Metamorphosis: Transformative Experiences
Understanding the Scientific Process through a Study of
Plants and Animals: How Biotic and Abiotic Factors Affect Change!

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This curriculum unit is recommended for:
Middle Grades Science Earth Science

Keywords: Metamorphosis, Scientific Process, Cellular Respiration, Photosynthesis, Bivalve, Life Cycle of Butterfly

Teaching Standards: See AppendixOnefor teaching standards addressed in this unit.

Synopsis: Metamorphosis is the experience of change or alteration of one's original being and design. During this unit students will investigate the Scientific Process through a study of biotic and abiotic factors and how they affect change within their environment. Students will manipulate variables to affect the growth of land based and aquatic plants. Students will apply this research to a study of caterpillars and bivalve organisms and how the metamorphosis of each is affected by its environment. Students will work with their learning team to design and perform independent investigations to test a hypothesis about their chosen organism. Students will design a digital presentation and share their research and conclusions with the class.

I personally plan to teach this unit during the 2014-2015 school year in Sixth Grade Science to 180 students.

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The butterfly's attractiveness derives not only from colors and symmetry: deeper motives contribute to it. We would not think them so beautiful if they did not fly, or if they flew straight and briskly like bees, or if they stung, or above all if they did not enact the perturbing mystery of metamorphosis: the latter assumes in our eyes the value of a badly decoded message, a symbol, a sign.
~Primo Levi

Introduction

Carmel Middle School serves over 1000 students in grades 6-8. Geographically, the school is located in an affluent suburban setting of Charlotte, NC in the Charlotte-Mecklenburg School District. 43% of our students qualify for free and reduced lunch. We are a racially diverse school of approximately 1.8% Asian, 18.8% Hispanic, 22% African American, and 55.4% White. 82% of our 8th grade students scored at or above grade level on the Science EOG and Carmel DID make Adequate Yearly Progress in 2012-2013 school year. Our school is fortunate to have an active PTSA and exceptional parental support. I teach sixth grade science on a rotating A day B day schedule. I teach the same lesson to six different classes over the course of two days. My classes are a heterogeneous group of students of varying abilities and science backgrounds. I create differentiated activities within the content objective to meet the diverse educational needs of my students.

My science curriculum is based on the North Carolina Essential Standards and paced according to the CMS yearly pacing guides. Activities are chosen that will create an inquiry based science experience for my students. Most lessons are interactive and are divided into teacher input, guided practice or additional investigation, independent practice or group inquiry activity, explanation of results or investigations, and finally additional questions or ideas to explore. I incorporate the use of a SmartBoard and video clips from Discovery Education, Study Jams, You Tube, and National Geographic on a daily basis. Last year we implemented the use of Discovery Education's Tech Book into our Science curriculum. This online resource provides a variety of video clips, reading passages, and activities through which to engage students. Students use my classroom desktop computers and a class set of Google Chrome Books to access a variety of web-based resources for both instructional input and interactive activities which supplement our informational text source. As a product of Bring Your Own Technology to school, students will be able to interact with our web resources in a more inclusive manner. I use

an iPad in my classroom and incorporate a variety of both content and product apps during classroom instruction. Throughout instruction I engage students by including hands-on activities, labs, and/or investigations during most class periods. Labs and activities include both teacher directed inquiry labs and student created labs which address a general inquiry question. Students frequently participate in learning stations consisting of both research based and hands-on activities.

Rationale

Sixth Grade is a unique experience from other middle school grades. Students come to me from multiple elementary schools and have been exposed to varying levels of science education. In order to assess and compensate for the inevitable learning gaps that exist, I conduct a formative assessment at the beginning of the year and then adjust my instruction as appropriate. Last year I incorporated student learning teams into my instructional strategies. These teams worked together throughout the school year and served as another level of accountability within the learning environment. As a function of the North Carolina teacher evaluation measure, learning teams contribute to a student's acquisition of twenty-first century skills and increase critical thinking practices. I will continue with the learning teams this year and find this unit on Metamorphosis and Change most conducive to the practice. Students will document change in themselves, their plant or animal specimen and their learning team. To facilitate the combining of and building upon prior knowledge, I intend to further integrate interactive technology into my instructional practices and use technology to allow students to create digital products to demonstrate mastery of concepts. Students will use technology to research topics, record data, and create presentations to share with their peers. Technology adds an element of relevance and rigor within the educational environment. Students will be instructed in appropriate digital citizenship and web-based applications in order to maximize the acquisition of science concepts.

