Discovering Ecosystem Relationships through "Adopting" an Animal

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This curriculum unit recommended for:
8th grade science but select parts can be adapted for
7th/6th grade science and some high school courses

Keywords: symbiosis, predator-prey, predation, mutualism, commensalism, parasitism, cooperation, competition, coexistence, and ecology

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

Synopsis: This unit will use the "adoption" of an animal to teach students about various ecological relationships.

I plan to teach this unit during the coming year to approximately 120 8th graders. This group is divided into 4 classes. Two of these classes are considered on grade level. One is considered to be above grade level and one is considered to be below grade level.

Introduction

Last year, during the 2017-2018 school year, I noticed a clear trend in our overall data at Eastway Middle School. Students were generally performing better on their math end-of-grade (EOG) tests than their English Language Arts (ELA) EOG tests. Before meeting the student population, this data seemed a bit confusing and I wondered what could cause such a gap in performance. However, after spending a few weeks teaching at Eastway Middle School, I realized why such an apparent trend exists. While only some students are designated as "EL" (English Learners), many students have recently exited that program and/or speak another language as their primary language outside of school. Also, students that do not or previously have not had this designation, grew up in environments that did not support language development (reading at home, etc).

As a science teacher, it is extremely hard to teach and engage my students when they struggle with ELA. In 8th grade, students will have an EOG in science for the first time in their academic lives. Our curriculum is heavily vocabulary based and, unlike with the math EOG, our EOG is very wordy. Generally, students' 7th grade ELA EOG scores are a good predictor of their scores on the 8th grade science EOG.

When developing this unit, I wanted to include as many opportunities for students to develop their language skills, while learning the science content. For example, students often struggle with basic science vocabulary, such as "increase" or "decrease," so much of this type of vocabulary will be included in this unit. Most teachers can remember a time when someone said to them, "All teachers teach reading and writing." I wanted this to be especially true in this unit, as this unit will be taught toward the end of the year and will be close to the time of the EOG.

The basic idea of this unit is for students to "adopt" an animal that they will use to learn about various relationships found in ecosystems. As students progress through this unit, they will be recording their ideas in a science notebook, to support their language development. Student progress will be measured both formally (through a test and several quizzes) and informally (through their work in their notebook and several other assignments). This unit will be very collaborative, as students will have many opportunities to interact with their peers and present information to the class. This will provide students many examples of the content, while being able to work on their English language skills.

Demographics

Eastway Middle School is a middle school serving around 900 students in grades sixth through eighth. Eastway is located in Charlotte, North Carolina in the Charlotte-Mecklenburg School District, which is the second largest in North Carolina and the nineteenth largest in the United States.

Eastway Middle School recently, according to the 2017-2018 school year data, moved from an "F" school to a "D" school. However, even with this slightly higher designation, Eastway's demographic still faces many issues that negatively affect the learning of the student population.

According to the 2016-2017 school's report card, approximately 64% of the student population is considered economically disadvantaged, meaning our school offers free lunch for all of our students. 97% of students are considered "minorities," and our newcomer (students with less than a year experience in the United States) is high. Eastway has significantly less proficiency on the math, language arts, and 8th grade science EOGs than other middle schools in both the district and across the state.

Over half of the teachers at Eastway have less than 3 years of experience. Many of these teachers come from non-traditional education programs, such as the lateral entry route or Teach for America, meaning they come to Eastway as first year teachers with little to no experience teaching middle school students. Additionally, we have a high teacher turnover rate, meaning that many teachers leave each year. This makes it hard to establish a school culture.

Both the background of our student population combined with our teachers' overall inexperience and turnover rate make it difficult for school improvement and proficiency. Therefore, any teaching must be very intentional and focus on building up the students' background knowledge, while also teaching content.

Rationale/Objectives

Eastway, being a school with many minorities, has students with many different backgrounds and language abilities. As Januszyk, Miller, and Lee (2016) write, "As traditional racial and ethnic minority students have become the numeric majority, teaching science for all increasingly means addressing diverse populations," (p. 47). This statement presents an interesting, pressing issue. While education policy is currently pushing for the implementation of STEM (science, technology, engineering, and math) in all classrooms, the population of diverse learners is also rapidly growing.

