Integrating Concepts in Life Sciences

The Components of Earth as a System: How Energy Flows Through an Ecosystem!

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This curriculum unit is recommended for:
Earth and Environmental Science, General Science Grades 6-8 (adaptable)

Keywords: Energy Flow, Ecosystem, Earth as a System, Trophic Level, Producer, Consumer, Energy Pyramid, Predator, Prey

Teaching Standards: See Appendix 1 for teaching standards addressed in this unit.

Synopsis: Investigating Earth as a system and recognizing the interconnectedness of its components will facilitate our exploration of how energy flows through an ecosystem. We will incorporate digital and text resources as students focus on data analysis as a method of gaining a deeper understanding of the unit's objectives. Students will complete a mini-project, Exploring Ecosystems, as a culminating project for our unit. Students will generate a series of food web simulations and analyze how abiotic and biotic factors influence species survival. This online activity will follow participatory games to introduce the concepts of food chains, food webs, and predator and prey feeding relationships. In keeping with district literacy goals, students will use a variety of close reading strategies to further their understanding of complex text. Text sets will include graphs, diagrams, and charts, online and written text. Students will work with a learning team during various activities and be held accountable for completed work with a Learning Team Evaluation.

I plan to teach this unit during the coming year to 180 students in Sixth Grade Integrated Science.

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COMMONER'S FOUR LAWS of ECOLOGY
~Everything is Connected to Everything Else
~Everything Must Go Somewhere
~Nature Knows Best
~There Is No Such Thing as a Free Lunch
~Barry Commoner, The Closing Circle: Nature, Man, and Technology

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 2013-2014 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 investigation and finally additional questions or ideas to explore. I incorporate the use of a Smart Board and video clips from Discovery Education, Scholastic Study Jams, You Tube, and National Geographic on a daily basis. These digital resources provide a variety of video clips, reading passages, and activities through which to engage students. Students are assigned individual Chrome Books to use during class investigation. I incorporate personalized learning goals and activities through digital storage sites such as LessonPaths and Blendspace. These sites allow students to work through a variety of steps at their own pace and select their method of presentation. One-to-one technology allows students to interact with our web resources in a more inclusive manner. I use iPads 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. Student learning teams are an integral part of my teaching strategy. Students work together over a course of time and learn from each other's strengths. Students complete a learning team evaluation which serves as another level of accountability within the learning environment. As stated on the North Carolina teacher evaluation measure, learning teams contribute to a student's acquisition of twenty-first century skills and increase critical thinking practices. During our unit investigating flow of energy through an ecosystem I will continue the use of learning teams and will use a jigsaw approach to investigate Earth as a system. Student teams will explore a sphere within Earth's system. The health of Earth's Atmosphere, Biosphere, Geosphere, and Hydrosphere are essential indicators of overall system stability. Exploring how energy flows through each of these spheres will allow students to understand the interconnectedness of abiotic and biotic components of our ecosystem. Students will also begin to understand how personal choices affect our planet. 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.

As stated previously, many learning gaps exist in science instruction for my students. Some are well versed in science experimentation and investigation while others have limited exposure to science inquiry. This unit will allow students to build upon content learned in fifth grade weather systems and fourth grade Earth science. We will relate that content to Earth as a system and investigate how humans impact the flow of energy through the ecosystem. Through personal accountability students will gain understanding of their role in our planet's health and inevitably become better stewards of their place in our world. I am excited to introduce data-based evidence for my students to investigate as we monitor Earth's ever-changing spheres. Students will explore the flow of energy

through an ecosystem by examining data showing trophic levels of an energy pyramid, playing an interactive Predator and Prey game, and creating a series of scenarios depicting flow of energy in an ecosystem during an interactive online game. Students will investigate data related to climate and precipitation of ecosystems and relate that to plant and animal biodiversity. Data-based analysis will allow students to grapple with complex information in a meaningful and relevant manner.

