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Abstract

Ways to incorporate climate change into K-12 curricula are of growing interest to many science educators. The International Cooperation for Animal Research Using Space (ICARUS) examines animal and bird migrations as a lens to understand climate change aiding educators with its emphasis on technological imagining in science and visual arts teaching and learning. This article presents an interdisciplinary unit pertaining to bird migration and climate change that integrates the arts and technology by placing upper-elementary students in the position of being citizen scientists and artists, leading to a culminating art installation project. The unit shows how a variety of digital resources available in an online environment allow students to become resourceful problem solvers, using technology to create and collaborate. Citizen science and the visual arts enable students to envision and creatively document evidence to inform solutions designed to assist in altering climate change. Taken together, this effort supports students to learn scientific concepts of altered bird migration due to climate change by investigating through the integration of the visual arts and technology.

Keywords

arts integration, bird migration, climate change, STEAM, technology integration

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Introduction

The Hydra of Greek mythology is a frightening serpent-like monster with nine heads. For upper-elementary fifth-grade students, technology in today's classrooms may be viewed as a friendly Hydra with tentacles that extend the platform for teaching and learning to just about any subject area, in this case, including climate change. To best understand the scope of climate change, technology can serve as a shared tool for both the scientist and the artist to deepen and express an understanding of science concepts and to facilitate group learning (Cicconi, 2014; Irving, 2006). The integration of science and the arts can bring forth analytical and empathetic thinking (Burnard et al., 2021), generating new knowledge and solutions for complex problems (Clark et al., 2020). This kind of transdisciplinary approach supports innovative thinking and praxis. In addition, by employing the citizen science approach, which involves integrating students into research activities (Pettibone et al., 2018), we can increase the transparency of scientific outcomes, generate public trust in science, and help enable citizens to advocate for change (Skarzauskiene & Mačiulienė, 2021).

In this article, we present a unit on scientific concepts that incorporates the arts and technology by using the citizen science approach in order to engage students in knowledge production. Students become citizen scientists observing climate change by watching birds from their homes and schools as well as in the outdoors, noting circadian rhythms. Mentoring in the arts is not limited to practicing artists; ornithologists are careful observers of the natural world (see https://www.amnh.org/ology) and, therefore, can also serve in a mentoring capacity. The proposed citizen, scientist, and artist interdisciplinary unit on climate change focuses on bird migration with group and individual learning formats culminating in an art installation.

Background Information

Examining bird and other animal migrations as a lens to understanding climate change has been the focus of a devoted group of scientists working on the International Cooperation for Animal Research Using Space (ICARUS- https://www.icarus.mpg.de/) project to uncover the role of animal mobility on our planet. Previously thought to be somewhat stationary in undisturbed landscapes, animal mobility monitored on a GPS site, for example, can teach us about the spread of disease, the dispersal of seeds, species adaptations, and habitat loss. Further, animal migrations affect the amount of fish available from the sea, the virulence of the pathogens we encounter, the predators that stalk livestock, and the birds and flowers that appear in our local landscape (Shah, 2021) and, therefore, intertwine with the health and overall balance of life on earth. Traveling in flocks, swarms, pods, herds, and colonies, animals have dynamic responses to changes in their environment. Geographic borders are porous, and migrating birds make their way across the globe almost effortlessly, like hang gliders on a front. For example, thrushes

spend more energy on stopovers than on flying (Shah, 2021). All of these factors make bird migration an engaging and dynamic area of study for students of all ages.

Putting Creativity to Work

Aristotle, the fourth-century BCE Greek philosopher, a keen observer of natural phenomena, also engaged in creative thinking. For example, noting the disappearance of birds during certain seasons, he surmised that birds hibernate. Noting this historical pedigree of creative thinking, pedagogical constructs in the upper-elementary classroom embrace student risk-taking conjectures and multilayered and flexible perspectives.

The proposed citizen, scientist, and artist interdisciplinary unit is anchored in the Next Generation Science Standards (NGSS) thread E-ESS3-1 Earth and Human Activity, where late-elementary-school students recognize and participate in interconnected science and visual learning as well as student-centered technology experiences (see https://www.nextgenscience.org/pe/5-ess3-1-earth-and-human-activity). The unit also meets the International Society for Technology in Education (ISTE) Standards for Students (3. Knowledge Constructor and 6. Creative Communicator) as well as the National Arts Standards Standard 2. Organizing and Develop Artistic Ideas and Work (see https://www.nationalartsstandards.org, VA: Cr2.2.5a, VA: Cr2.3.5a, and Standard 4. Select, Analyze and Interpret Artistic Work for Presentation VA: Pr6.1.5a).

