Ecosystem Shake Up: An Environmental Change Adaptation Project

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Abstract

This practical article reports an intriguing diorama project for third grade elementary students (ages 8-9 years). Students worked as partners to create dioramas of given ecosystems made in pizza boxes. Then, students rolled a die to determine a change in some environmental factor that affected the ecosystem. The students discussed how this change affected the ecosystem and made a second part of their diorama showing the ecosystem after the change. Finally, students made class presentations concerning their dioramas and ideas. A rubric for assessing the projects is included. Results of this science project indicate that students became deeply engrossed in their work, successfully generating cause and effect explanations and altered ecosystems.

Key Words

Arts integration, dioramas, ecosystems, elementary students

Introduction

This practical article focuses on student-made dioramas depicting the landscape, flora and fauna of given ecosystems. The "shake-up" aspect of the project involved students rolling a die to determine a new environmental effect that would change the ecosystem and cause them to think more deeply about interactions of the various ecosystem components.

Literature Review

In this brief review of pertinent literature, the science learning benefits of dioramas are first discussed, noting observed enrichment of conversations at science museum diorama displays. The benefits of student-made dioramas regarding deeper engagement, spatial thinking, emotional expression, creativity, new perspectives, and greater longterm science content retention are also mentioned.

Science Benefits of Museum Dioramas

Science museum dioramas position museum objects such as preserved animals, dried botany specimens, or skulls in a naturalistic setting, providing science learning opportunities (Reiss & Tunnicliffe, 2011). Dioramas tell stories that allow viewers to connect to science content through their own feelings and experiences (Reiss & Tunnicliffe, 2011). Dioramas provide a platform for thinking and discussing as viewers identify components of the scene they recognize and peers or teachers request justifications for these labels (Alexander, 2008). Exchanges regarding what is happening in a diorama can begin with "how" and "why" questions, but progress to hypotheses and philosophical conversations (Reiss & Tunnicliffe, 2011). Visitors to museum dioramas tend

to follow a sequence of interaction that often begins with identification of aspects, generates interest, moves to interpretation and motivates further investigation, although these steps may occur out of sequence (Tunnicliffe & Scheersoi, 2010).

Benefits of Student-Made Dioramas

Museum dioramas clearly benefit visitors by engendering story-telling and science rich conversations; what additional benefits might student involvement in making a diorama hold?

Hands-on engagement. The professional literature contains few examples that have addressed student-made dioramas. One published project (Rule, Tallakson, Glascock, & Chao, 2015) involved middle school students in exploring the home, habitat, form/ structure and function body attributes and skeletons of a chosen animal (squirrel, rabbit, deer, groundhog, and opossum). Students made three-dimensional dioramas from papier-mâché-covered cereal boxes that opened like books after observing the live animals, taking photographs, and researching information. They made polymer clay models of the animals and their teeth and constructed papier-mâché burrows and scenes of animal homes and habitats, writing explanations. Students found the hands-on projects engaging, creative, and fulfilling, expressing pride and satisfaction in their accomplishments.

Enhancement of spatial skills. Besides addressing the science concept learning of structure and function of animal bodies and homes, the project (Rule et al., 2015) practiced the important skills of spatial thinking. Spatial thinking has been identified as a factor in success in science, technology, engineering, and mathematics (STEM) subjects. This proficiency is key to students selecting careers in STEM areas (Lubinski and Benbow 2006; Wai, Lubinski, and Benbow 2009). The reason spatial thinking skills are so important to STEM careers is that they allow students to succeed in working with many complex science or mathematics concepts before students have developed a large store of content knowledge. This success in introductory STEM subjects motivates students to delve deeper into STEM, and to picture themselves in successful STEM careers. Spatial thinking, hand-eye coordination, and fine motor skills are needed for science laboratory procedures. Science observation skills are developed through drawing and sketching which involve these important skills (Root-Bernstein and Root-Bernstein 2013).