Students will utilize the book *The Omnivore's Dilemma*[1] as a resource during our unit. Our district and school are increasing our focus on literacy in all content areas. Students will engage in reading techniques from the books *Rigorous Reading*[2] and *Reading for Understanding*[3] as we examine this complex text. Students will interact with the text using metacognitive strategies such as "Talk to the Text" and "Think Aloud" which allow students to think about the text before trying to decipher its meaning. Text in the science classroom will consist of printed material, data-based diagrams, charts and illustrations, video clips, and student created data.

Objectives:

Charlotte Mecklenburg School science instruction is based on the North Carolina Essential Standards. Designing goals and activities based in these standards will create a unit consistent with state science objectives. According to the North Carolina Department of Education, 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 process skills and concepts:

- *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.*
- *Design and perform an experiment or investigation demonstrating 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.*
- *Evaluate complex text for reading elements, context clues, and applicable research data.*

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.

Students will investigate the life cycle of plants and relate this to flow of energy in an ecosystem. Students will investigate how these biological processes affect plant growth and health of a plant population. Students will explore the importance of plants as producers within the energy pyramid and investigate the increased energy displayed at this trophic level. Students will incorporate the LINK strategy from *Reading for Understanding* to brainstorm and identify learning goals related to the flow of energy and use these goals during our culminating mini-project. Students will use the teacher created LessonPaths to investigate how abiotic factors influence plant biodiversity.

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 investigate and discuss the flow of energy within an ecosystem. Students will explain how Earth as a system is affected by alterations to an ecosystem. Students will investigate the carbon cycle and nitrogen cycle and explore how food chains and food webs recycle nutrients and energy throughout the ecosystem. As students interact with the biogeochemical cycles we will incorporate the Talk to the Text reading strategy. Students will interact with a variety of carbon and nitrogen cycle diagrams and informational text as they annotate and describe new information about the cycles. Students will work individually as they create a set of responses, otherwise known as "Talks", to the text. Students will then discuss and share their ideas and responses with a partner. Students will participate in two teacher-created interactive games "Find a Food Web Friend" and "Predator-prey". Both will be described in the activities section.

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 investigate the health of Earth as a system. Students will discuss how the four spheres are affected by changes to our environment. Students will work with their learning team to investigate one of Earth's spheres and create a presentation and assessment to teach the content to their peers. Students will use this content for a culminating mini-project. We will examine concepts in *The Omnivores Dilemma*[4] as they relate to our own practices and explore food consumption decisions. We will investigate how farming and food production affects Earth as a system. Additionally, students will examine data related to abiotic factors in the atmosphere, biosphere, geosphere, and hydrosphere.

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 Earth as a system and investigate one of Earth's spheres with their learning team. 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. Students will create a digital mini-project describing an ecosystem which will include how abiotic factors such as temperature and precipitation affect food webs and energy flow through the ecosystem.

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 the flow of energy throughout the ecosystem. Students will identify how energy changes through trophic levels and compare how abiotic factors affect the flow of energy and biodiversity of an ecosystem. Students will interact with various diagrams and models displaying biogeochemical cycles and energy pyramids and make comparisons throughout the process. Students will analyze written text and visual models to determine elements of energy flow in an ecosystem. Providing students with a variety of resources will scaffold the instruction to meet the needs of all students. Students will access a teacher created LessonPaths to aid in Ecosystem research. Digital resources allow for visual representation of energy pyramids and transfer of energy. Students will create a technology based product presentation as part of a culminating project.

Scientific Content: Overview for Teachers

Vocabulary

Atmosphere: gaseous mass surrounding Earth; shapes Earth's climate and weather patterns

Biosphere: space on or near Earth's surface that supports living organisms; all living things on Earth

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

Consumer: animals and other organisms that cannot produce their own food; primary consumers eat plants

Decomposer: organisms which break down dead organic material; recycle nutrients

Energy Pyramid: illustrates how the amount of energy entering each level varies from one trophic level to the next; approximately 10% of the energy entering a level is transferred to the level above[5]

Food Chain: linear depiction of predator and prey relationships within a specific ecosystem

Food Web: graphical description of the multiple pathways of energy transfer and feeding relationships within an ecosystem

