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Integrating Felting in Elementary Science Classrooms to Facilitate Understanding of the Polar Auroras

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Abstract

The Next Generation Science Standards (NGSS) emphasize conceptual science instruction that draws on students' ability to make observations, explain natural phenomena, and examine concept relationships. This paper explores integrating the arts, in the form of felting, in elementary science classrooms as a way for students to model and demonstrate understanding of the complex scientific processes that cause the polar auroras. The steps for creating felting, and using the felting artwork students create for assessing science learning, are described.

Keywords science education; interdisciplinary approach; early childhood; teacher education; science song project

Introduction

The Next Generation Science Standards (NGSS) were implemented in the United States partly as a response to the achievement gap that was present in the sciences on international comparison tests, such as the Program for International Student Assessment (PISA). The NGSS focus less on teaching science as fact-based recall (as previous state standards often did), and instead emphasize interrelated concepts in the sciences to prepare students for modern careers in science, technology, engineering, and mathematics (STEM) through a conceptual science approach (Krajcik, Codere, Dahsah, Bayer, & Mun, 2014). These standards were intended to allow students to explain phenomena in the natural world by identifying patterns and exploring cause and effect relationships. Additionally, the NGSS require students to construct models and make evidence-based arguments to explain their observations. In this paper, we present an arts-based assessment as one method to allow students to make connections, create models based on evidence, and support their explanations about the polar auroras in an elementary science classroom.

STEM and the Arts

The STEAM initiative, which is the integration of the arts in STEM, is a cross-curricular initiative, similar to what the NGSS attempt to promote. Arts integration can allow students make connections between and within subject areas, develop creativity, and utilize problem solving. Some research findings have documented that the arts contribute to students' development of skills necessary for STEM fields. In one longitudinal study, Wai, Lubinski, and Benbow (2009) found that spatial ability, which is present in the arts, was predictive of students' ability to obtain advanced STEM degrees. The authors interpreted the results as partially being indicative of the similarity between STEM and the creative arts, such as the ability to cognitively manipulate and transform visual images. On the importance of spatial reasoning and STEM, they concluded, "Enough empirical evidence has accrued to register another rare example of a solid empirical generalization within the human psychological sciences" (p. 827). The arts should be looked at not as a frill subject, but a means for helping to promote knowledge and skills, many of which are vital in the STEM subjects.

Incorporating the arts into STEM might do more than support student learning. The arts may also encourage student interest in STEM (Land, 2013), which is a requirement for reaching more diverse populations often marginalized from or underrepresented in STEM fields (Stoycheva & Perkins, 2016). Although women are nearly proportionally equal to men in most non-STEM fields, they are underrepresented in STEM careers in the United States (Clark, Brown, Johnston, & Diekman, 2017). Perhaps this is because women sometimes demonstrate less confidence and interest in STEM at the K-12 level (Genareo, Mitchell, Geisinger, & Kemis, 2016). Even with persistent efforts to recruit minority students into STEM programs and careers, students of racial or ethnic backgrounds are also underrepresented in STEM careers, even as their representation in the total United States population grows (Yu, Corkin, & Martin, 2016). Next, we describe concepts of the polar auroras and how teachers can integrate the arts to facilitate elementary students' science engagement and interest.

Polar Auroras

Description and Concepts Taught

Auroras are present near the northern and southern poles (Figure 1). The *Aurora Borealis*, or northern lights, is a natural phenomenon of flickering and dancing lights that are visible in the northern sky. It is named after Aurora, the Roman goddess of dawn, and boreas, the Greek term for a northern wind (Jóhannesson & Lund, 2017). It is typically seen in the extreme northern latitudes of the world, often observed in parts of Alaska, the northern continental United States, Canada, Greenland, Iceland, Scandinavia, and Russia. Although it is always present, the Aurora Borealis is most visible in the hours just before or after midnight (called *magnetic midnight*), and during the winter, late fall, and early spring months. The *Aurora Australis*, or southern lights, is more rarely seen than the Aurora Borealis simply because the areas where these lights would be visible are less inhabited. It can be observed in the extreme southern latitudes of the world, including Antarctica and parts of Australia, Tasmania, New Zealand, and countries in southern South America.