Motivation through expression of feelings. There are many benefits of incorporation of the arts into science, such as the motivating effects of student exploration and expression of feelings through art. Other published projects described upper elementary students making diorama-like pop-up scenes to express their understandings of ecology with accompanying essays (Olsen, Zhbanova, Parpucu, Alkouri, & Rule, 2013; Gray, Elser, Klein, & Rule, 2016). Students in these studies were highly motivated by the artwork that allowed them to demonstrate their emotions regarding ecology issues. One barrier students, especially females, who are considering working in STEM fields encounter is that many careers are stereotyped to be cold, impersonal, and "masculine". These cultural perceptions are partly responsible for the lower numbers of women in STEM fields (Nosek, Smyth, Sriram, Lindner, Devos, Ayala, & Bar-Anan, 2009). Incorporation of arts and emotions into STEM can change this perception. An investigation of a project in which elementary students made dioramas of accomplished diverse women scientists (Teske, Gray, Klein, & Rule, 2014) found that although, initially, most male and female students in the class thought that women were unsuitable for science, they changed this attitude by the end of the five-day course. Exposure to the stories of successful, caring women scientists and involvement in making a diorama of a female scientist's career drove this change in perception.

New creative perspectives. Art integration into science allows a new perspective through creative, rather than logical, thinking (Bequette, & Bequette, 2012). This new mode of thinking prompts new ideas to come forward related to a problem through divergent thinking of many possible approaches and ideas instead of one convergent answer (Land, 2013). Creative thinking related to making a diorama or other model also influences student motivation to study science. A meta-analysis of 15 studies (de Jesus, Rus, Lens, & Imaginário, 2013) revealed a significant positive relationship between intrinsic motivation and creativity related to producing a product, such as a diorama or model.

Improved longterm learning of science content. Studies are emerging indicating that arts integration is beneficial to greater longterm learning of science content (e.g., McCartney, Mochal, Boyd, Rule, & Montgomery, 2017; Teske, & Pittman, 2017; Hardiman, Rinne, & Yarmolinskaya, 2014). Mechanisms naturally part of the arts have been identified (Rinne, Gregory, Yarmolinskaya, & Hardiman, 2011) as fueling this greater learning of content: rehearsal, elaboration, generation, enactment, oral production, effort after meaning, emotional arousal, and pictorial representation.

The Lesson

The main idea of this lesson was for students to produce a diorama of an ecosystem and to hypothesize the effects an environmental change may have on the given ecosystem. Students were expected to explain their dioramas and how the animals in their ecosystems could adapt to the environmental change.

Setting and Participants

This lesson was designed for third grade students from the Midwest of the United States. This lesson was taught in a public school to 20 students with an assortment of academic needs and learning styles. There was a mix of boys and girls in the class and a variety of cultural ethnicities represented. The school provided Title I services and was on the SINA (federal Schools in Need of Assistance) list for the academic year in which the lesson was implemented.

Materials and Equipment

A variety of art materials was used for this project. The main materials used for the base of the diorama were pizza boxes (2 for each diorama) and hot glue. Students used tempera paint, paintbrushes, and water in small buckets to create the background of their diorama. They, then, added animals using foldable animal templates, scissors, and tape. The teacher asked a local pizza parlor to donate the pizza boxes. Most of the other supplies were available in the school art room.

Standards Addressed by the Lesson

The NGSS (Next Generation Science Standards; NGSS Lead States, 2013) standard that this lesson addressed was standard 3-LS4-4: Make a claim about the merit of a solution to a problem caused when the environment changes and the plants and animals that live there may change. Students primarily engaged in the Science and Engineering Practice of "developing and using models" as they created a model of an ecosystem before and after a catastrophic change to the environment. The Crosscutting Concept of "cause and effect" was made explicit when students rolled the die to find out what major change was going to occur in their ecosystem, and then they had to recreate the ecosystem showing how the organisms that lived there responded to the change.

The art standard supported by this lesson is Anchor Standard #2. Organize and develop artistic ideas and work.

Lesson Procedures

Preliminary activities. To engage the students the teacher first asked them what they need to live. She asked them how they meet these needs here at school. The teacher asked them what they would do if they didn't get hot lunch at school each day. During this part of the lesson the teacher was checking to ensure the students knew that they needed water, food, and shelter to live. She was also checking to see if they were able to apply this concept to their own environment, as well as their background knowledge concerning the idea of adaptation.

The students were next asked to explore an animal on the Internet. Students found where the animal lived and how the animal obtained food, water, and shelter. Students were asked what their animal would do if humans poached or ruined their main food source. This problem could be connected to their own human adaptation to a lack of food.