Geosphere: solid portion of Earth's system; lithosphere and mantle

Hydrosphere: component of Earth's system containing all water on or near Earth's surface; including water in the atmosphere

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
Producer: organism which produces its own food using energy from the sun, water, and carbon dioxide through a process called photosynthesis; plants are producers
Secondary Consumer: consumers that eat animals; second step in the food chain
Tertiary Consumer: top consumer of a food chain or web; generally has limited predators
Trophic Level: position in the food chain; determined by the number of energy transfers to that level

Science Concepts

Interacting components work together to form the system of Earth. The atmosphere, biosphere, geosphere, and hydrosphere work as integrated spheres and a basis for chemical, biological and physical processes.[6] The four spheres make up basic elements of Earth including air (atmosphere), life (biosphere), land (geosphere), and water (hydrosphere) with none being capable of operating independently of the other. Earth as a System is the sum of its parts. During this unit students will investigate how the processes of one component effect the organisms of another. For example, how do alterations to our water system limit or increase the ability of organisms within the ecosystem to survive? How do abiotic factors in the atmosphere, geosphere, and hydrosphere directly influence life in the biosphere? Information on Earth as a System will be accessed through the Blendspace Carmel Earth as a System.
https://www.tes.com/lessons/Gd4NEq4ouyu3sw/edit [7]. Students will use this resource throughout the unit.

Flow of Energy in an Ecosystem

An ecosystem is a community of living organisms interacting together in conjunction with the nonliving components of the environment to form a system.[8] The biotic and abiotic factors work together to allow the transfer of energy and cycling of matter. This flow of energy in an ecosystem is facilitated by the predator-prey relationship. This relationship allows nutrients and matter to recycle and replenish the ecosystem.[9] This energy flow begins with the process of photosynthesis when energy from the sun is harvested by producers and combined with carbon dioxide and water to produce glucose and oxygen. The producer is the bottom trophic level of the energy pyramid and has the greatest amount of energy available for transfer. The producer is eaten by a primary consumer which is then eaten by a secondary consumer. The top predator in a food web is a tertiary consumer and eats one or more of the secondary consumers within the web. Approximately 10% of energy at each trophic level is passed to the next level. This low level of available energy requires greater consumption of energy as the trophic levels move up the energy pyramid. Energy is lost due to metabolic heat and other life

processes. Decomposers are increasingly important to the flow of energy because of their ability to release energy during decomposition.[10]

Strategies

An instructional strategy that I will incorporate this year in my classroom is the Claim, Evidence, Reason framework when completing all explanation analysis of lab data and hands-on activities. National science education standards and education researchers Sandoval and Reiser[11] recognize the need for students to create evidence-based scientific explanations during hands-on inquiry investigations. Providing students with a concrete framework to follow when constructing an explanation encourages an analysis based in fact and conceptual observations. This framework requires students 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, cite pertinent information discovered during research, or other source of factual information which directly supports 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. The Reason should 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. Additionally I expect students to use this framework as they analyze and decipher graphs and data. Students will use a graphic organizer to record their information. This organizer is a district resource provided by the secondary science department. I have adapted it for my classroom. Students will be encouraged to analyze data and lab results using the graphic organizer to plan their response.

The **LINK** Model from the book *Reading for Understanding*[12] is a strategy that will incorporate our increased focus on literacy in the content classroom. This model encourages students to List, Inquire, Note, and Know information about a specific topic. It is similar to the KWL chart used for many years in education settings. Students brainstorm ideas and activate prior knowledge on the topic and then build and alter their schema on the topic after reading and investigating specific texts or data samples. The LINK Model can serve as a vehicle through which students create personal learning goals about a topic. Students use the brainstorming session to activate schema and then revise that schema after further investigation. Focusing student thinking in this manner provides students with a process by which to understand new information. The LINK Model can also be used as an informal assessment of student understanding. The LINK Model follows the following process.