Lesson Procedures

Designing and implementing an arts and technology integrated interdisciplinary unit requires an investment of time and planning by all teachers involved, including those in the sciences, arts, and technology. The following unit may take up to 8-10 weeks with concurrent implementation in separate science, art, and technology classrooms as well as planned shared-time collaborations. Materials such as art supplies, including canvases, cellophane, colored wire, mylar, small brown boxes, origami paper, balloons, and glow sticks, need to be budgeted and purchased in advance of the project. The installation space is another preplanned component involving the science and art teacher working with the administration to determine a visible area.

Proposed Steps of the Unit

1. Students engage in group Internet research (on each of the continents, except Antarctica) to identify global migrating birds (swans, cranes, herons, cardinals, eagles, albatrosses, and artic terns) and the reasons for migration (breeding, nesting, surviving).

2. Students keep a sketchbook with a hand-drawn world map, and record and draw bird sightings near their home and/or school. Students are introduced to an artist and an ornithologist (James Audubon's website; http://www.audobon.org) and visual thinking strategies: "What do I see, what more is there in the picture, and what else can I find?" (Yenamine, 2014). Then they view the immersive artistic technology of Teamlab (https://www.teamlab.art).

3. Students collectively examine through the Google Map program sightings of actual bird flyways across continents and create their own map and corresponding data set. For this lesson, the bird migration data are provided by Audubon Alaska.
   - Data source: https://tinyurl.com/2ww3d3ut/
   - Video tutorial showing how to map this data set: https://ak.audubon.org/conservation/part-3-use-google-maps-map-measure-bird-migration

   a. Students see bird migration patterns. A discussion can lead to questions such as, "Why do birds often fly south for the winter?" "Why are some flight patterns different than others?" "What do bird migration patterns have in common with those of other animals?" "Are changes in temperature due to climate change impacting bird migration patterns? If so, how?" "How can scientists find out where the birds are going?"

   b. Students review a case study of changes in bird migration patterns focusing on how this can be harmful. The aim should be to foster "system thinking."

4. Students watch a TedTalk and read a *Guardian* newspaper article on the effects of climate change on bird migration.
   - How small birds enrich our view on global warming: https://www.youtube.com/watch?v=hUQeE4Hr3qA
   - Climate change driving birds to migrate early, research reveals: https://www.theguardian.com/environment/2016/dec/28/climate-change-driving-birds-migrate-early-research-reveals-edinburgh-global-warming

5. Students research on Google Scholar how birds fly and migrate with the use of thermals – hot air currents, orographic thermals – hot air currents next to mountains, updrafts, and storms that affect bird flight.

6. Teachers facilitate student use of the Google Document to compile information on the reasons and obstacles of migration – breeding, survival, nesting, toxic waterways, wind turbines, pesticide sprayed crops, glass skyscrapers, and temperature change.

7. Students learn and practice origami techniques from online and/or book instructions to create origami birds.
   - How to make an origami swan: https://www.youtube.com/watch?v=f0zTNCRg-Uc
   - How to make a heron origami: http://www.origami-instructions.com/origami-heron.html

8. Students plan and implement a multidimensional science and art installation:
   a. The teacher selects a public site in the school with a 10-15' wall and attaches a sheet of blue canvas with double-sided Velcro.

   b. Working in groups, students cut the continent shapes out of multicolored cellophane and glue them to five large, marbleized balloons (facsimile global spheres depicting earth), and hang them from the ceiling in the school hallways, thereby creating an entranceway to the canvas art installation.

c. The art teacher projects a world map onto the large blue canvas outlining the shape of the continents students previously traced and cut out.

d. Students learn and practice making origami birds; cranes, blue bar pigeons, woodpeckers, cardinals, swans, eagles, and herons are common origami models.

e. Students glue (using a glue gun) origami birds to thin pieces of colored wire and attach the bird-laden wires to the canvas with push pins to provide depth on the canvas to illustrate the global bird flyways with attention to the seasonal paths of bird migration. The global canvas map becomes a vibrant linear design with multi-colored wires at minimally raised heights as a relief installation. (See J. Elphick's *Atlas of Bird Migration* [2011] for a visual example).

f. Students locate bird apps on a digital device to be programmed to play when tapped while somebody is standing in front of the canvas art installation (sample apps: Smart Bird ID, ChirpOMaticUSA, SongSleuth:AutoBird Song ID), to identify flyways.

g. The students augment the global science art installation by strategically attaching to the blue canvas various obstacles to bird migration created out of found materials such as bubble wrap as large expanses of water, small bent brown boxes as mountains, folded pieces of mylar as glass skyscrapers, and aluminum-paper-wrapped toothpicks as wind turbines.