Students had the opportunity to explain their solutions to the food problem. They first shared their idea with a partner. As they were talking, the teacher walked around and listened to conversations. Next, a few students were chosen to share their thinking with the entire class. The teacher was checking for any misconceptions and that their solutions were reasonable.

Presentation of the project. The teacher then presented the diorama project to students. They were given the rubric in Table 1 that was used to grade their final projects. They were then told the name of their ecosystem and their partner's name, which were recorded at the bottom of their rubrics. The teacher explained to them the requirements to score a full four points in each rubric category. They were told that they would be making a diorama that modeled their ecosystem in its natural state on one side, and their ecosystem after an environmental change on the other side. Students would be using one pizza box for each side. Students were required to include several animals on each side. These animals had to be able to survive with the other plants, water sources, and landforms included in the diorama.

Table 1. *Rubric Used to Score Student Products*

Aspect	4 Outstanding!	3 Good	2 Okay	1 Not So Good
Animals	We included at least three animals.	We included two animals.	We included one animal.	We did not include any animals.
Animal Survival	We correctly included **all three** things our animals need to survive in our ecosystem: food, water, and habitat.	We correctly included **two** of the three things our animals need to survive in our ecosystem: food, water, OR habitat.	We correctly included **one** of three things our animal(s) need to survive in our ecosystem such as food, water, OR habitat.	We did **not** correctly include **any** of the things our animals would need to survive in our ecosystem: food, water, or habitat.
Natural State	We accurately included an example of **each** of the following: plants, landforms, and water sources, to show what our ecosystem normally looks like.	We accurately included **two** of the following: plants, landforms, or water sources to show what our ecosystem normally looks like.	We accurately included **one** of the following: plants, landforms, or water sources, to show what our ecosystem normally looks like.	We did **not** accurately include **any** plants, landforms, or water sources, to show what our ecosystem normally looks like.
Animals After Change	We accurately showed how the environmental change affected the food, habitat, and water of **all** of our original animals.	We accurately showed how the environmental change affected the food, habitat, and water of **most** of our original animals.	We accurately showed how the environmental change affected the food, habitat, and water of **some** of our original animals.	We did not accurately show how the environmental change affected the food, habitat, and water of **any** of our original animals.
After Change	We accurately included an example of **each** of the following: plants, landforms, and water sources, to show what our ecosystem looks like after the environmental change.	We accurately included **two** of the following: plants, landforms, or water sources to show what our ecosystem looks like after the environmental change.	We accurately included **one** of the following: plants, landforms, or water sources, to show what our ecosystem looks like after the environmental change.	We did **not** accurately include **any** plants, landforms, or water sources to show what our ecosystem looks like after the environmental change.
Neatness	Our project has **all** of the following: no paint drips, evenly painted or cut outlines, and securely attached parts.	Our project has **two** of the following: no paint drips, evenly painted or cut outlines, and securely attached parts.	Our project has **one** of the following: no paint drips, evenly painted or cut outlines, and securely attached parts.	Our project has **none** of the following: no paint drips, evenly painted or cut outlines, and securely attached parts.
Creativity	Our project has **all** of the following: unique ideas, many components, and lots of detail.	Our project displays **two** of the following: uniqueness, many components, and lots of detail.	Our project displays **one** of the following: uniqueness, many components, and lots of detail.	Our project does **not** display **any** of the following: uniqueness, many components, and lots of detail.
Presentation	We correctly explained **all four** of these things: how food, water, and habitat were affected by the environmental change, as well as how at least one animal could adapt to the environmental change.	We correctly explained **three** of these things: how food, water, and habitat were affected by the environmental change, as well as how at least one animal could adapt to the environmental change.	We correctly explained **two** of these things: how food, water, and habitat were affected by the environmental change, as well as how at least one animal could adapt to the environmental change.	We correctly explained **one** of these things: how food, water, and habitat were affected by the environmental change, as well as how at least one animal could adapt to the environmental change.
Team Work	We **always** both worked together on this project. We each did our share creating and presenting the project in a cooperative way.	We **usually** worked together on this project, doing our share creating and presenting the project in a cooperative way.	We **sometimes** worked together on this project, doing our share creating and presenting the project in a cooperative way.	We **did not** work together on this project or do our share creating and presenting the project in a cooperative way.