List: Students are given a specific amount of time to work on their own to create a list of ideas, words, phrases or illustrations which relate to the topic. The teacher then creates a class list of ideas and thoughts. No valuation is given to any listed ideas.

Inquire: Students are encouraged to inquire about specific ideas on the class list. The student who authored the idea may comment or explain the reasoning behind its inclusion on the list. A class set of questions is created to direct student reading and investigation.

Note: Students are given a text set about the topic. They may choose to read one or more articles centered on the topic. In the science classroom students should also be given applicable data and models to investigate. As students interact with the text they will make notes that begin to explain or further question understanding of the text or topic. Students should begin to list items of understanding as well as points where clarity is needed. This may serve as an informal assessment of students understanding and allow the teacher to address misconceptions which may arise.

Know: During this phase of the process students should be reflective about their understanding of the topic. How is their thinking different from the start of the activity and before interacting with the text? Why are these new ideas important and how can they be incorporated into new understanding? Students should reflect on their learning goals and list any unanswered questions about the topic. As a class, this is a time for reflection as well. Do we understand the topic better? How has our thinking changed? Students should recognize unanswered questions as an area for further investigation.

The LINK Model requires a text set for students to investigate. Teacher should be conscious of student Lexile levels and reading comprehension abilities in order to select a meaningful set of texts. The texts should be varied in difficulty and structure so as to reach a wider audience of students. The text set will consist of graphs, data tables, poems, nonfiction articles, or current research on a topic. Varying the text encourages students to interact with a text that is meaningful and relevant and increases student engagement. Allowing students to investigate the topic in an inquiry setting provides personal accountability for content mastery.

An additional strategy to encourage students to practice metacognition is the Think Aloud. This strategy discussed in *Reading for Understanding*[13] suggests giving students a text with which to grapple that is accessible yet somewhat challenging. The text may be a written sample, video of a science experiment, diagram, graph, or other information source. Students are given the opportunity to think about thinking. This metacognition practice encourages students to use words, phrases, and illustrations to visually represent their thinking. Student writing responses could include questions, connections, and predictions. Students may be given a Metacognitive Bookmark with sentence starters such as: I can see…, This reminds me of…, I'm not sure about…, The main idea is…, I want to know more about…, I wonder what would happen if… The use of the sentence

starter triggers student thought processes and encourages a variety of responses to the text. It is essential that teachers model the Think Aloud before asking students to take on the task. It can be a difficult and uncomfortable practice to reveal and articulate one's thinking process. Offering examples and modeling encourages a low-risk environment for students to develop metacognitive awareness. Students should undertake this process with a partner as they work through the text. Students may alternate reading and responding to the text with listening to their partner. Students should begin to recognize what it means to be "mentally active"[14] as they read and respond to the text. The use of Think Aloud can be a routine introduction for new content and texts. It is essential for teachers to model for students how to interact with the text[15]. Teachers should model what is difficult for students and encourage students to work through the confusion caused by complex text.

After students are comfortable with incorporation of the Think Aloud strategy I will introduce the Talk to the Text strategy. This strategy encourages students to interact more deeply with written text. We will use Part I of *The Omnivore's Dilemma* to investigate the use of corn in the food industry. Students will identify hidden uses of corn and examine their personal choices as they relate to food and our environment. The Talk to the Text technique suggests that students examine the text on their own before being asked to discuss it in class. Preparation is encouraged so that the interaction with the text is more authentic and in-depth. Students create a set of metacognitive responses to the text as they read and decipher the meaning and information contained. Students will use this strategy to identify patterns and trends in experimental data.

The Talk to the Text strategy works well in the science content as students are asked to interpret and make observations about data in addition to create inferences regarding the data presented. Students will be given a set of data in a table to decipher and use the Talk to the Text technique to make relevant observations and identify possible explanations of the data. This reading strategy may also provide insight and information for an explanation written using the Claim, Evidence, Reason framework. Students may refer to their metacognitive reasoning and responses to complete an analysis of labs and activities. Encouraging an interaction between metacognition while reading and science allows students to recognize the cross-curricular value of informational text in the science classroom. Student understanding is increased when thinking about text is personal and deciphered through metacognition practices.