My middle school incorporates a Language Arts program called Springboard. Through this program, sixth grade students and teachers develop lessons and ideas under the overall theme of "Change". I find it appropriate to use this theme as a basis for our unit of study on the Scientific Process as I address the seminar and unit title of "Metamorphosis: Transformative Experiences, Understanding the Scientific Process through a Study of Plants and Animals: How Biotic and Abiotic Factors Affect Change!" Students will investigate the Scientific Process as we explore biological processes which affect plants and animals. Many learning gaps exist in science instruction for my students, so some are well versed in the Scientific Process while others can not define a hypothesis. To alleviate this discrepancy, the sixth grade year always begins with an investigation of the Scientific Process. My goal with this unit is to increase the rigor and Science content of our study and also introduce some of the Ecology concepts that we often lack time for at the end of the year. By frontloading some of the material in the beginning, my students will be better prepared for a more in-depth discussion of these concepts at the end of the

year. Cellular respiration, photosynthesis, and responses of plants to external stimuli are abstract concepts unfamiliar to students. By germinating and growing plants and adjusting the plant's growing environment, students will be able to witness how biotic and abiotic factors affect change for that plant. We will develop these concepts as we compare the effect on plants and animals. Students will explore how altering variables within an ecosystem can change the survival outcome for a plant and/or animal.

During our initial discussion of abiotic factors students will use land plants to explore the concepts of variables and change. After this is firmly understood, we will apply this knowledge of how variables affect change to our study of phytoplankton and aquatic plants. Students will investigate phytoplankton and view samples under the microscope. Other students will investigate responses of plants to different factors and explore which plants are necessary for the growth of a caterpillar into a moth or butterfly. Students will either investigate the life cycle of a freshwater bivalve organism such as the *Eastern Elliptio, Utterbackia,* or *Corbicula* or the life cycle of a caterpillar into a moth or butterfly. Students will identify biotic and abiotic factors necessary for the organisms to survive and undergo metamorphosis. We will describe how changes to an ecosystem such as the introduction of the *Corbicula*, an invasive species often called the Asian Clam, have affected native species. During this discussion I will show students an animated map from the USGS website http://nas.er.usgs.gov/queries/SpeciesAnimatedMap.aspx?speciesID=92[1] depicting the progression of the Asian Clam since its introduction in 1924 off the coast of Vancouver to its now ubiquitous presence in the waters across the United States. Students will observe their chosen organism, and explore how they undergo metamorphosis from the larval stage to adulthood. We will explore how variables within the organism's ecosystem can alter its life cycle. Students will create conditions conducive to algae growth for the bivalve or plant growth for the caterpillar and then vary those conditions for purpose of scientific study. Students will introduce the bivalve or insect into the habitat and record data based on its response to the environment. Students will collect and record date to apply to a broader study of how biotic and abiotic factors affect change within an ecosystem. As students investigate either the bivalve or the caterpillar and its metamorphosis, they will create a digital presentation to share with their classmates. While specific study of the lifecycles of the *Eastern Elliptio* and other bivalve organisms is not specifically listed in the sixth grade science standards, I feel that this will provide a real world example to students of how metamorphosis occurs in animals and allow students to draw conclusions about environmental conditions based on these investigations. Students will incorporate Common Core standards for technology and research into their investigations and digital product. Increasing student awareness of how environmental conditions can affect the growth and metamorphosis of bivalve and insect organisms will encourage students to recognize that all organisms have a place in our ecosystem and that place can be greatly affected by change.

In designing this unit about Metamorphosis, I originally thought of metamorphic rock and the process of metamorphism as it pertains to the rock cycle. Metamorphism in rock is defined as the process by which a rock's structure or mineral composition is changed by heat and/or pressure. During our unit on Earth's structure and changing surface, we delve quite deeply into the rock cycle and discuss at length how rocks change through metamorphism and how new minerals and crystals are created through the geologic processes. I am comfortable with the Earth science curricula and feel confident in leading the discussion. However, as I began to understand true Metamorphosis as it relates to biology and living creatures, I realized that my thinking was a bit skewed. During this seminar I have come to better understand and respect the unique and sometimes specific conditions under which many animal species go through Metamorphosis. Biology online http://www.biology-online.org/dictionary/Metamorphosis defines metamorphosis as the change in form and often habits of an animal after the embryonic stage in normal development.[2] Additionally, metamorphosis is described as a biological process by which an animal physically develops after birth. This involves an abrupt change in the animal's form or structure through cell growth or differentiation.[3] Animals metamorphose, transform, at different rates and often under incredibly unique conditions. By guiding my students through the process of metamorphosis in aquatic and insect organisms, we will learn more about the dynamic changes continuously occurring in our world.

Objectives

Charlotte Mecklenburg Schools shifted science instruction to focus on the North Carolina Essential Standards during the 2012-2013 school year. We will continue to root our curriculum within these standards and objectives for 2013-2014. Designing goals and activities based on these standards will create a unit more focused on the direction of Science instruction within CMS. These objectives will add relevance to the exploration of the Scientific Process and increase student understanding of the biological processes which affect plant and animal growth within an ecosystem. Our studies will incorporate the objectives and concepts of the Scientific Process and Life Sciences. The NC Essential Standards do not specifically address objectives for understanding the Scientific Process; however, students are expected to recognize and apply the process within the science classroom. According to the North Carolina Department of Education[4], students are expected to demonstrate scientific literacy as they describe, explain, and predict natural phenomena, identify scientific issues underlying national and local decisions, and pose explanations based on evidence derived from one's own work.