9. The technology teacher adds to the school website platform podcasts by the student research team on the reasons for bird migration, the effects of climate change on bird migration, and the geological and atmospheric obstacles to bird migration. For example, Buzzsprout, a free, easy-to-use program, may be used to create the podcasts (https://www.buzzsprout.com/). Instructions for how to create a podcast may be found at https://tinyurl.com/mv9wefr5

10. The art teacher and students collaborate and add an aesthetic extension to the canvas relief science and art installation consisting of glow stick weavings of the bird migration paths with attention to modern and contemporary artists' work, such as Sol LeWitt, Brice Marden, Sheila Hicks, and Jesus de Soto. The art teacher secures multiple glow sticks using the art supply budget and mentors students in weaving techniques. (It is recommended that the glow stick art project be kept at a cold temperature for several hours before it is displayed to maintain the brightness of the coloration.) Alternative weaving materials to indicate bird migration flyways include yarn, string, and felt.

11. Science, art, and/or social studies teachers engage students in researching First Nations peoples' aesthetic use of bird feathers in costumes and artifacts as indications of the presence of specific birds (e.g., eagles in Utah, Colorado, and Texas) and their migrations to specific geographic areas. This extension of historical research broadens one's understanding of the symbolic imagery of birds and the ecological role of bird migration (see Arts Standard VA: Re7.2.5a).

Conclusion

More than 4,000 birds are regular migrants, flying at varying heights above sea level and covering tremendous distances. The interdisciplinary unit pertaining to bird migration and climate change presented here integrates the arts and technology by placing upper-elementary students in the role of citizen scientists and artists. Specifically, the scope of bird migration in this unit brings students with a wide range of abilities and interests into the daily practice of natural observation critical to ensuring a sustainable planet. Further, the arts standards are well integrated into the democratic participatory citizen-scientist art installation learning experience (Hunter-Doniger, 2021). By the fifth grade (chosen for the proposed unit), students in the visual arts combine understandings in different content areas to generate innovative ideas, demonstrate diverse methods of investigation, experiment with and become skillful at new artistic techniques, document areas of personal interest, engage in curatorial practices, and analyze and interpret artifacts from diverse cultural contexts. The proposed science art installation project involves students in all of the above experiences with a unique opportunity to come to understand curatorial practices. Art installations are a contemporary practice that creates art as an immersive experience, moving beyond the more traditional decorative framed work of art (see Figure 1). Visual art installations empowered by technology provide a venue for generating concurrent emotive and cognitive reactions to complex issues such as climate change.

Figure 1

Blacksun 2010 by Erica Zoe Loustau. Used with permission.

Returning to the metaphor used at the beginning of the article, technology may be thought of as one of Hydra's tentacles essential for documenting, realizing, and enlivening the bird migration science and art installation. Specifically, documenting the multiple constructive steps in the aesthetic bird migration and climate change unit detailed above informs individual and/or collective student portfolios – systematic collections of student written assignments, research, drafts, artwork, and oral presentations representative of the development of the student. Further, understanding learning over time through multifaceted educational experiences and outcomes in a portfolio is an authentic assessment strategy for the science art installation. Artistic extensions to the science art unit may be implemented through transposing the linear designs of the seasonal bird migrations into individual weavings using diverse materials.

Recognizing First Nations peoples' scientific knowledge of bird migration inherent in earth's intertwined ecological networks is an under-researched and little understood area of art history (see https://americanindian.si.edu/). The powerful presence of soaring eagles that migrate in the winter to avoid the frozen lakes and lack of food in the North American plains noted by First Nations peoples such as the Cheyenne is highlighted in their highly feathered headgear or war bonnet. The regalia has both political and spiritual importance: Eagles represent courage and cunning both in human battle and in daily survival. Using the activities presented here, young science-art-citizen-researchers confronting the crisis of climate change can be the first to learn from First Nations peoples' long-established comprehension of bird migration.

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