ength** is always a question: I want a scientific report. NO FLUFF, just facts. It is more important to focus on fully answering the questions you pose than to be concerned about length of your paper. (A 10 page paper full of fluff will tell me less than a 5 page paper written scientifically focused on facts). A news article is brief and to the point. This is not a full length research style paper.

- Formatting: 12 pt Times New Roman

- A "catchy" title: think of what catches a reader in a news headline

- Have a peer review your paper before turning it in. There will be class time set aside for this

Part #2 Presentation Requirements:

- Create a presentation for your peers. Can be any multimedia presentation format as long as it is appropriate and understandable

- Outlines the main ideas and questions of your article: think of a news report

Self-assessment of Ocean News article

The following questions the author (student) should ask themselves while writing this article. These questions will be asked by the teacher while grading the article. With minor adjustments the following questions were retrieved from page 150 of Saul, W., Kohnen, A., Newman, A., & Pearce, L. (2012). *Front-page science: Engaging teens in science literacy*. Arlington, VA: NSTA Press.

1. Topic: Does the topic of the article meet the following criteria: threat to the world ocean, focused on one specific problem

2. Sources: Does the article contain multiple sources of information with various kinds of expertise and/or perspectives?

3. Sources: Are there places in the article where information needs to be attributed or cited?

4. Sources: Is there enough information provided about the sources to establish credibility? Are sources cited at the end of the article?

5. Sources: are there any sources with questionable credibility?

6. Context: Does the article provide details about how the topic fits into the world? Thoughts of: Costs involved? How many people are affected, how does this problem affect humans, is there technology involved or being created, is there political or economic consequences, is the content accepted or controversial? Are there special interest groups/agencies involved?

7. Relevance: does the article answer the author's or reader's questions?

8. Accuracy: Does the author explain all of the science accurately? Are all unfamiliar terms defined?

9. Do you feel your article is Awesome / Pretty good / So-So / Needs Work

[Peer Review check: This rubric was retrieved from page 151 in Saul, W., Kohnen, A., Newman, A., & Pearce, L. (2012). *Front-page science: Engaging teens in science literacy*. Arlington, VA: NSTA Press.]

The article being assessed contains: check the box that applies to the article

	Complete or nearly complete	Needs improving	Absent
1. Two or more sources of information that are credible and properly attributed	□	○	◊
2. Viewpoints from more than one perspective, when appropriate	□	○	◊
3. A clear explanation of the science content, which indicates a basic understanding by the author	□	○	◊
4. Assertions that are reasonable; if not attributed, are within the general knowledge of the audience	□	○	◊
5. Information is relevant to readers	□	○	◊
6. Information that is factually accurate	□	○	◊

Comments to the author:

Printed Name of peer reviewer: _____

Signature of peer reviewer:_____

Rubric for Ocean Problem News Article

Drafting	4	3	2	1	0
Proposal	Proposal for topic has been completed and includes all parts required with great detail	Proposal has been completed and includes at least 3 of the required elements. Detailed is less than a 4	Proposal has been completed with only 2 of the required elements. Lacks detail	An attempt was made to create a proposal with at least one of the required elements. Lacks detail	No attempt made in proposal
Graphic Organizer	Graphic organizer (RAFT or SWH) has been completed and shows clear, logical relationships between all topics and subtopics.	Graphic organizer (RAFT or SWH) has been completed and shows clear, logical relationships between most topics and subtopics.	Graphic organizer (RAFT or SWH) has been started and includes some topics and subtopics.	Graphic organizer (RAFT or SWH) template has been included without any additional writing	Graphic organizer (RAFT or SWH) has not been attempted.
Teacher Conference	Completed	----	----	----	Did not complete
Self-assessment	Completed	----	----	----	Did not complete
Peer Reviewed rough draft	Draft completed, peer reviewed with comments, completed rubric and signed	Draft completed. Peer reviewed with only comments and signature	Draft completed. Peer reviewed with only a signature	Draft completed. No peer reviewed evident	No attempt at a rough draft

