Into the Woods - environmental problem solving through STEAM lesson planning

Laura Rachel Fattal
William Paterson University, Wayne, NJ

Into the Woods - environmental problem solving through STEAM lesson planning

Abstract

Title - Into the Woods – environmental problem solving through STEAM lesson planning

Abstract

The STEAM conversation takes on new urgency in the preservice university classroom due to its potential for synergistic problem solving of real world problems. The visual and performing arts invite creativity to be understood as social practice and aesthetic flexibility and the assessment of the practice through student/student and student/teacher curiosity building. In this article pedagogical praxis is centered on the critical issue of climate change caused by global warming. The praxis addresses:

- University preservice candidates' arts-integrated teaching and learning focusing on climate change,
- Provocative rewriting of beloved fairy tales, and
- Preservice candidates' emerging understanding of interdisciplinary lesson construction in STEAM

Arts-integration interdisciplinary experiences require students to assume greater responsibility for their learning through a wider repertoire of communication than in a non-arts integrated classroom (Lynch 2007).

Keywords

Creative Commons License

Cover Page Footnote

I am not including footnotes but do list references at the end of the article. I am not including acknowledgements.

Into the Woods - environmental/problem solving through STEAM lesson planning

Laura Rachel Fattal

Blurring the Lines

In the Impressionist artist Claude Monet's painting La Gare Saint-Lazare (1877) billowing clouds of steam emerge from the locomotives entering and departing from the busy Parisian train station. The steam from the trains blur the outlines of other train cars, the curved tracks, and triangular roof of the station. When viewing the painting, one gains an impression, not a visual reproduction, of the train station. As Monet's technique revolutionized aesthetic understanding, so, too, is STEAM – (science, technology, engineering, art, and math), an educational curricula-making movement transcending the limitations of any singular subject area to advance creative problem solving (Rolling, 2011).

Arts Integration – a pivot for STEAM collaboration

Preservice teacher education programs require an arts-integration course where teacher candidates integrate artistic learning activities to reinforce learning in the core academic curricula. Preservice teachers align their lesson plans with national and state standards in the arts and the other core content areas. During two semesters in a mid-sized public university, preservice elementary teachers developed interdisciplinary STEAM lessons infusing arts- integration strategies to problem solve environmental issues. The preservice teachers were introduced to STEAM thinking through, varied resources and readings and the modelling of select interdisciplinary environmental lessons by the arts-integration university faculty member. The engineering framework for the preservice teachers' lesson planning proposed for elementary age students included cyclical steps to problem solve; ask, imagine, plan, create, and improve upon a

solution. Technology was a resource to scaffold new content learning in science and math and the visual and performing arts and a means of expressive documentation of interdisciplinary learning. Mel Alexenberg (2005) describes science and art learning through technology as an adventurous romp through a dynamic ecosystem of interrelationships blowing between real space and cyberspace. Due to practicum school-based experiences, preservice teachers recognized the potential of developmentally challenging STEAM lesson planning for elementary age students to develop real life solutions to environmental problems. Transferring personal and academic understanding to a broader civic context would extend students' engagement in learning.

The goals of STEAM lesson planning were to enable preservice teachers:

- To identify and conceptualize key environmental concerns affecting our global community
- To align interdisciplinary thinking with core content standards
- To inspire aesthetic flexibility as a pedagogical imperative
- To invest in collaborative practices in real life problem solving

Modelling an environmental STEAM lesson

The Next Generation Science Standards curricula theme 'Ecosystems: Interactions, Energy and Dynamics' aligned with the university professor's lesson on dendrochronology for preservice teachers.

**Dendrochronology**

Dendrochronology, is the study of tree rings and, thereby, the health of trees and forests. Tree rings are indicators of tree growth and reflect the effects of climate change and global warming over time. Mathematical graphing of changes over centuries based on observation of tree rings provides real life learning to understand climate change. In temperate climatic zones, a tree's

age is identifiable by examining the rings in the trunk of the tree. If there is a drought, the rings are thin, if there is an abundance of rain and sun, the tree rings are wide. The strength of the wind and the variance of temperature also affects the size of tree rings. In tropical rainforests where there are no discernable seasons, trees do not have rings. With warming temperatures over longer periods of time, tree rings become a ledger to learn about past climate changes and current trends of our warming planet.