During this unit I plan to address the following concepts related to an understanding of the Scientific Process:

- *Identify and describe Independent, Dependent, and Controlled Variables within a science experiment or investigation.*

- *Identify and create qualitative and quantitative observations within a science experiment or investigation.*
- *Recognize how variables within an ecosystem affect change within an animal or plant specimen.*
- *Design and perform an experiment or investigate a topic using the Scientific Process.*
- *Collect, Record, and Share data within an experiment or investigation.*
- *Evaluate experimental data, draw conclusions based on the data, and communicate the conclusion within the science classroom.*

Students will germinate, plant, and observe plants within the classroom. My plans will be to define various criteria for each group of plants. Students would then select variables to manipulate in order to optimize or deter plant growth. Students will use digital resources to document and record their plant's progress. During this process students will also investigate how abiotic factors affect change within the plant specimen. We will use digital resources to explore how biotic and abiotic factors affect animals and then compare our findings. Students will address the importance of biotic and abiotic factors for ecosystems. Students will begin their study of variables through a focus on land plants and then apply this knowledge to aquatic plants and the *Eastern Elliptio* aquatic bivalve organism. Students will eventually research a variety of bivalve organisms and create a digital presentation discussing how biotic and abiotic factors affect change in aquatic ecosystems.

The following objectives from the North Carolina Essential Science Standards will be addressed within the unit:

Overall Standard 6.L.1
Understand the structures, processes, and behaviors of plants that enable them to survive and reproduce.

Substandard 6.L.1.2
Explain the significance of the processes of photosynthesis, respiration, and transpiration to the survival of green plants and other organisms.

Using a modified Jigsaw instructional format, student learning teams will research and explain the processes of photosynthesis, cellular respiration, and transpiration. Students will use their research to create a digital product to share with the class. Students will act as the expert as they share their product with their peers.

Overall Standard 6.L.2

Students will understand the flow of energy though ecosystems and the responses of populations to the biotic and abiotic factors in their environment.

Substandard 6.L.2.1
Students will summarize how energy derived from the sun is used by plants to produce sugars(photosynthesis) and is transferred within a food chain for food web(terrestrial and aquatic) from producers to consumers to decomposers.

Students will investigate and illustrate the nitrogen cycle. Students will identify how decomposers affect the nitrogen cycle and how abiotic factors can influence the success of the cycle. Students will explore land and aquatic food webs. Students will research how land plants and animals are affected by and/or affect aquatic plants and animals. Students will design a food web which incorporates both land and aquatic organisms in a student-selected environment.

Substandard 6.L.2.2
Explain how plants respond to external stimuli (including dormancy and forms of tropism) to enhance survival in an environment.

Students will observe and record data based on their study of plants within the classroom. Students will alter variables of the plant environment and record results of those variances. Students will chart and share data with their learning team and peers.

Substandard 6.L.2.3
Summarize how the abiotic factors such as temperature, water, sunlight, and soil quality of biomes affect the ability of organisms to grow, survive, and/or create their own food through photosynthesis.

Students will alter the growing habitat of the land plants and also phytoplankton. Student learning teams will identify variables to alter during the growth process and record that data. Students will examine how abiotic and biotic factors can become limiting factors within an ecosystem.

The following Cross-Curricular Essential and Common Core Standards will be addressed within this curriculum unit:

Overall Technology Standard 6.TT.1
Students will use technology and other resources for the purpose of accessing, organizing, and sharing information.
Substandard 6.TT.1.1
Students will select appropriate technology tools to gather data and information (e.g., Web-based resources, e-books, online communication tools, etc.).

Substandard 6.TT.1.3
Students will select appropriate technology tools to present data and information effectively (multimedia, audio and visual recording, online collaboration tools, etc.).

Students will use text and web based resources to research bivalve organisms and phytoplankton. Students will investigate how metamorphosis occurs for each organism and how biotic and abiotic factors can limit or facilitate that metamorphosis. Students will create a technology based presentation incorporating teacher created guided questions. Students will select and justify web and text resources for research and presentation. As a 21st century skill, it is essential that students recognize and select credible web sources. We will use an evaluation checklist to establish credibility of websites chosen for research. The following document by Kathy Schrock is available for reproduction for classroom use http://kathyschrock.net/abceval/5ws.pdf.[5] This basic guide provides students with direction when selecting a web resource and establishing its credibility.

Common Core Standard CCSS.ELA-Literacy.RST.6-8.9
Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Students will conduct online and text based research on metamorphosis and its evolution in nature. Students will use the article "How Did Insect Metamorphosis Evolve?" from Scientific American[6] as a comparison for their technology based research. Students will compare metamorphosis for an insect to that of the bivalve organism. Throughout the comparison, students will identify the role biotic and abiotic factors play in the process of metamorphosis. Students will view various diagrams and models displaying insect and bivalve metamorphosis and make comparisons throughout the process. Ideally students will interact with actual bivalve glochidia and note the difference between the larva and the mature bivalve. Students will also view caterpillar and moth/butterfly species to compare the changes which insects experience. Students will analyze written text and visual models to determine elements of evidence to identify metamorphosis in the bivalve and the insect. Providing students with a variety of resources will scaffold the instruction to meet the needs of all students. Students will access a teacher created Lesson Paths to aid in bivalve or insect research. Students will use this information to identify characteristics of bivalve organisms and describe how biotic and abiotic factors affect their ability to grow and metamorphose. Students will alternately investigate the life cycle of a caterpillar into a butterfly and similarly address variables that influence growth and change. These website resources will allow for visual representation of bivalve and insect larva and adult organisms. Students will create a technology based product presentation as part of a culminating project.