Rubric used by the teacher and peers for grading of final Ocean News article

Article	10 "Out of this world awesome"	9 "Amazing work"	8 "Outstanding"	7 "Needs some pizazz"	6 "Are you on board?"	5 "Where are you?"
Topic	Clearly stated and defined as a problem in the ocean	Defines problem in the ocean, may need little more focus	Defines the problem but with questions, may be missing location or clarity	Not directly stated as a problem in the ocean.	Where is the problem?	What is your topic? No focus to the topic
Questions asked	Questions raised to answer are deeply thought about	Questions raised are appropriate and well thought out	Questions are appropriate	Questions need some more thought	Questions are not relevant or are too basic	Good try however, those questions can be found in the textbook
Relevance	Information is well organized, clearly written and thoughtfully answers the research questions. May raise more questions for further research	Information is well organized, clearly written and answers the research questions	Information is organized and clearly written, does not answer all of the questions	Information is not well organized, written well, does not answer all of the research questions	Information is not clearly written, does not answer all of the research questions, contains too much fluff	There are lots of words. Information is unorganized, does not answer research questions and may be irrelevant, full of fluff
Sources	Contains more than 3 *credible* sources and cited properly	Contains at least 3 credible sources and cited properly	Contains 2 credible sources cited properly	Contains 1 credible source cited properly	Does not cite credible sources properly	Does not contain credible sources or cites sources not used in article
PowerPoint or other form of presentation	Contains all required elements, goes beyond expectations in presentation	Shows in depth reflection of topic question. Contains all required elements. Lacks the pizazz of a 10	Shows basic understanding of topic and answers focus question. Contains most of the required elements	Shows some understanding. Lacks research and required elements	Limited effort shown in research. Missing most of required elements	Turns in words on slides. Shows no understanding of topic, lacks organization

Name of Student: _____

Title of article: _____

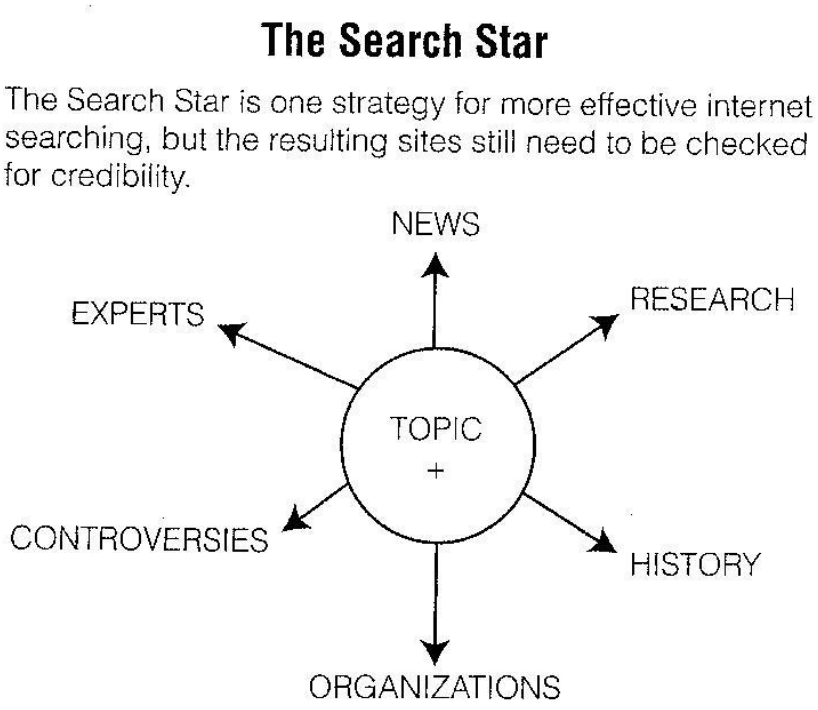
Final Grade on Ocean News Article/Project

Category	Points Earned
Drafting /20	
Article /50	
PowerPoint or other style of presentation /10	
Extra Credit Presentation /10	
Final Grade /80	

A rewrite is always acceptable to regain some points, see teacher if you want to rewrite.

Teacher comments:

[This graphic can be used to help students direct their questions on a topic and gives ideas of directions to research. For a well-rounded article students should investigate several of these aspects, depending on their central question.]



[Image retrieved from page 97 in Saul, W., Kohnen, A., Newman, A., & Pearce, L. (2012). *Front-page science: Engaging teens in science literacy*. Arlington, VA: NSTA Press.]

This rubric is designed for use with partner activities/projects for students to grade their partner's contribution to the group. It is designed with hopes of encouraging students to participate and work together as a team.