Because of this issue, it is imperative that language is intertwined with science content. In fact, most researchers agree that language and content are inseparable (Hakuta, Santos, & Fang, 2013, p. 451). Students must strengthen their language skills while also learning concepts. They work together and should not be taught separately. Weinburgh et al. (2014) reinforces this when stating, "Language and conceptual understanding are two sides of the same coin and, as such, complement and reinforce each other," (p. 532).

Currently, North Carolina has a modified version of the Next Generation Science Standards (NGSS). Over the next couple years, the state will fully implement these standards. The NGSS provide a solution to addressing both these issues at once. Miller, Lauffer, and Messina (2013) write, "The NGSS expands our traditional notion of science mastery and offers new language opportunities," (p. 57). Implementing the NGSS can support language growth through content knowledge as the set up of the standards themselves support strategies that can help students build a deeper understanding of science, while increasing their language skills. To build this deeper understanding of science, the NGSS has three parts or dimensions that also support language learning. Tretter et. al (2014) writes, "The NGSS emphasis on the three fundamental dimensions – disciplinary core ideas, science and engineering practices, and crosscutting concepts – likewise highlights the importance of students' mastery of science-specific language structures to effectively learn these interrelated dimensions," (p. 40).

Engineering is also another huge component of NGSS and in the recent push for STEM. The engineering practices that support the content in the standards also support global ideas that students need specific scientific practices for life beyond school. Januszyk et. al (2016) write, "This new wave calls for all students to learn academically rigorous science, become college and career ready, and take part in the global community," and explain that, "By recognizing engineering, the NGSS open the door to contributions of non-western cultures as demand for technological innovation grows," (p. 47). By aligning this unit to both the modified, North Carolina standards and the NGSS standards, students will become more college and career-ready, increase their language skills, and have a better, deeper understanding of the scientific concepts taught.

Best Practices in Science

In order to teach this unit or any science unit, teachers must make clear what is meant to be scientific and make students understand that the science and engineering practices outlined in NGSS can look different depending on the activity. Almost every new scientific investigation demands a new conversation about what is considered "good scientific work," (p. 69).By having these conversations, every student is held accountable for expressing scientific thinking. Teachers must have expectations that students will think scientifically, which, again, will have different meanings in different contexts. Students may generate questions, share their observations or explanations, or just listen to one another's ideas with an open mind (p. 69).

Most importantly, Carlone and Smithenry (2014) explain that teachers should reinforce diversity by praising the different ways that students perform scientifically. They explain that being scientific does not necessarily mean obtaining the right answer, but also, as they state, "thinking divergently, solving problems, asking questions, making unique observations, and thinking of new investigations," (p. 69). This technique of supporting and encouraging different ways of scientific thinking allows students to feel safe and supported in the science classroom.

Background Information on Student Learning and Achievement

Students have some familiar with this content as these standards were scaffolded in both 6th and 7th grade (in all district schools). Students learned the basic terms that come into play for these relationships and have most likely heard of the simpler ones (such as predator/prey).

For example, in 6th grade students discussed survival and reproduction in ecosystems through the lens of plants. Students also learned about abiotic and biotic factors, as well as biomes, giving them some background information when beginning this unit. In 7th grade, students looked at organisms on more of a cellular level, also giving them some background information on ecosystems. In 8th grade, there is only some building up to this content. The units in the fall semester are on chemistry and water, which gives students some idea how organisms interact with the hydrosphere (an important factor in an ecosystem). The unit right before this discusses microbiology, so students will be slightly familiar with living things. Much of the information presented in this unit will be brand new for students or will be more complex than information they've seen before on this topic.