Scientific Content: Overview for Teachers

Vocabulary

Bivalve organism: a mollusk having a shell consisting of two lateral plates or valves joined together by an elastic ligament at the hinge, and held together by muscles.
Carbon Dioxide: odorless, colorless gas naturally present in air and is absorbed by green plants during photosynthesis and released during respiration; it is also produced as a waste product by burning carbon and organic compounds.
Cellular Respiration: process in which cells use oxygen to release energy stored in sugars.
Chlorophyll: a light absorbing chemical that traps energy in sunlight and converts it to chemical energy; it is a pigment found in chloroplasts of plant cells.
Chloroplast: organelle which contains chlorophyll, a chemical that uses the energy from sunlight to make sugars in plants during photosynthesis.
Controlled Variable: factor within the experiment that is not changed.
Dependent Variable: factor that is being measured within the experiment.
Glochidia: larval form of a freshwater bivalve organism.
Glucose: sugar molecule that is the major energy source for most cells, produced by the process of photosynthesis.
Hypothesis: an educated statement based on observations or prior knowledge that can be tested using the Scientific Process.
Independent Variable: factor within the experiment that is intentionally changed to affect the outcome.
Inference: a reasonable explanation for an observation.
Nitrogen Cycle: continuous movement of nitrogen throughout Earth, its atmosphere, and the living things on Earth.
Observation: statement describing what one can see, hear, smell, taste, feel, or measure with an instrument or device.
Photosynthesis: process by which green plants and other producers use simple compounds and energy from light to make glucose, an energy-rich compound. Light is absorbed and used to change carbon dioxide and water into glucose and oxygen.
Phytoplankton: microscopic algal plants that live in water.
Qualitative Observation: statement about a situation using your five senses; what do you see, hear, feel, taste, or smell?
Quantitative Observation: statement about a situation using a measurement or number; quantity, size, weight.
Variable: factor or condition that affects a process or system in some way.

Science Concepts

Scientific Process

I plan to use this unit to increase the relevance and rigor of our discussion of the Scientific Process. I prefer to use Scientific Process over Scientific Method because I want students to understand that the steps may not always be the same for every experiment or investigation. It is vital that students use correct terminology in the science classroom. We will learn to identify qualitative and quantitative observations and recognize the difference between an observation and an inference. Students will identify the independent and dependent variables as well as the controlled variables. Students will be taught to conduct experiments by manipulating only one variable at a time. While more complicated testing is often appropriate, at the sixth grade level we will only change one at a time. As I teach students to write a hypothesis, we will learn the If, Then, Because format. This method works well with the Claim, Evidence, Reason framework and encourages students to formulate support for the hypothesis as opposed to just making a statement. For example, during our virtual lab a hypothesis could be "If bright light instead of dim light is used, then there will be more tomatoes per plant because light levels affect the growth and production of plants." Students will engage in a variety of activities as they practice this process. A fun source of Scientific Method practice activities is available at Science Spot http://sciencespot.net/Media/scimethodconvar.pdf[7].

Butterfly Metamorphosis

Adult Butterflies develop through a process called metamorphosis. Each organism must go through the four stages of the life cycle to become a full adult capable of reproduction. The first of the four stages is the egg, which is laid by the adult butterfly. The next stage is the larva manifested as a caterpillar, which feeds to store energy for the metamorphosis process. After the caterpillar is full-grown, it forms a chrysalis and enters the pupa stage. View the following website, http://phenomena.nationalgeographic.com/2013/05/14/3-d-scans-caterpillars-transforming-butterflies-metamorphosis/ [8], to see 3-D scans of caterpillars as they metamorphose into butterflies. At the end of the metamorphic process, the butterfly or moth will emerge. The following website http://www.boredpanda.com/caterpillar-transformation-butterfly-moth/[9] has labeled photographs showing caterpillar to moth and butterfly transformations. Each specimen is labeled and photographed in detail. I will use this site to generate excitement for my students. Students will access the following Lesson Path http://www.lessonpaths.com/carmel-butterfly-metamorphosis/19-before-and-after-photos-of-butterfly-and-moth-transformations, Carmel Butterfly Metamorphosis, to research the life cycle of the butterfly and the process of metamorphosis. The final steps of the playlist offer vocabulary flashcards and an interactive life cycle game that allow students to test their knowledge.

Freshwater Mussels

Bivalve organisms such as the *Elliptio* and *Corbicula* produce larvae that undergo metamorphosis to become a full adult capable of reproduction. Students will access the Lesson Path http://www.lessonpaths.com/carmel-bivalve-metamorphosis/fmcs-freshwater-mussels, Carmel Bivalve Metamorphosis, to investigate the life cycle and metamorphosis of the bivalve.