Project_____ Name:_____
Date _____

Rubric created with rubistar.4teachers.org

Peer Evaluation	4 points	3 points	2 points	1 points
Contributions	Routinely provides useful ideas when participating in the group and in classroom discussion. A definite leader who contributes a lot of effort.	Usually provides useful ideas when participating in the group and in classroom discussion. A strong group member who tries hard!	Sometimes provides useful ideas when participating in the group and in classroom discussion. A satisfactory group member who does what is required.	Rarely provides useful ideas when participating in the group and in classroom discussion. May refuse to participate.
Attitude	Never is publicly critical of the project or the work of others. Always has a positive attitude about the task(s).	Rarely is publicly critical of the project or the work of others. Often has a positive attitude about the task(s).	Occasionally is publicly critical of the project or the work of other members of the group. Usually has a positive attitude about the task(s).	Often is publicly critical of the project or the work of other members of the group. Often has a negative attitude about the task(s).
Preparedness	Always brings needed materials to class and is always ready to work.	Almost always brings needed materials to class and is ready to work.	Almost always brings needed materials but sometimes needs to settle down and get to work	Often forgets needed materials or is rarely ready to get to work.
Pride	Work reflects this student\'s best efforts.	Work reflects a strong effort from this student.	Work reflects some effort from this student.	Work reflects very little effort on the part of this student.

Rubric for Notebook Appearance

This rubric is created to give students a guideline in what is important in keeping a science notebook, keeping it organized and personal.

Notebook Appearance	Unit Cover page	Pages
5 "Totally Awesome"	- Includes Title of Unit - Artistic with lots of color…"Exciting" - Page covered with words and pictures pertaining to Unit	Contains all information Dates, #s, and labels
4 "Awesome"	- Includes Title of Unit - Lacks color - Page is full of pictures and words pertaining to Unit	Contains most of the Dates, #s and labels
3 "Pretty Good"	- Includes Title of Unit - Lacks color - page only contains words - Lacks pictures	Missing a few Dates, #s or labels
2 "Kick it up a Notch"	- Missing some Units - Lacks color and personal touch - words and/or pictures are not relevant to units	Missing several Dates, #s, and/or labels
1 "Better Get Moving"	- Page Only includes title - Missing more than it contains -words and/or pictures are not relevant to units	Missing most of the Dates, #s, and labels
0 "What are you thinking?"	- No effort - few to No Unit title pages - Lacks personal touch - words and/or pictures not relevant to units	Contains few to no dates, #s, and labels
Total points Earned		
Teacher Comments:		

Titles for points retrieved from Marcarelli, K. (2010). Teaching science with interactive notebooks. Corwin press. Page 154.
Other sources: Chesbro, R. (2006). Using interactive science notebooks for inquiry-based science. *Science Scope, 29*(7), 30–34.
Young, J. (2003). Science interactive notebooks in the classroom. *Science Scope, 26*(4), 44–47.

This rubric is designed for assessment on the quality of notebook entries. Individual activities may have a different rubric. This is a general guideline for students and teacher for expectations

Notebook Writing

	Left side	Right Side
10	- Shows deep personal and prior knowledge connections are made to learning concepts - Writing shows deep understanding - Goes beyond expectations for personalization and writing - Contains all required work and more	- Lecture notes go beyond basic requirements - Color enhances diagrams/pictures - Diagrams, pictures and data are *labeled and detailed* - Data clearly written - Shows care and attention to concepts and quality of work - Contains all required work and more
9	- Much like a 10 but lacks some "pizazz" - Reflections are in depth - Shows understanding but not as in depth - Follows basic requirements, does not go beyond - Contains all required work	- Lecture notes are fairly detailed - Notes meet requirements, do not go beyond - Color enhances diagrams/pictures - Diagrams labeled with some details - Contains all required work - Shows care and attention to concepts and quality of work
8	- Written reflections are not in depth - Reflections are difficult to follow/understand - Writing shows some understanding - Basic requirements are met - Missing some parts to work	- Lecture notes meet requirements without detail - Some color is used for enhancement of diagrams/pictures/data - Diagrams/pictures/data are labeled with little to no details - Missing some (< 25%) work - Shows care and attention to concepts and quality of work, neat and organized
7	- writing is fragmented, not complete sentences - reflections are not personalized - Does not show understanding of concepts - fairly organized	- Lecture notes are not complete (missing <50%) - No color used for enhancement of diagrams/pictures/data - Most of diagrams/pictures/data are labeled, no details - Missing a great amount of work - Shows care and attention to concepts and quality of work, neat and organized
6	- Written work does not show understanding of concepts - writing very fragmented and difficult to read (illegible) - Reflections do not correspond to Right side activities/notes - Unfinished work - Unorganized	- Lecture notes are incomplete, more than 50% are missing - No color - More than 50% of diagrams/pictures/data are not labeled, no details - Data is missing or inaccurate without explanations - Missing a great amount of work - Writing is sloppy, little to no care is taken in neatness and organization
5-4	Teacher discretion about how much is complete and neatness	Teacher discretion as to how much is complete and neatness
3	- Notebook turned in - Most pages are blank - very few reflections - writing is brief - Does not show understanding - does not show personalization	- Notebook turned in - pages only contain blank templates - little to no diagrams or pictures - sloppy writing, illegible - no care taken - no color