The 8th graders that I plan to teach this unit to have varying backgrounds in science as well as varying academic achievement in previous science assessments/courses. In my first block, on grade level, class students received mostly C's or D's on their 7th grade Science North Carolina Final Exam (NCFE), which is a less intense end-of-year test that students take after 7th grade science. In my third block, honors, class students received mostly B's and C's on their 7th grade science NCFE. In my fourth block, below grade level, class students received mostly D's and F's on their 7th grade science NCFE. And, in my last block, on grade level, class students received mostly C's on their 7th grade science NCFE. Scores, in all classes, were higher on their ELA EOG in all classes than in years past, but still could be improved.

Background Information on Science in this Unit

Studying and learning about ecosystems (Lesson 1 of this unit) is truly important to today's society, especially with declining biodiversity. Duffy (2009) writes, "Researchers conclude with some confidence that, on average, higher species richness increases biomass accumulation and resource use within trophic levels. (p. 442). However, ecosystems are not simple content to study. Loreau (2010) addresses this when he writes, "One of the distinctive and fascinating features of ecological systems is their extraordinary complexity." (p. 49). Keeping in mind the importance of this topic and its difficulty, the unit below was strategically divided up into small segments that will hopefully increase student understanding and help inspire awareness to issues such as climate change.

After students are introduced to the unit, they will be given an opportunity to "adopt" an animal that will help them learn about various relationships discussed in the unit. All children have some relationship with animals and the students at Eastway are no different. Melson and Fine (2015) discuss this when they state, "No matter what facet of human–animal interaction one examines—pet ownership, fascination with wild animals, imaginary animals, robotic pets—children are particularly involved," (p. 195). Therefore, linking the learning of somewhat difficult concepts

with this “adoption” of animal should and hopefully will help students master the content of this unit.

Students will then learn about producers, consumers, and decomposers. Matthews et. al (2011) explains how this connects to the over concept of ecosystems when they state, “Extensive research has explored how this diversity of predators, grazers, primary producers and decomposers can affect key ecosystem processes,” (p. 691). Students will apply this information to help classify their “adopted” animal.

The next segment focuses on various relationships in ecosystems, such as predator/prey, cooperation, coexistence, competition, and symbiosis. While students will not learn all about the complex details of the relationships, they are important to ecosystems. For example, predator/prey relationships contribute to the cycling of nutrients in an ecosystem. Vanni (2002) supports this when he says “When an animal feeds on benthic prey and excretes nutrients into the water, it translocates nutrients from benthic to pelagic habitats and converts nutrients from particulate to dissolved forms. In this case, animals move nutrients between habitats within a single ecosystem,” (p. 344).

Symbiotic relationships are also important to study. In a study of seagrass ecosystems, Heide et. al (2012) found that, “the bivalve-sulfide-oxidizer symbiosis reduced sulfide levels and enhanced seagrass production as measured by biomass,” (p. 336). Again, students may not understand the difficult concepts outlined in this study. However, these ideas are essential to the natural world.

Teaching Standards Addressed

The essential standard addressed in this unit is 8.L.3 is students will be able to “understand how organisms interact with and respond to biotic and abiotic components of their environment,” (NC Science Essential Standards).

The first clarifying objective for this standard is students will be able to “explain how factors such as food, water, shelter, and space affect populations in an ecosystem.” According to the district resources, this standard means students will be able to understand that ecosystems are complex and understand both the abiotic and biotic factors of the environment. Secondly, students will know how factors such as food, water, shelter, and space affect populations in ecosystem. Students should also understand that energy can change from one form to another in living things and that all food energy comes from sunlight. Finally, under this, clarifying objective, students should know that in all environments, organisms with similar needs may compete with one another for limited resources, including food, space, water, air, and shelter. Students will explore this objective as they think about how the environment could support competition or any of the other relationships described below. This clarifying objective will be intertwined within the unit.

The second clarifying objective for this standard is students will “summarize the relationships among producers, consumers, and decomposers including the positive and negative consequences of such interactions including: coexistence and cooperation (predator/prey), parasitism, commensalism, and mutualism. This means that students should know that one of the

most general distinctions among organism is between plants, which use sunlight to make their own food, and animals, which consume energy-rich foods. Students should also know that, in any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources . And, also understand this standard, students should know that there are several types of relationships that exist between organisms: predation, competition, symbiosis. This clarifying objective will be the focus of this unit. However, the other clarifying objectives are important because they either come before, after, or intertwined in this objective.