Strategies

As this unit will be taught towards the beginning of the year, I will need to frontload some vocabulary that we will discuss more in-depth later in the year. Teaching the vocabulary before the lessons begin is a strategy that will allow students to process the information as they are exposed to the concepts within the investigation process. I plan to begin with a discussion of the scientific process and the steps involved. Students will create a Circle map about the scientific process. Students will work with their learning team to list multiple terms and phrases about the scientific process. We will then share as a class and discuss unfamiliar terms. After discussing initial vocabulary, students will participate in an activity using Jolly Rancher candy, a fruit flavored hard candy, to help them identify and list qualitative and quantitative observations. This is our Confection Connection lab (Appendix 2). This activity will generate excitement for our unit. Students will close their eyes and each be given a candy to describe. As a group we will feel the candy, smell the candy, listen to the candy as we open the wrapper, and then open our eyes and look at the candy. During the activity students will be advised to silently think of words and phrases that would describe the candy using their senses. After opening their eyes, but before tasting the candy, students will write down these observations on an activity sheet. We will then use science process skills to measure the candy's length and width. Students will use a triple balance scale to weigh their candy. Students will record the observations and then finally get to taste their candy and record those observations. As a class we will discuss the difference between qualitative and quantitative observations and how they are useful in the scientific process. Students will be asked to make an inference based on their observations. For example, "I think my candy contains sugar because it smells so sweet". This activity will serve to generate prior knowledge about observations and how they are an essential part of the scientific process. Students will discuss how the observations they make and share can "Change" the other person's perception of the candy. Building on this activity we will talk about how the observations we made about the candy are that candy's properties and how a different candy will have different properties. We will also discuss how changing the color of the candy could be an independent variable in the scientific process.

Students will participate in an interactive lab on the Discovery Education website[10], www.discoveryeducation.com, "How Does Your Garden Grow?" http://gtm-media.discoveryeducation.com/videos/dsc/externalApplications/accessible/virtual_labs-es/Plants/index.html. Students will manipulate variables within the virtual lab to

understand how a change in growing conditions can affect the outcome. We will use this lab experience to discuss independent and dependent variables. Students will work to write a hypothesis about their activity. Providing students with a variety of basic lab experiences at the beginning of our study of the scientific process will allow students to incorporate this knowledge about the scientific process into a more complicated investigation. Students will then investigate variables as they relate to the plant investigation. "What variables would affect how well a plant grows?" We will then use this discussion to identify how changes to these variables could have a negative or positive effect on the plant. Students will work with their learning team to identify which variables they would like to manipulate during the experimental phase of the plant investigation. During our investigations we will use the practice of only changing one variable at a time in order to create an experiment that is interpretable, and also discuss the importance of replication and repeatability. I will explain to students that in a more complex experiment multiple variables may be manipulated to test a hypothesis, but for our purposes and understanding we will restrict changes to only one independent variable. This simplified approach is better suited to student understanding at the sixth grade level. Students will chart the data from their virtual lab and use these data to decide how to manipulate variables as we begin to grow plants in the classroom. Students will record their hypothesis and lab observations on the provided class activity sheet (Appendix 3).

Interactive technology and its incorporation into my teaching methods and student product is an important strategy for students as we develop the 4 C's of 21st century skills: Communication, Collaboration, Critical Thinking, and Creativity. As students begin their investigations about plants they will access "The Great Plant Escape" http://urbanext.illinois.edu/gpe/index.cfm[11] which is a website offered in English and Spanish which will benefit my English as a Second Language students. It is published by the University of Illinois Extension office and directs students to work through a variety of Mystery Cases as they learn more about plants and their unique characteristics. Students are able to research information, participate in interactive activities, and quiz themselves based on their gained knowledge. Students will also use the Learning Path website, formerly known as MentorMob, http://www.lessonpaths.com/[12] to access teacher selected websites, videos, articles, and virtual labs. Teachers may create a Learning Path on the website for student use. This website allows the teacher to include a variety of web-based and teacher created materials. Students work through a series of steps to complete their research or an activity. Teachers may publish a quiz as well to test student comprehension. I will use this website to direct student web based research as they investigate the nitrogen cycle, and biological processes for plants. A Lesson Path will be created for each area of research. Students will use the lesson path link http://www.lessonpaths.com/learn/i/cellular-respiration-and-photosynthesis/assignment-discovery-shorts-06070708-cellular-respiration-video-discovery-channel to access information on Cellular Respiration and Photosynthesis. Students will work through the

steps as they explore these topics. Students will research the vocabulary for each biological process, but they will be divided into expert groups to research and create a digital presentation for their specific process. Students will be given guiding questions to consider as they create their digital presentation. Students will use web based resources learned previously to share their information with the class.