The interdisciplinary assignment for small teams of preservice teachers was to, initially, write a potential scenario of tree growth and then to create a mixed media collage paired with the described scientific scenario's data. Using marbleized paper of swirling concentric ovals and circles, brown to yellow hued yarn, thin tan rope and actual tree bark of a portion of a tree trunk, and glue, students envisioned tree rings width during variant climatic changes and/or affected by natural catastrophes. Building on the work of dendrochronologists, the collages were a unique artistic re-imagining of the effects of climate change on singular trees and by extension whole forests. To be part of STEAM projects, art educators need to step into the arena where others have not gone before and undertake the hard work that will expand our cognitive and aesthetic horizons (Ulbricht, 2005). STEAM thinking is a collaborative approach to both curriculum and pedagogy involving teachers in multiple grades and content areas.

Examples of preservice teachers' mixed media collages on tree rings.
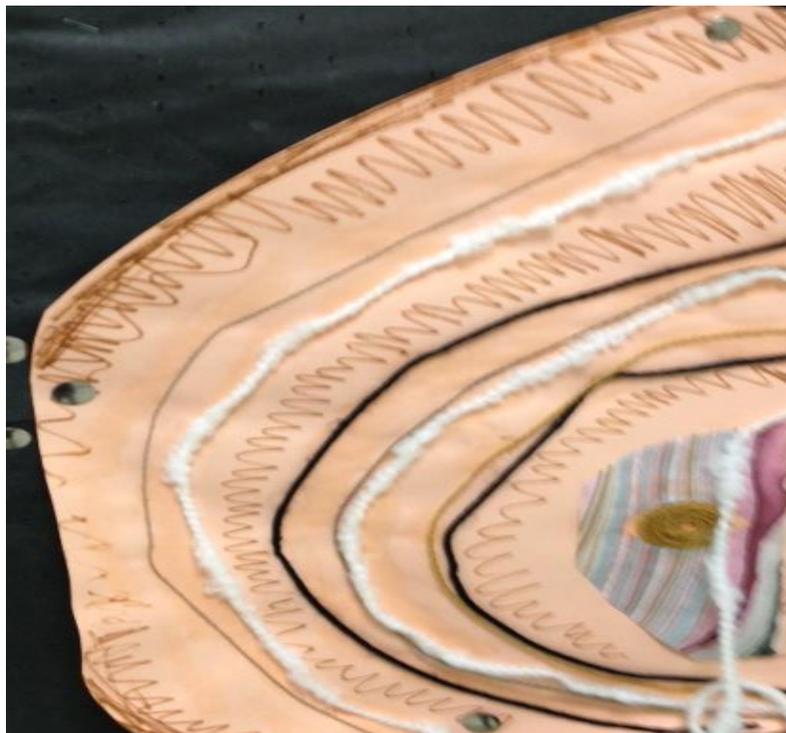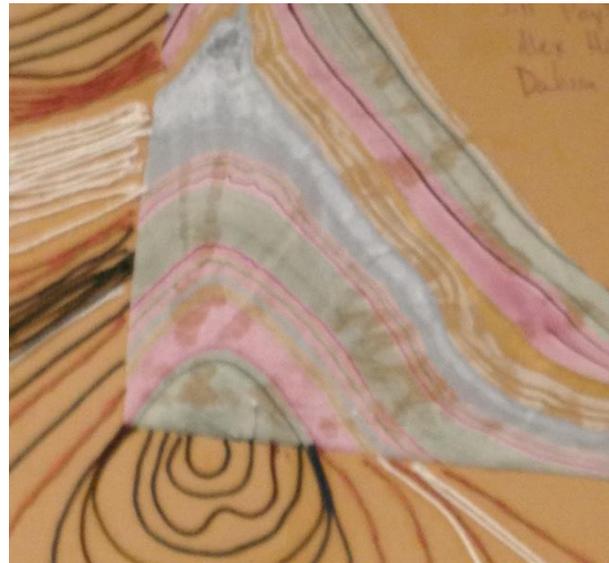
Fairy tales, an impetus for STEAM curricula collaborations

The following preservice teachers' STEAM lesson plans are based on the fairy tales of The Three Bears, Hansel and Gretel, and Jack in the Beanstalk to reveal new perspectives on the human impact on interdependent earth systems. The preservice teachers' lesson plans embrace student interaction and dialogue through aesthetic approaches to storytelling to solve environmental problems. The fractured storylines of the fairy tales are provocative invitations to further investigate beloved narratives to involve students in proactive community projects. Arts educators have long noted that sounds and images of the natural world empower our imagination and sensibilities (Heald, 2008). Through inventive songwriting, script writing and theatrical performance, and the construction of three dimensional sculptures each of the fairy tales was repurposed to provide an accessible platform for collaborative interdisciplinary STEAM lessons.