A successful learning strategy in my classroom is Student Learning Teams. The use of teams creates a learning environment that encourages students to be accountable for their own learning. The learning team offers them opportunities to exercise their learning strengths and benefit from peers when facing their learning struggles. The learning team will work together during specific classroom activities to complete directed learning outcomes. Students will work with the same team of students throughout the unit. This creates consistency and responsibility for all students in the classroom. Students will

establish roles within the learning team. The Team Monitor will track student participation within the team activities. At the end of each team learning activity, students will be required to complete a Learning Team Evaluation. During this reflective practice, students will be required to assess their own contributions as well as those of their teammates. Students will assign a grade for themselves and each of their team members. The grade must also be qualified with an explanation of why each team member received their grade. This evaluation serves to establish an atmosphere of mutual respect and responsibility.

Student Learning Teams have served a dual purpose within my classroom. Students enjoy working with a partner or group, but often the discussion and activity load is less rigorous and evenly distributed than I would prefer. The Learning Team Evaluation (Appendix 2) serves as an assessment for the teacher and also makes every team member accountable for their own contributions. In developing and using the Learning Team Evaluation, I worried that students would go easy on their friends and give everyone an "A". By requiring specific examples of contributions from each team member, I have increased the critical thinking component of the reflection and can further assess each student's participation. I have noted that students are very honest and often grade each other more critically than I might have. Students see the value of their own contribution to the group and also expect the same level of participation from their teammates. An excellent paper on effective use of learning teams in the classroom is available at http://www4.ncsu.edu/unity/lockers/users/f/felder/public/Papers/Oakley-paper%28JSCL%29.pdf. This paper titled "Turning Student Groups into Effective Teams" was originally published in the *Journal of Student Centered Learning*[16].

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/ [17] 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 describe the flow of energy through Earth as a System. Groups will focus on either the Atmosphere, Biosphere, Geosphere, or Hydrosphere. 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. Students will complete the Learning Team Evaluation at the end of their research and teaching session. This will serve as an assessment in addition to the informal evaluation provided by student created questions. As a culmination activity, students will use this research as they develop an individual mini-project on an ecosystem (*Appendix 3*). For the Exploring Ecosystems mini-project students will be given guiding questions to consider as they

investigate their ecosystem and develop a presentation method. Students will refer back to our instruction on digital literacy and select an appropriate application with which to create their digital presentation.

Student use of interactive technology and Reading Apprenticeship reading strategies facilitates the development of the 4 C's of 21st century skills: Communication, Collaboration, Critical Thinking, and Creativity. Through learning teams students are engaged in the 4 C's and become well versed in working with their peers to accomplish learning goals. These 21st century skills are an essential component in my classroom.

Classroom Activities

Introductory Activities

Students will have been introduced to the concept of biomes and ecosystems prior to this unit. We will begin our discussion of energy flow by incorporating the **LINK** strategy. Students will brainstorm a **L**ist of words, phrases, and create illustrations or diagrams which they relate to the phrase "Energy Flow in the Ecosystem". We will use these lists to create a class list of terms and phrases. Students will then **I**nquire about each other's lists and establish a set of questions about the topic. These will serve as learning goals for students during our unit. Later in the unit students will **N**ote information about the topic as we examine written text and data-driven examples of energy flow. Finally students will reflect on their thinking and knowledge gained during the unit and establish a set of ideas and new information that they **K**now from interacting with text and data during the unit. We will revisit the original class set of questions and respond to any unanswered questions. After our initial brainstorming exercise students will play "Find a Food Web Friend" game. During this teacher-created game students will each be given an animal or plant picture and be instructed to find relational organisms for their specimen. For example a student with a sun photo would connect to blades of grass which would relate to a grasshopper and then a bird. Students will find a food chain initially and then form a larger web by connecting with other groups. At the end of the game each group will diagram their web and label the organisms as producers, consumers, etc. Students will use this diagram later as we map the flow of energy within an ecosystem.