In addition to research, students will use web-based resources to create and publish presentations and record data to share with other learning teams. The use of technology as a method to create and publish work directly facilitates student acquisition of 21st Century Skills. As students create and publish information to share with their classmates, they gain a deeper understanding of the concepts. Students will use Google Presentation, Google Docs, Power Point, Prezi, and/or Movie Maker on the desktop or Google Chrome Books to create and publish documents. Students will choose from iMovie and Doceri applications on the iPad for document publication. As not all students are familiar with these applications, we will spend a class period investigating the resources. Many students are comfortable with specific applications, but I would like to expand their knowledge of these sources and encourage them to carefully select an application that best suits the unique characteristics of the activity. I will also instruct students in effective digital citizenship. We will investigate the website "Help Save the Endangered Pacific Northwest Tree Octopus from Extinction" http://zapatopi.net/treeoctopus/[13] as an example of a false online resource which looks authentic. Students will use an evaluation tool to examine the website and list factors that make the website look real. An increased focus on interactive technology will allow students to explore the science concepts and attain content mastery in a personally meaningful manner. Encouraging positive digital citizenship assists students in developing skills necessary for appropriate interaction with technology.

Another strategy that I plan to incorporate into this unit is a modified version of the Jigsaw Method. During this type of instruction, I will serve as the facilitator as students research and investigate specific topics with their learning team. In traditional Jigsaw format one student from each group will meet with students from other groups to investigate a topic. Students then meet back with their group and share what they have learned. The website "Jigsaw Classroom" http://www.jigsaw.org/[14] offers an in-depth explanation of the benefits to behavior and learning with the Jigsaw method. I plan to use a modified approach. Students will work as a learning team to research and explain a particular topic. Students will be given guiding questions to consider as they investigate their topic and develop a presentation method. Teams will refer back to our instruction on digital literacy and select an appropriate application with which to create their digital presentation. Each team will act as an expert group as they teach their content to their classmates. Students will also create an assessment to monitor student understanding. By incorporating this strategy students are more accountable for their learning and the rigor of the lesson is increased

An additional instructional strategy that I will incorporate this year in my classroom is the Claim, Evidence, Reason framework when completing all explanation analysis of lab and hands-on activities. National Science Education Standards[15] and education researchers recognize the need for students to create evidence-based scientific explanations during hands-on inquiry investigations. The English Language Arts Common Core standards in writing also offer support for the use of the Claim, Evidence, Reason framework. Common core Standard CCSS.ELA-Literacy.W6.1a states that students will introduce a claim and organize the reasons and evidence clearly. Additionally, Common Core Standard CCSS.ELA-Literacy.W.6.1b states that students will be expected to support claims with clear reasons and relevant evidence, using credible sources and demonstrating an understanding of the topic or text. The integration of common core language arts standards into the science classroom supports the reinforcement of cross-curricular objectives.

The CER structure is adapted from Toulmin's model of argumentation and was presented during a Sixth Grade Science Curriculum Study Professional Development in August 2013. The presenter referenced the book Supporting Grade 5-8 Students in Constructing Explanations in Science: The Claim, Evidence, and Reasoning Framework for Talk and Writing by McNeill and Krajcik[16] as the source for the Claim, Evidence, Reason framework adaptation. The reference book offers further explanation of the rationale behind the framework. This synthesis of information provides students with a concrete framework to follow when constructing an explanation analysis. This encourages an analysis based in fact and conceptual observations and reinforces writing practices. Students are required to write a complete sentence making a **Claim** about the lab they performed. Students will write this claim as a statement or conclusion addressing the original question or problem. Students will then compose two or three sentences stating the **Evidence** from the lab. The evidence will be based on accurate data and observations from the activity. The evidence explanation will require students to reference data and observations from the lab activity. Students may also cite relevant information discovered during research or refer to alternate sources of factual information. This evidence will be used to directly support the stated claim. The final step in the framework is to state the **Reason** behind the claim. The reason should draw upon the evidence for support and relate directly to the claim as well as address why the student thinks the claim is true. This explanation analysis requires students to move beyond simply a literal explanation and encourages them to synthesize the observations and data into a detailed analysis of the activity.

Classroom Activities

Introductory Activities

Students will begin the unit with a study of the Scientific Process. To introduce important vocabulary students will view a video clip from the Study Jams website[17]

http://studyjams.scholastic.com/studyjams/jams/science/scientific-inquiry/scientific-methods.htm. We will explore steps of the scientific process through our Confection Connection Lab*(Appendix 2)* described previously under Rationale. Students will become familiar with terminology necessary to understand the process through this investigation. After we explore the scientific process and experience a variety of teacher directed labs, such as "How Does Your Garden Grow", a virtual lab described in the objectives section of this unit *(Appendix 3)*, students will be charged with creating an experiment testing the affect of variables on plant growth. Students will identify biotic and abiotic variables to manipulate in order to affect the outcome of the plant growth. Some students will focus on land plants, such as herbs or flowers, while others will grow algae in an aquarium. I have a grow lab so that students can change light and temperature variables more easily. Students will create a lab report where they will identify variables manipulated, materials used, procedures followed, and tables or figures of their results. Students will select a figure or table to share their results with the class. Based on their experiment results students will complete the Claim, Evidence, Reason analysis to share their results with the class.