Figure 1. Aurora picture courtesy of www.pexels.com (2017)

The polar auroras are caused by energized particles in the solar wind, which are contained in the Earth's magnetosphere (Laroussi & Akman, 2014). The colors appear due to interactions of charged, accelerated electrons or protons emitted from the sun, which collide with gas atoms and ions in the earth's magnetosphere (Matsushita, 2013). This creates excess energy that is emitted as light particles, or photons. Typically, particles that interact with oxygen may be seen as green and red lights, and nitrogen interactions may appear as blue and dark red lights. Additionally, altitude affects the emitted color. Green lights may be caused by particle interactions occurring at an altitude of 120 to 180 km. Red lights are often generated at higher altitudes (240 km or higher), and blue or violet colors often occur at lower altitudes (95 km or lower; Baranoski, Rokne, Shirley, Trondsen, & Bastos, 2000).

Shapes of the polar auroras also vary and may or may not contain rays, or thin streaks (Cárdenas, Sánchez, & Domínguez, 2016). They are often seen in the shapes, or structures, called corona, diffuse, arcs, or drapery. Corona structures appear like a crown with rays converging at a single point; diffuse structures appear shapeless, and are very rarely observed; arcs are rainbow-like streaks across the sky; and drapery appears as a series of long rays which look like a curtain (Baranoski, Rokne, Shirley, Trondsen, & Bastos, 2003). It is important to note that colors and shapes of the polar auroras are constantly shifting and changing, so the visible shapes and colors may change from moment to moment.

The Polar Auroras and NGSS

The following arts-integrated polar aurora activity is recommended for students in Grade 4 or 5. It addresses the following NGSS standards (Geophysical Institute, 2016, p. 3):

- (Grade 4) Energy can be transferred from place to place by electric currents, which can then be used locally to produce light (NGSS DCI: Energy PS3.B: Conservation of Energy and Energy Transfer)
- (Grade 4) Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat and electric currents. (NGSS 4-PS3 Energy: 4-PS3-2)
- (Grade 5) The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon and stars at different times of the day, month and year. (NGSS ESS1.B: Earth and the Solar System: 5-ESS1-2).

Next, we describe the process of felting as a way of helping students understand the polar auroras. Integrating felting, a form of creative arts, allows students to model and explain the colors and shapes of the polar auroras depending on its scientific characteristics. Additionally, if students live in an area where the polar auroras are visible, connections can be made between their natural observations and the felting product they create. In other words, they may create shapes and colors that they have personally observed in the sky. For current forecasts of the Aurora Borealis and Australis visibility, see http://www.aurora-service.org/aurora-forecast/.

Teaching About the Aurora

There are many resources available to teachers for teaching about the solar auroras. We recommend first involving students in a discussion of electromagnetism and charged atoms. We also recommend engaging students in an activity and subsequent discussion about atom charges, such as rubbing a balloon on a sweater or their hair and using it to attract metal objects, such as empty soda cans. Although a good number of lessons can be found online, we provide three sources for teaching solar auroras below.

Dancing lights. Exploring the aurora through art and writing: A teacher's guide. This resource is provided by the Laboratory for Atmospheric and Space Physics (2011). It offers a number of lesson plans, readings, assessments, and resources. Some solar aurora lessons can be taught in conjunction with language arts lessons about myths and legends of the lights, while others can be approached using videos and questioning strategies. Link: http://lasp.colorado.edu/home/wp-content/uploads/2011/08/Dancing-Lights-Lessons.pdf.

Imager for magnetopause-to-aurora global exploration: Archive of classroom activities. This resource is provided by the National Atmospheric and Space Administration (NASA, 2007). There are many lesson plans, explanations, pictures, links to videos, and assessments for students in grades K-12. Link: https://image.gsfc.nasa.gov/poetry/activities.html.

Auroras! Mysterious lights in the sky. This flash-based book was developed in collaboration with NASA and University of California, Berkeley (2002). This short, nonfiction text provides colorful, moving digital pictures of the solar aurora. It can also be freely printed and folded into classroom books. Link: http://ds9.ssl.berkeley.edu/auroras/.