The third clarifying objective for this standard is students will "explain how the flow of energy within food webs is interconnected with the cycling of matter (including water, nitrogen, carbon dioxide, and oxygen). Under this objective students should understand that the sun is the ultimate source of energy, over time matter is transferred from one organism to another repeatedly and between organisms and their physical environment, and the flow of energy is interconnected with the cycling of matter through food chain relationships. This objective will be addressed at the end of the unit.

Instructional Implementation

Creating an "Ecosystem" and Exploring Relationships - Description of Each Lesson:

*Each lesson is meant for 1-2 class periods, depending on the ability level of students.
*To fully understand the description of each lesson, please use the links for the Powerpoints, activities, and Student Sheets.

All lessons will have a "Do Now," an activating, engaging question that sets the tone for the class each day. Most of the time these are review of the previous lesson. All lessons will have an "Objective," which is the goal of each lesson. All lessons will have an exit ticket, which will act as an informal assessment for the instructor.

Introduction to Ecosystems and Abiotic/Biotic Factor - Lesson 1: Powerpoint and student sheet

This lesson will be the introduction for the unit. After the "Do Now" students will learn about what an ecosystem is by watching a BrainPop on ecosystems. Then after a quick class discussion of the BrainPop, students will begin to think about the criteria for something to be living. Students will identify non-living and living factors in various pictures. These pictures are on the Powerpoint, but also can be printed out and passed around. Students can work together or in pairs to find these factors.

After having background information on these factors, students will fill in notes about abiotic and biotic factors. Students will watch a video clip on these factors and ecosystems.

Students will then do a quick reading and answer several questions to reinforce their knowledge of ecosystems, abiotic factors, and biotic factors. Finally, students will do an exit ticket, which the instructor will look at before the next lesson to determine what students in the class mastered today's objective.

Organisms and Ecosystems in North Carolina - Lesson 2: Powerpoint and student sheet

In this lesson, students will be introduced to "adopting" an animal that they will use to exemplify various relationships throughout the remainder of the unit. The instructor will explain this idea and give an introduction to how this will all work. Students will then be given 35 animals to choose from. Students will pick three animals that they may be interested in "adopting" and will answer several questions about each animal to guide their research. After this, as their exit ticket, students will rank, in order, which animals they would like to "adopt." The instructor will then assign each student an animal. In each class, no two students will have the same animal.

Organization of Ecosystems - Lesson 3: Powerpoint and student sheet

After the "Do Now," students will think about the question "How can we classify organisms in an ecosystem?" In order to guide their thinking, students will participate in a "Think-Pair-Share." This means that students will first record their answer on their paper under "Think." Then students will record a partner's idea under "Pair." Finally, students will record another classmate's idea as we share out as a class under "Share."

Students will look at several diagrams that show levels of organization in an ecosystem - an organism, a population, a community, and an ecosystem. Students will also view a short video clip explaining this concept. Students should already be familiar with the term "ecosystem." Students will then create a chart, using their animal as their "organism," where they list and draw out examples of each one of these levels of organization. Students will then do an exit ticket that will act as an informal assessment for the instructor to see who has mastered today's objective.

Producers, Consumers, and Decomposers - Lesson 4: Powerpoint, card sort, and student sheet

After the "Do Now," students will reflect on what they have learned about ecosystems by completing a "KWL Chart." First students will fill out what they know about ecosystems and then they will list some ideas about what they still want to know. After the lesson, the students will out what they have learned.

Students will then read a short passage and answer several questions about producers, consumers, and decomposers. This will give students some background information on these concepts. After this, students will work in small groups or pairs to complete a card sort on producers, consumers, and decomposers. Students can then fill in the "L" for what they learned in their "KWL Chart."