Study of Biological Processes

Students will investigate and explain the biological processes of Cellular Respiration, Photosynthesis, and the Nitrogen cycle and their dependence on Earth as a System. Students will investigate these processes using a variety of web-based and print resources to identify how Earth affects these biological processes. This activity will allow students to apply knowledge gained about biotic and abiotic factors as well as how they influence processes germane to Earth as a system. Students will work individually to investigate these processes and complete an analysis chart (*Appendix 4*). Students will understand how biotic and abiotic factors allow these processes to continue and how they change as Earth's system changes. Students will access the website Lesson Paths[18], http://www.lessonpaths.com/ and use teacher created paths to aid in the research process. Lesson Path http://www.lessonpaths.com/learn/i/cellular-respiration-and-photosynthesis/assignment-discovery-shorts-06070708-cellular-respiration-video-discovery-channel offers information on cellular respiration and photosynthesis.

Students will expand on this research with their learning team as they develop a digital presentation about one of these processes. Working with their learning team, students will use the resources provided as well as student chosen web based sources in order to create a presentation focused on key terms or an explanation about the biological process. Students will use a modified Jigsaw format to perform their class presentations. Students will be given a topic to research and teacher created vocabulary words and/or guided questions upon which to focus their research. Students will access the website Lesson Paths, http://www.lessonpaths.com/, discussed previously as well as the following web resources to help with research. Students may also access print resources or other websites after teacher approval. Students my use the animation found at

http://www.sumanasinc.com/webcontent/animations/content/cellularrespiration.html[19] to help them understand the input and output of cellular respiration and photosynthesis. Another resource which will assist students in their research about photosynthesis specifically is http://biology.clc.uc.edu/courses/bio104/photosyn.htm[20] website. This is a college level website and the reading level may be difficult for students, but the information is well developed and clearly explained. Finally, students may choose to access Rader's Biology 4 Kids http://www.biology4kids.com/files/plants_photosynthesis.html[21]. This website offers basic information on photosynthesis. Students will work with their learning team to research important facts and key terms and then create a web-based product to share with the class. Students will serve as experts as they share their information with the class. Students may use a web based or iPad presentation application. Options include, but are not limited to, PowerPoint, Google Slides, Doceri, iMovie, and FlowBoard. Students will use the planning guide below *(Appendix 5)* to organize their research and then gather notes from other expert groups. This activity will prepare students for the web based research activity and digital presentation at the end of the unit. As a culmination activity students will study the metamorphosis of the caterpillar to moth or butterfly or the change of a Glochidia Bivalve larva to its adult form.

Study in Metamorphosis

Students will investigate the metamorphosis of a butterfly or Bivalve organism during this activity. This study will begin early in the unit as students identify which organism they wish to investigate and how they will study its metamorphosis from a caterpillar to a butterfly or Glochidia into an adult bivalve. Student will use their research of biotic and abiotic factors to identify the conditions necessary to effectively allow the larval forms to grow and metamorphose into an adult form. Ideally we will collect natural specimens and establish conditions conducive to metamorphosis. I would like for students to collect native moths and/or butterflies and allow them to lay eggs, hatch into caterpillars and then metamorphose into the adult form. Students will need to research the biotic and abiotic factors needed for metamorphosis to occur. Students will identify how variables can become limiting factors if the conditions are not kept in balance. Students who choose to research the bivalve will establish aquatic conditions that will allow algae to grow. We will introduce the bivalve into the environment and note how they react to the biotic and abiotic factors of their environment. Students will research the concept of parasitism in fish and other aquatic organisms that allow the Glochidia to undergo metamorphosis. Students will be given guiding questions to consider and a rubric to follow for their research and presentation *(Appendix 6).* Students will address biotic and abiotic factors, the natural habitat of the organism, environmental factors which can become limiting factors for the organism, the benefit of the organism to its environment, the process of metamorphosis, and human impacts on metamorphosis. Students will use a variety of web-based and print resources during their research. Students will access the

Lesson Paths “Carmel Butterfly Metamorphosis” and “Carmel Bivalve Metamorphosis” to assist with research.

I am excited to incorporate more rigorous science content into my unit on the Scientific Process. I am confident that doing so with increase my students’ understanding of the curriculum and steps needed for valid experimentation.

Appendix 1: Implementing Common Core and Essential Standards

Overall Standard 6.L.: *Understand the structures, processes, and behaviors of plants that enable them to survive and reproduce.*

Substandard 6.L.1.2: Explain the significance of the processes of photosynthesis, respiration, and transpiration to the survival of green plants and other organisms.
Students will research and explain the processes of photosynthesis, cellular respiration, and transpiration.

Overall Standard 6.L.2: *Students will understand the flow of energy though ecosystem and the responses of populations to the biotic and abiotic factors in their environment.*

Substandard 6.L.2.1: Students will summarize how energy derived from the sun is used by plants to produce sugars (photosynthesis) and is transferred within a food chain for food web (terrestrial and aquatic) from producers to consumers to decomposers.
Students will identify how decomposers affect the nitrogen cycle and how abiotic factors can influence the success of the cycle.