Student Partner #1_____ Student Partner #2_____

Ecosystem _____ Ecosystem Change _____

Painting of backgrounds and determination of ecosystem change. Once students were told what their ecosystem would be, they started working with their partners on making the natural state side of their dioramas. They painted the background and what they would see on the ground of their ecosystem. See Figure 1. As they were working on creating the natural state, the teacher called one group at a time to roll the die to determine the environmental change affecting their ecosystem. The template of this die is shown in Figure 2. They recorded information of the environmental change on their rubrics. Then, they were able to begin working on the background that reflected the change. Backgrounds were left to dry overnight.

Figure 1. Example of Painting the Background.

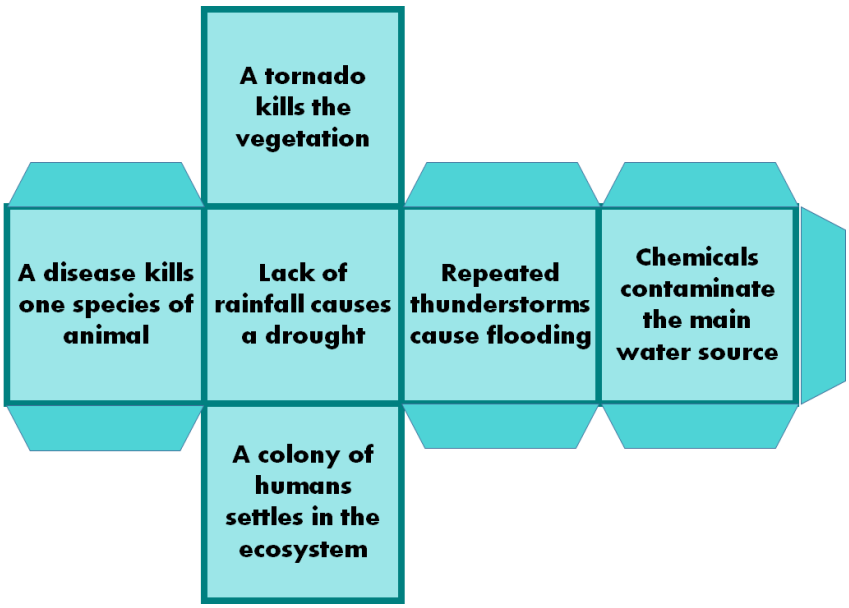

Figure 2. Paper layout of die. Fold on heavy lines and glue tabs to make a cube.

Adding animals and plants. The next day, students added animals and plants to both sides of their dioramas. Their animals and plants may have looked very different on each side, or they may have looked fairly similar. To make the animals, students were given a set of two-sided paper animals in color. They had to cut out the animals they wanted to use out, fold them, and tape them to the diorama. Figure 3 shows how the given paper animals were made by one of the authors for students to use. Figure 4 shows a student assembling an animal. If they didn't want to do it this way, they were allowed to find pictures from magazines to include. If they used pictures from a magazine, they had to glue them to a thicker paper to help them be more stable. Next, they made the plants. See Figure 5. Students were quite creative during this part. Some students used simple construction paper, some used pop bottles, while others used an array of recycled and craft items. Students were allowed to figure out how to incorporate different materials as plants themselves. Figure 6 shows one side of a diorama being completed.