Description of Felting

After studying the polar auroras, students will be asked to demonstrate what they have learned through the process of creating a model of the polar auroras using felting. Felt is one of the oldest textile fabrics, potentially dating back over 2,000 years (Lane, 2012). Felt, a product of pressed wool, has fibers that are like scales. During the process of felting as described below, those scales stick to one another and, in this case, create artwork that models the polar aurora particles, altitude, and shapes about which the student learned. In this case, the backdrop of the felting product is a landscape. Students studied landscapes of an area where the Aurora Borealis is visible (in this example, a student chose Norway), and researched and created the landscape of Norway (snowy mountains). In that sense, the project was an artistic, cross-curricular integration of both social studies and science subjects.

Necessary Materials

To create this felting project, teachers will need to provide felting wool, sink or tub, sponge, water, mesh fabric (even old dryer sheets can work for this project.), felting needles, thick Styrofoam, rectangles of screen, paper towels, and soap.

1. Begin by asking the students to lay out the wool on the mesh fabric in one of the polar aurora patterns they learned about, and on the location-based landscapes they studied. Then, place the fabric atop the thick Styrofoam. After setting clear expectations about how the barbed felting needles are to be used, instruct the students to punch the needles through the wool and fabric and down into the Styrofoam. Because the needles are barbed, the scales in the wool will begin to stick together and become locked onto the mesh fabric beneath.

2. After the students have needled the wool to their liking, instruct them to place it between the two screens. It is nice to have a waterproof tray underneath; we used meat trays. Clean meat trays can be purchased at most retail box stores and craft supply chains.

3. Using the sponge and warm water, students should soak the wool fibers. The water and the heat cause the scales of the wool to open.

4. Next, students should gently rub the soap atop the wet screen. Wool has an acidic pH. The alkaline in the soap reacts with the acid in the wool, causing the open scales to attach themselves to one another.

5. The students will need to rub the screen with their hands until lather is formed. Then, they should gently rub, in small circles, over the entire screen. This motion will continue to make the fibers in the wool stick together.

6. Instruct students to roll the screen tightly to begin to squeeze out the soapy water. Then, rinse out all of the soap in a sink. Once again, instruct students to squeeze out the remaining water.

7. Finally, gently remove each screen and place the artwork atop a towel for drying.

Assessing Understanding of the Polar Auroras through Felting

Simply completing the felting process, as described above, meets elementary-level artistic standards. It is not necessary for the teacher to have a strong background in the art of felting to use this project as a science assessment. As students create their felting models, teachers should question students during the process, asking them connecting questions (What would be causing the blue color in the aurora?) and having them assess their own progress. Options for using the felting model as an assessment could include presenting, writing, and/or labeling the colors and shapes in relation to the particle interactions and altitude of the polar aurora model they created.

To address key science concepts present in the NGSS, teachers should check that students understand the emitted light colors they are modeling in their projects are a result of energy transfer. Please note that there are resources available to teachers that equate the northern lights to fireworks – be careful not to use analogies such as these, since very different processes form the lights and colors emitted by the solar auroras and fireworks.

If using the felting assessment model, we would recommend students present to their classmates about what the colors and shapes mean in relation to the solar auroras. Students should verbally demonstrate they understand that the colors of their felting models represent altitude and energy transfer. If they created one with vibrant, green colors, they should exhibit the understanding that this color of light typically occurs at an altitude of 120-180 km and may represent oxygen particle interactions occurring as a result of emitted photons. They should also name the solar aurora shape(s) that are most closely demonstrated in their felting model. For more information about, and pictures of, the polar aurora shapes and colors, see https://adventures.is/information/about-northern-lights/.

Conclusion

It is necessary that we nurture elementary students' STEM interest in order to encourage later STEM career confidence and interests (Genareo, Mitchell, Geisinger, & Kemis, 2016). The creative arts serve an important role in doing so. This elementary-level felting project is one way to allow students to creatively model and demonstrate their understanding of complex scientific concepts, such as particle interactions and energy transfer. We feel it meets the scientific practices and standards set forth by the NGSS, while giving students an engaging and motivational way to demonstrate their STEM learning. Of course, teachers should feel free to adapt this project as needed to suit their students, standards, and styles.

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