Substandard 6.L.2.2: Explain how plants respond to external stimuli (including dormancy and forms of tropism) to enhance survival in an environment
Students will observe and record data based on their study of plants within the classroom.

Substandard 6.L.2.3: Summarize how the abiotic factors such as temperature, water, sunlight, and soil quality of affect the ability of organisms to complete photosynthesis.
Students will examine how abiotic and biotic factors can become limiting factors.

Overall Technology Standard 6.TT.1: *Students will use technology and other resources for the purpose of accessing, organizing, and sharing information.*

Substandard 6.TT.1.1: Students will select appropriate technology tools to gather data and information (e.g., Web-based resources, e-books, online communication tools, etc.).

Substandard 6.TT.1.3: Students will select appropriate technology tools to present data and information effectively.
Students will use text and web resources to research bivalves and phytoplankton.

Common Core Standard CCSS.ELA-Literacy.RST.6-8.9: *Compare and contrast the information gained from multiple sources.*
Students will analyze written text and visual models to determine elements of evidence to identify metamorphosis in the bivalve and the insect.

Appendix 2

Lab Activity	***Confection Connection Lab***
Objectives: ~Identify Qualitative and Quantitative Observations. ~Identify an Inference based on Observations.	Key Terms: Qualitative Observation: Quantitative Observation: Inference:
Qualitative Observations:	**Lesson Notes:**
What do you Feel?	
What do you Smell?	
What do you Hear?	
What do you See?	
What do you Taste?	
Quantitative Observations:	
1. How long is the candy? 2. How wide is the candy? 3. How much does it weigh?	
Make an Inference based on your observations	

Appendix 3

How does your garden grow???
Discovery Education Virtual Lab Level One

Student Planning Sheet:

Variables (List the factors that can change to grow the tomatoes):

_____ _____ _____

Variable that I will change (Only select one for this trial): _____

Testable Question: _____

This is a well-designed experiment because:_____

Hypothesis (What I think will happen and why I think so.):

_____

Procedure (Explain the steps you took to complete the Lab.):

Trial #	Soil	Water	Light	Tomatoes per plant	Tomato Size

Analysis:

Why is it important to only change one variable at a time?

How does creating a testable question help to plan your experiment?

Did your data support or not support the hypothesis? If it did not support the hypothesis, how would you change your hypothesis to start the scientific process over?

Appendix 4

Dependence of Biological Processes on Earth as a System:
How does Earth as a system affect these Biological Processess???

Use the Lesson Path: "Cellular Respiration and Photosynthesis" to identify how each process is dependent on Earth as a System.

Use the animation to assist with the Input and Output Table.

Biological Process	Atmosphere	Biosphere	Geosphere	Hydrosphere
Cellular Respiration				
Nitrogen Cycle				

Biological Process	***Input***	***Output***
Photosynthesis		
Cellular Respiration		

Appendix 5

Biological Processes Investigation Jigsaw Activity and Response

Access Lesson Paths Cellular Respiration and Photosynthesis

Other Digital Resources to review:

The Great Plant Escape at http://urbanext.illinois.edu/gpe/index.cfm and

Biology for Kids at http://www.biology4kids.com/files/plants_main.html,

Claremont University http://biology.clc.uc.edu/courses/bio104/photosyn.htm

Presentation Method: _____

Other resources Used: _____

Key Words to know…

Cellular Respiration

Cellular Respiration:

Transpiration:

Stomata:

Oxygen:

Questions to consider as you plan your presentation on Cellular Respiration…

What is Cellular Respiration?

How is Cellular Respiration affected by Earth as a System?

Where does Cellular Respiration occur?

How is Cellular Respiration DIFFERENT from Photosynthesis?

Photosynthesis

Photosynthesis:

Chlorophyll:

Carbon Dioxide:

Glucose:

Questions to consider as you plan your presentation on Photosynthesis…

What is Photosynthesis?

How is Photosynthesis affected by Earth as a System?

Where does Photosynthesis occur?

How is Photosynthesis DIFFERENT from Cellular Respiration?

Appendix 6

A Study in Metamorphosis
Research Guidelines

Specimen: _____

Method of Presentation: _____

Metamorphosis

Detailed description of metamorphosis as it relates to your specimen.
Include a detailed explanation of the change from larva to adult.

Biotic and Abiotic Factors

Create a detailed description of how biotic and abiotic factors influence the life cycle of your specimen.
Discuss specific factors necessary for metamorphosis to occur.

Environmental Concerns

Discuss potential or current hazards which affect your specimen.
Include human influence as well as natural variables.

Environmental Benefits

Explain how your specimen is important to its environment or ecosystem.
Include a discussion of how this specimen supports the life cycle of other organisms.

Bibliography

Cite at least 4 resources used during your research. At least one must be a print resource.

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Notes

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[2] (Biology Online 2008)
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[12] (MentorMob Inc. 2012)
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