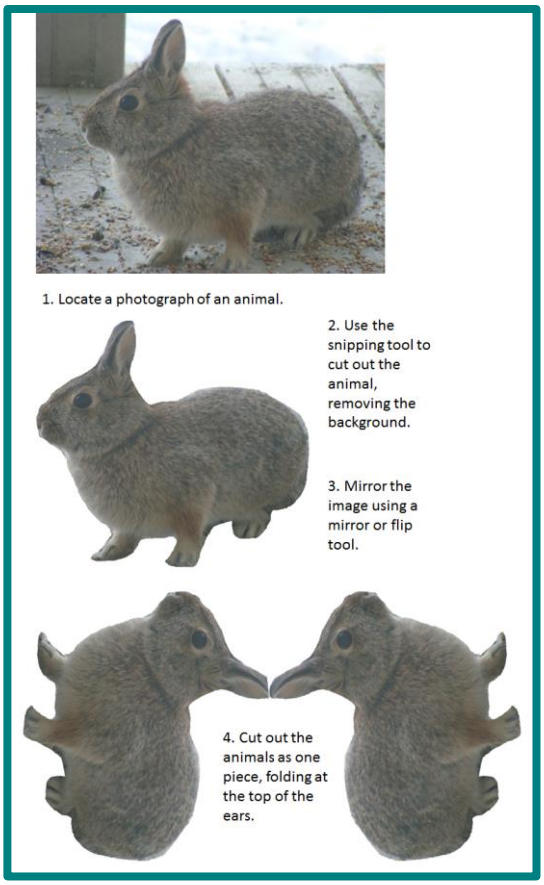

Figure 3. How to prepare double-sided animals.

Figure 4. Making animals for the diorama. White space was carefully left around the cutout animal.

Figure 5. Adding plants. This tree was built with a soda bottle as an underlying support.

Figure 6. One finished side.

Assessment. Finally, it was time to evaluate students' work. Students had to present their projects to the class. They were graded based on the rubric that was given to them at the beginning. Before the teacher graded the student products, students were asked to assess their own work. The teacher graded them on the same rubric. The

students gave oral presentations to their classmates to explain their ecosystems. Figure 7 shows finished diorama products.