Students will also participate in a game titled "Predator-prey". In each group students will be given a different tool to model the food acquisition method of a predator. Predator tools will include tweezers, a spoon, a knife, a toothpick, or a small suction cup dart. Students will use their given tool to collect as much prey as possible in a specific amount of time. Students will collect "prey" including a marble, metal washer, piece of string, straw section, pull tab from soda can, small pony bead, crumbled up bits of paper, small strips of cardboard, and mini marshmallows. At the end of the game students will analyze the diversity of the prey they collected as well as discuss difficulties encountered given

their "predator" tool. Teacher will engage students in a discussion of how biotic and abiotic factors could influence the available prey and how that would affect the survival of their predator specimen. Teacher will also engage students in a discussion of how changes to the ecosystem would influence prey availability and thus predator survival. Students may further decide to infer actual organisms represented by their predator model and available food. Students will create a graph (Appendix 4) identifying types and amounts of prey collected during the game and complete a reflection and analysis based on personal and group results. Finally students will write a Claim, Evidence, Reason paragraph identifying the predator best suited for survival based on their findings.

Earth as a System

Students will access a teacher created Blendspace titled Carmel Earth As a System https://www.tes.com/lessons/Gd4NEq4ouyu3sw/edit [18]to conduct research on a specific component of Earth as a System. Students will complete a description of one component of Earth as a System with their jigsaw group. Students learning teams will consist of four members. Each member will research either the atmosphere, biosphere, geosphere, or hydrosphere of Earth's system. Students studying the same topic will work together. Students will be charged with defining types of systems and establishing that Earth is a closed system. Students will research specific details about their sphere and will create a digital presentation about their sphere. During jigsaw group presentations, students will complete a notes sheet about each sphere. (Appendix 5) Student presentations may include an iMovie, Prezi, PowerPoint, Google Presentation or other digital method.

Flow of Energy through an Ecosystem

Students will use the website http://www.learner.org/courses/envsci/interactives/ecology/index.php[19] to access a science interactive from the unit The Habitable Planet: Ecosystems located on the website http://www.learner.org/courses/envsci/unit/text.php?unit=4&secNum=3 [20]. Students will complete the "Food Web" interactive and select producers and consumers to include in their ecosystem. When the program runs it will construct a data table depicting species survival based on given parameters. Students will use the data form (Appendix 6) to record and interpret the data provided during the simulation. Students will respond to analysis questions on the data form and illustrate the food interactions which occur. Students will use the diagram created during the "Find a Food Web Friend" activity to further study the flow of energy throughout the ecosystem. Students will be charged with analyzing Trophic levels for their web based on how organisms are classified, e.g. producer or consumer. Students will work with their food web group to create this analysis. Student may use both the food web diagrams and data analysis during research for their mini-project. Through recording and interpreting data students will more completely understand the relationship of organisms within the ecosystem.

Additionally Students will use a teacher created LessonPaths to investigate Earth's ecosystems. Students will analyze ecosystems, climate and plant diversity, and temperature and precipitation relationships within the biome. Students will access the website LessonPaths: Carmel Ecosystem Data Analysis http://www.lessonpaths.com/learn/i/carmel-ecosystem-data-analysis/carmel-ecosystem-data-analysis [21]to research the plant diversity and climate of Earth (Step 1), biome type regarding rainfall and temperature (Step 2), and their chosen ecosystem (Steps 4-11). Students will again use the data on the LessonPaths to research an ecosystem and complete the requirements of the mini-project. Students will complete the Investigating Ecosystems Analysis (Appendix 7) to respond to critical thinking questions and form observations based on given statistical and text resources. Students will use the LessonPaths and the activities completed to aid in research for the mini-project on their ecosystem.