Finally, students will apply today's new knowledge to their animal. They record what their animal is considered - a producer, consumer or decomposer. They will also begin to think other animals that interact with their animal or are found in the same ecosystem and classify those. This will help set the stage as students begin to think about their animal's relationships in its ecosystem in the next couple lessons.

Trophic Levels and Food Chains/Food Webs - Lesson 5: Powerpoint and student sheet

After the "Do Now," students will look at an activity where they transfer water from one glassa to another. Each time they only transfer 10% of the water. After doing this, students will have a discussion where the instructor will explain that the water represents the energy that is transferred through trophic levels. To better understand this, students will read a short passage and answer a few questions about food chains versus food webs.

Then the instructor will introduce the concept of "Energy Pyramids," students will use this information to fill out an energy pyramid with their animal as one level. Students will color code this pyramid and label the energy transfers that occur. Students will then do an exit ticket that will act as an informal assessment for the instructor to see who has mastered today's objective.

Competition - Lesson 6: Powerpoint and student sheet

After the "Do Now," students will do an activity where they act as animal and fight for resources. These resources will be represented by Fruit Loops (for full instructions, see the Powerpoint). Students will then have a quick discussion on what this activity showed. E instructor should guide students to discuss how the activity showed competition.

To reinforce this concept, students will read a short passage and answer some questions. Through a short video, students will learn about the concept of limiting resources and carrying capacity. After this, students will record how all of today's concepts affect or apply to their animal. Students will then do an exit ticket that will act as an informal assessment for the instructor to see who has mastered today's objective.

Coexistence and Cooperation - Lesson 7: Powerpoint and student sheet

After the "Do Now," students will do a short reading that discusses the terms "Cooperation" and "Coexistence." Students can work together, by themselves, or this activity can be done as a class. At this point in the unit, students have learned a lot about ecosystems and various factors/relationships in ecosystems. As a review, students will watch an episode of "Planet Earth." As students watch this, students will record examples of all the relationships they have learned about.

Once the video is complete, students will look back on the passage/questions on cooperation and coexistence. Students will be given time to research these concepts in relation to their adopted animal. Students will write these down in their notes. Students will then do an exit ticket that will act as an informal assessment for the instructor to see who has mastered today's objective.

Predator and Prey - Lesson 8: Powerpoint, activity, and student sheet

After the "Do Now," students will do an activity called "Deer Me" (see above link) to introduce them to predator/prey relationships. Students will record ideas after this and any observations of the activity. To further their learning about predator/prey relationships, students will read and answer questions. Finally students, will watch a quick video and fill in notes about predator/prey relationships.

Students will then list some predators and/or prey of their animal. Students will then do an exit ticket that will act as an informal assessment for the instructor to see who has mastered today's objective.

Symbiotic Relationships - Lesson 9: Powerpoint, activity, and student sheet

After the "Do Now," students will do the above activity in which they sort the examples into three categories that are explained on their paper. These three categories represent the three symbiotic relationships. Once the examples are sorted, the class will discuss these three relationships. Students will then read and answer the questions to reinforce this new concept.

Students will then, as a class, fill out a definition and example chart and a chart where they look at the symbiotic relationships for their animal or for animals in their animal's ecosystem. Students will then do an exit ticket that will act as an informal assessment for the instructor to see who has mastered today's objective.

Final Project - Lesson 10: Final Project:

Students will use all their notes to fill out an animal profile. Students will present their information to the class. As other students present, students will be required to fill out a worksheet to give them more information on the various relationships studied.

Appendix 1: Teaching Standards

Implementing District Standards

My unit would implement the North Carolina essential science standards in in a thorough way. This standards-based unit would incorporate one very important standard, as well as its three clarifying objectives.

Students will have the opportunity to strengthen their English writing skills while developing their knowledge on the information outlined in essential standard 8.L.3 (students will be able to "understand how organisms interact with and respond to biotic and abiotic components of their environment," (NC Science Essential Standards)).

Please see the information contained in the Curriculum Unit under "Standards Addressed" for more information.

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