	- unorganized, sloppy, does not show pride in work	- Does not meet requirements - work not completed
0	- written material is not relevant to lesson material - notebook is not turned in	- diagrams, pictures, data missing and/or is not relevant to lesson material - notebook is not turned in
Total Points Earned:		
Teacher Comments		

Sources: Chesbro, R. (2006). Using interactive science notebooks for inquiry-based science. *Science Scope, 29*(7), 30–34.
Marcarelli, K. (2010). Teaching science with interactive notebooks. Corwin press. Page 154.
Young, J. (2003). Science interactive notebooks in the classroom. *Science Scope*, *26*(4), 44–47.

(Vocabulary Word)		
Pronunciation (your own style)		
DEFINITION (Text book)	[be sure to define any words unknown]	
EXPLANATION OR EXAMPLE OF THE PROCESS	<u>Examples</u>	<u>Non-examples</u>
ILLUSTRATION, DIAGRAM, SYMBOLS		
REFERENCES AND/OR WEBSITES		
RELATED TERMS OR TOPICS		

Common Core State Standards for *Writing* in Science

Retrieved from: http://www.corestandards.org/ELA-Literacy/WHST/9-10/

Text Types and Purposes:

CCSS.ELA-Literacy.WHST.9-10.1: Write arguments focused on discipline-specific content.

> CCSS.ELA-Literacy.WHST.9-10.1.a: Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
>
> CCSS.ELA-Literacy.WHST.9-10.1.b: Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.
>
> CCSS.ELA-Literacy.WHST.9-10.1.c: Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
>
> CCSS.ELA-Literacy.WHST.9-10.1.d: Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
>
> CCSS.ELA-Literacy.WHST.9-10.1.e: Provide a concluding statement or section that follows from or supports the argument presented.

CCSS.ELA-Literacy.WHST.9-10.2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

> CCSS.ELA-Literacy.WHST.9-10.2.a: Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
>
> CCSS.ELA-Literacy.WHST.9-10.2.b: Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
>
> CCSS.ELA-Literacy.WHST.9-10.2.c: Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

CCSS.ELA-Literacy.WHST.9-10.2.d: Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

CCSS.ELA-Literacy.WHST.9-10.2.e: Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

CCSS.ELA-Literacy.WHST.9-10.2.f: Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

CCSS.ELA-Literacy.WHST.9-10.3: Write narrative to develop real or imagined experiences or events using effective technique, well-chosen details and well-structured event sequences. (See note; not applicable as a separate requirement)

Production and Distribution of Writing:

CCSS.ELA-Literacy.WHST.9-10.4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CCSS.ELA-Literacy.WHST.9-10.5: Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

CCSS.ELA-Literacy.WHST.9-10.6: Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge:

CCSS.ELA-Literacy.WHST.9-10.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

CCSS.ELA-Literacy.WHST.9-10.8: Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

CCSS.ELA-Literacy.WHST.9-10.9: Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing:

CCSS.ELA-Literacy.WHST.9-10.10: Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

*Note: Students' narrative skills continue to grow in these grades. The Standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.

Common Core State Standards for *Reading* in Science

Retrieved from: http://www.corestandards.org/ELA-Literacy/RST/9-10/

Key Ideas and Details:

CCSS.ELA-Literacy.RST.9-10.1: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

CCSS.ELA-Literacy.RST.9-10.2: Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

CCSS.ELA-Literacy.RST.9-10.3: Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure:

CCSS.ELA-Literacy.RST.9-10.4: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

CCSS.ELA-Literacy.RST.9-10.5: Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

CCSS.ELA-Literacy.RST.9-10.6: Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas:

CCSS.ELA-Literacy.RST.9-10.7: Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

CCSS.ELA-Literacy.RST.9-10.8: Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

CCSS.ELA-Literacy.RST.9-10.9: Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Range of Reading and Level of Text Complexity:

CCSS.ELA-Literacy.RST.9-10.10: By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.

Standards were retrieved from http://www.corestandards.org/ELA-Literacy/RST/9-10/ on October 16, 2015

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