Assessment

Informal Assessment

1. Student created assessment on Earth as a system.
2. Learning Team Evaluation
3. Predator-prey Activity Sheet Data, Graphs, and Analysis
4. Ecology Food Web Interactive: Data and Analysis

Formal Assessment

1. Exploring Ecosystems Mini-Project
2. Claim, Evidence, Reason Explanation Paragraphs
3. Investigating Ecosystems Analysis

Assessment of Student Growth

During this unit students will complete an activity analysis using the Claim, Evidence, Reason framework. I will assess student growth by comparing the analysis written at the beginning of the unit during our analysis of the results of the Predator-prey game and closer to the end of the unit when students analyze the Ecology Food Web Interactive. Student paragraphs will be examined to determine level of understanding and mastery of content.

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 or 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. Students will select an ecosystem and an organism within the ecosystem and map the flow of energy for that organism.

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 ecosystems and organisms within the ecosystem.

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 the flow of energy of an organism through a chosen ecosystem.

Appendix 2

Learning Team Evaluation

Name: _____ Block: _____

Comprehension

1. Explain the topic of the lesson.
2. What did you learn about the topic?
3. What additional questions do you have about the lesson objective?
4. What was your favorite part of the lesson?

Self-Reflection

1. Why were you a good team member? What did you do or say to help your team be successful?
2. What strategies could your team use next time to be more effective learners?

Evaluation

1. I think that I deserve the following grade_____.
   I deserve this grade because_____.
2. List your team member's names and the grade you think they deserve. Give specific examples of participation or contribution that justify this grade.

Member #1:_____
Member #2:_____
Member #3:_____
Member #4:_____

Appendix 3

Exploring Ecosystems
Mini-Project Guidelines

Research Materials may include:

- *Group Food Web*
- *Predator-prey Analysis*
- *LessonPaths: Carmel Ecosystem Data Analysis*
- *Earth as a System Jigsaw Activity and Notes*
- *Blendspace: Carmel Earth as a System*

Ecosystem: _____
Presentation Method: _____

Ecosystem Components

Using the data contained in the LessonPaths: Carmel Ecosystem Data Analysis, Write a data-based, detailed description of your chosen ecosystem.

Biotic and Abiotic Factors

Create a detailed description of how biotic and abiotic factors influence the biodiversity of your ecosystem. How do these factors affect the available food? Changes to what abiotic factors would most affect the ecosystem? Cite evidence from the data contained in the LessonPaths to support your answers.

Environmental Concerns

Discuss potential or current hazards which affect your ecosystem and its ability to support biodiversity. Include human influence as well as natural variables. You may need to access additional information for this step.

Environmental Benefits

Explain how your ecosystem supports Earth as a System. Cite data to support your discussion.

Energy Flow Diagram

Select an organism and design a multi-dimensional food web for your ecosystem. Include the flow of energy through each trophic level. Use the LessonPaths to cite data-based evidence.

Bibliography

Cite at least 3 resources used during your research. At least one must be a data-based resource. You may use information from the LessonPaths: Carmel Ecosystem Data Analysis.

Appendix 4

Predator ~ Prey

1. Describe your Predator tool:
2. This tool could be a model for what real life organism?
3. Use the table below to list the quantity of each prey collected:

Predator Tool	Cardboard	Marble	Marshmallow	Metal Washer	Paper	Pony Bead	Pull Tab	Straw	String

4. On the back of this paper, create a graph depicting the data above.
5. Compare your graph and raw data to the other predators in your group.
6. Utilize the **"Talk to the Text"** strategy to analyze your data. Consider the

following…

- What differences do you notice about your data?
- What could account for these differences?
- Was a certain predator more successful at collecting prey? If so, how could you explain this?
- Which prey were easier/more difficult to collect? Why do you think this is so?

Analyze...

7. Considering your results, what could influence the survival of your predator?
8. What do you think would happen to the predators in your group if one or more of the most collected prey disappeared?
9. What changes to the ecosystem could cause this disappearance?
10. Which predator do you think has the best chance of survival if the most collected prey were no longer available? Write an explanation using the **Claim, Evidence, Reason** framework. Be sure to cite evidence from the raw data and graphs from your group to support your claim.