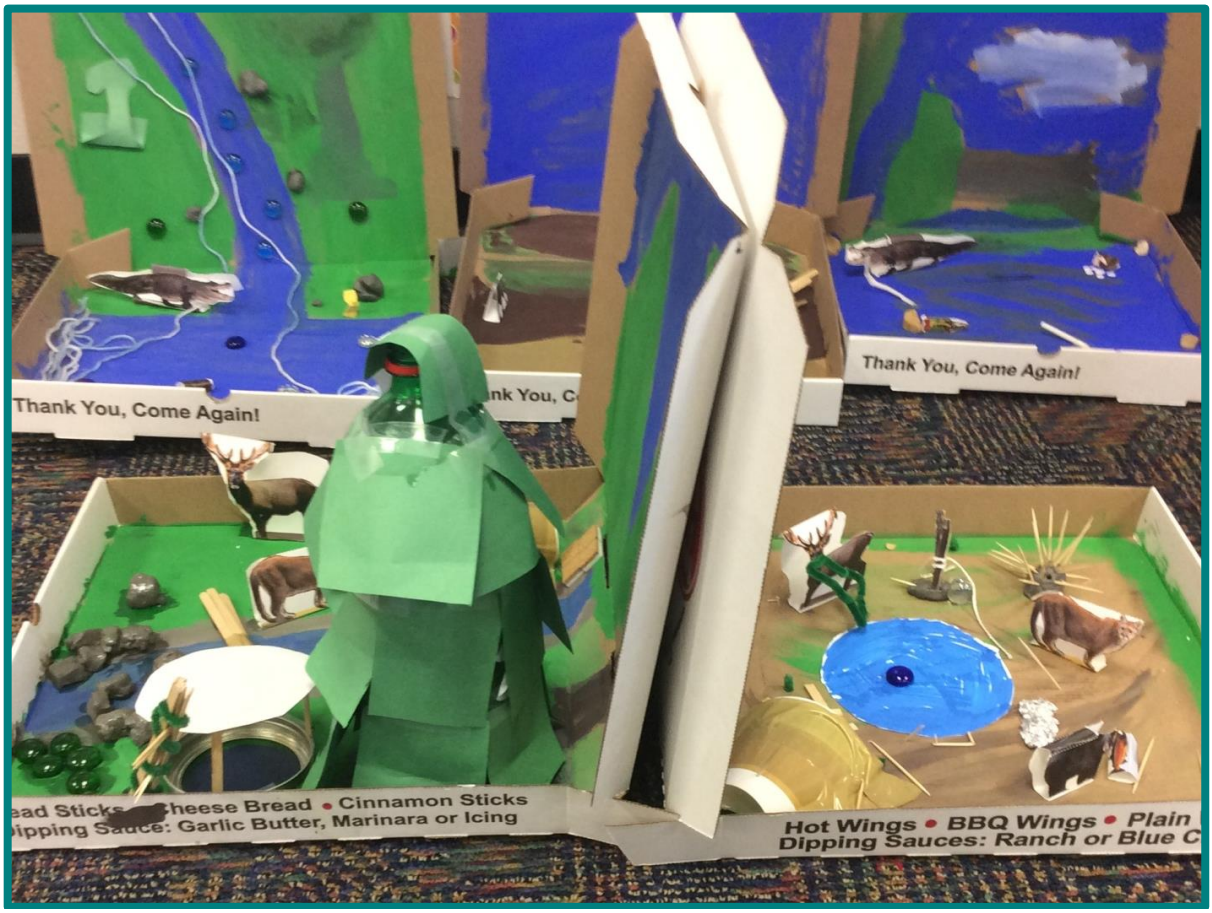

Figure 7. Final completed projects.

Results and Conclusions

Overall, the lesson went very well as planned. Students made good connections between their needs and the needs of the animals in their ecosystems. Students generally worked well with their partners and were engaged both in the discussion and the hands on parts of the lesson.

Teacher Observations of Student Learning

Spatial visualization issues. The students' final products met the teacher's expectations. Many students took their time and painted the backgrounds neatly. Some spatial thinking struggles with the concept of the bottom of the pizza box being the ground and the vertical open lid being a distant view occurred. These students experiencing this difficulty often painted trees lying down. These observations indicate the need for more practice in spatial visualization. Some students painted the ecosystem the way that they pictured it, making the desert sand yellow and the tundra bright white. The teacher encouraged students to use photographic images on the computer to make their ecosystems as realistic as possible.

Organizing ideas during presentations. Students performed well in their explanations during their presentations. Often, they needed to have their rubric or a script in front of them to remember what they were going to say.

Connections between human and animal needs. Students almost instantly made the connection between the

animals and themselves. They were able to combine their knowledge of the ecosystems and the animals to generate food chains within their different ecosystems. The part that the students struggled the most with generating a way for their animal to adapt to their environment after the change occurred. They needed some examples to ignite their thinking about how their animals could adapt, such as animals finding an alternate food source or migrating to a new area or building a home underground when trees were destroyed. After they were given examples, this process became easier for them.

Creativity. The teacher was most surprised with what some of the students chose to use when making their plants, such as using a soda bottle for an underlying structure. This aspect was the most creative part of the activity for them. The teacher was very pleased with their creative thinking skills during this part of the project.

Teacher Reflection

I learned a lot from this lesson as a teacher. The first thing I would suggest would be to team up with your art teacher. The art teacher at my school was my biggest resource during this project. She not only gave me resources, but offered the kids different suggestions throughout their work. It was also nice to have access to the art room student workspace. Students were accustomed to the art room being a creative space and used the materials appropriately. Also, it was easier to remove paint from the tiled flooring than it would have been from the carpet of our classroom.

I also learned to reach out in the community for resources. I asked a local pizza parlor if they would be willing to sell me pizza boxes. They donated them instead. I presumed if I asked a local business (one that we often utilize for class pizza parties), they would be willing to donate the boxes, or offer them at a discounted price.

Next I learned that sometimes when the students have little guidance, they can lose sight of the goal. A few students started making random animals out of the craft materials instead of only animals that fit in their ecosystem. They needed a reminder that the purpose of the project was to show what animals and plants belong to the ecosystem.

Finally, I learned that art projects are very messy and take much longer than I had planned. Some of the students that had the best results for their projects had the messiest work spaces. I had to be prepared for every possible mishap that could happen. Luckily, we had minimal spills and zero injuries! I had to be flexible with timing as well, because student creativity takes time.

Possible Lesson Modifications

This lesson could be done with every group working on the same ecosystem if needed. It may be beneficial for students to work on the ecosystem in which they live. This may save some time on research because they should have some background knowledge. Students might also have an easier time generating ways for local animals to adapt because they know their own community and its resources. One way to increase the level of complexity of the project, for example, to meet the needs of gifted and talented students to be challenged could be to add more animals and plants to the ecosystem.

Conclusion

The biggest win from this project, according to the teacher, was seeing students' creative thinking being directed toward solving a problem. Until this point in the school year, students had a hard time opening their minds to thinking about problems in different ways and to generating different solutions. The effective, creative idea discussions that occurred between the partner groups was very encouraging for future projects. The teacher will use students' problem solving skills gained in this project in other critical thinking skills throughout the year.

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