Appendix 5

Earth As a System

System: _____
Open System: _____
Closed System: _____
Steady State System: _____

Atmosphere	***Biosphere***
What is it??? **How does energy flow???** **Role in Earth's System???** **Illustration & Example???**	**What is it???** **How does energy flow???** **Role in Earth's System???** **Illustration & Example???**
Geosphere	***Hydrosphere***
What is it??? **How does energy flow???** **Role in Earth's System???** **Illustration & Example???**	**What is it???** **How does energy flow???** **Role in Earth's System???** **Illustration & Example???**

Earth As a System

My System Component: _____

My Group Members: _____
My Role in the Group: _____
Method of Presentation: _____
Resources Used: _____
Planning Notes: _____
Reflection on our product and group collaboration: _____

Appendix 6

Ecology Food Web Interactive: Data and Analysis

Steps to Follow:

- Use the website http://www.learner.org/courses/envsci/interactives/ecology/index.php to access the Food Web Interactive from Learner.org.[22]
- Select the Food Web Activity. Read the information under Challenge and then follow the instructions under Step 1. Be sure to only select one organism from each level.
- Click on Open Simulation, make and record your selections.
- Predict what will happen: Population increase (+) Population decrease (-) or Die Out (XX)
- Complete the Data Chart below to record your selections and results.
- Click Step and record your results for each day.

Step 1 Selections and Results:

Day	Plant___	Prediction	Herbivore___	Prediction	Omnivore___	Prediction	Top Predator___	Prediction
10								
20								
30								
40								
50								
60								
70								
80								
90								
100								

1. What do you notice about the population of the Herbivore? Was your prediction correct?
2. What factors influenced the population level for each organism?
3. How would the introduction of a second omnivore affect the ecosystem populations?

Step 2 Selections and Results: (Students will need two copies of this data sheet)

Day	10	20	30	40	50	60	70	80	90	100
Plant A										
Predict										
Plant B										
Predict										
Plant C										
Predict										
Herb A										
Predict										
Herb B										
Predict										

Herb C										
Predict										
Omnivore A										
Predict										
Omnivore B										
Predict										
Omnivore C										
Predict										
Top Predator										

1. What changes did you make from the first trial to the second?
2. How did these changes affect the number of each population of organisms?
3. How were your predictions correct/ or different from the actual outcome?
4. What do you think would happen if another top predator were introduced?
5. Were you able to secure the survival of each species? If so, how?

Energy Flow Reflection:

Using the data and information learned, explain how energy flows through an ecosystem. Use the Claim, Evidence, Reason framework to explain your answer. Be sure to cite evidence from the data to support your response.

Appendix 7

Investigating Ecosystems Analysis

Use the LessonPaths: Carmel Ecosystems Data Analysis to respond the following questions.

<u>Step One: Plant Diversity</u>

1. What do you notice about the location of the areas with minimal plant diversity (tan color) and those with the most diversity (red)?
2. What abiotic factors could explain the lack of plant diversity in some areas?
3. How would an increase in plant diversity affect other organisms in the ecosystem?

<u>Step Two: Temperature and Rainfall</u>

1. Use the pyramid to explain the climate you would expect to find in each of the following biomes:
   - Tropical Rainforest
   - Temperate Deciduous Forest
   - Tundra (Arctic)
2. What do you notice about the relationship between the location of each of the deserts and the amount of precipitation?

<u>Step Three: Temperature and Precipitation Graphs</u> (Click source at the bottom of the page for the page to load correctly.)

1. Select two different biomes and write two observations comparing the temperature of each biome. Write two observations comparing the precipitation of each biome.
    a. Temperature
        i.
        ii.
    b. Precipitation
        i.
        ii.
2. Do you notice a correlation between high temperatures and levels of precipitation? Is this correlation consistent among all biomes or are there variations? Why do you think this is so?

<u>Step Four through Eleven: Biome Information</u>

- Use Steps Four through Eleven to conduct research about an ecosystem within one of the biomes for the Exploring Ecosystems Mini-Project.
- Select an ecosystem within one of the following biomes: Rainforest, Desert, Temperate Deciduous Forest, or the Tundra. There are two steps/websites for each biome.

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