The Three Bears

In the story of The Three Bears, Goldilocks walks through the woods with an internal sense of rhythm to her step. Lost in the woods, she tires and stops at a seemingly empty house. She tries to find a bed that is just the right size for her and bravely sings herself to sleep creating a momentary silence in the lyrical storytelling. The three bears return to their house and with great surprise find that Goldilocks has tried out their beds and has fallen asleep in one of them. The low pitch and hushed tone to the three bears' conversation in the preservice teacher's third grade lesson plan provides a tonal dissonance to that which was established in Goldilocks high pitched singing of spirited lyrics. Goldilocks wakes up expressing great dismay seeing the bears. The father bear offers to take her home since he knows his way through the dark woods. The bear family's offer is presented through harmonizing lyrics of compassion by the mother, father and baby bear.

Before father bear walks Goldilocks home, he offers her honey to eat to give her strength for the long walk. The refrain from Goldilocks brave bedtime song is sung at this point of the story bridging the plotline of the original story and providing an environmental turn. Onomatopoeic musical sounds such as bees buzzing provide an entry to the ecological STEAM lesson addressing the diminishing population of bees in the world. Without bees, humans will no longer enjoy eating honey. Bees are pollinators transferring pollen and seeds from one flower to the next so plants can reproduce and create food from their seeds. Crops of apples, pears, berries as well as cucumbers and alfalfa would be greatly reduced if bees continue their decline; 44% of honeybee colonies collapsed over the past year (2016) - known as Colony Collapse Disorder – the second highest rate ever recorded.

Overdevelopment, the lack of rotation of crops and pesticide use on flowers and plants have caused the great reduction of the bee population. Many scientific studies identify a widely used class of pesticides called 'neonics' as a leading culprit in the devastating decline of the bee population. The pedagogical challenge is to link the heartfelt fairy tale with its unique musical rendering with the gathering of environmental resources on bees' beneficial effect on human food supplies and the negative effect of pesticides. The preservice teacher's lesson plan includes a family engagement component that calls attention to a honey breakfast cereal companies' website that is giving away wildflower seeds to help save the bee population. Measuring the decline of the bee population due to the detrimental effects of pesticides over time provides mathematical practice in graphing and estimating data. Recording the musical retelling of Goldilocks and her encounter with The Three Bears offers a technologically accessible and memorable interpretation to bring awareness to the environmental crisis of the status of the endangered species of our bee population.

Hansel and Gretel

In the story of Hansel and Gretel, the children's parents were in grave poverty and could no longer provide food for them. The family went into the forest to cut wood for a fire with the step-mother and reluctant father's intention to leave their children deep in the woods so they no longer had to feed them. Hansel had taken the bread crumbs his parents had given him and used it to mark a trail back to their house; since birds had eaten the bread crumbs, the children were now truly lost in the woods. The hungry children enticed by a house made of candy go inside and meet the witch who lives there. Instead of the witch eating the children, as she had planned by baking them in the oven, Gretel pushes the witch in the oven where she is burnt to death. In the Grimm folktale, before Hansel and Gretel return home, they stuff their pockets with the dead witch's jewels to take them to help support their father since the step-mother has passed away.

The preservice teacher's fifth grade STEAM lesson plan based on the story of Hansel and Gretel, set in a forest, asks students to create a script with an alternative narrative based on the critical environmental issue of global warming caused by deforestation. The students are to practice their recently learned theatrical gestures, movements and entrances/exits, and voice intonations to act out a solution to end deforestation. Conflict resolution, an underlying theme in the original folktale and in the fractured script on competing factions on global warming can best be explained through theatrical human interactions. In the preservice teacher's alternative ending to the folktale, Hansel and Gretel find themselves startled by deforested swaths of land as they return home to their father. The trees were intentionally burnt to make land available for housing and urbanization, and to harvest the timber to create furniture, homes and paper. The deforested land is now available for cattle ranching, a methane producing activity increasing carbon emissions expediting global warming. Hansel and Gretel are confronted by this barren stretch of land with

no animals to hunt or plants to eat. Deforestation can lead to species extinction due to the loss of animal habitats and the medicinal qualities of plants. The fifth graders' theatrical scripts and videotaped performances advanced their abilities:

1. to research online environmental resources on clear cutting and slash and burn deforestation techniques
2. to analyze percentages and ratios of destroyed trees increasing global warming over time
3. to generate possible solutions to ecological trauma
4. to portray characters using voice and movement for storytelling to propel civic action against deforestation

Jack and the Beanstalk

Jack and the Beanstalk is a story of a poor boy who lives with his mother. She asks him to sell their only cow because they need money to buy food. The young boy sells the family cow at the market not for money but for magic beans. His despondent mother throws the beans out the window of their cottage. Overnight a beanstalk grows outside the family's house high into the sky; Jack climbs up the beanstalk three times taking from the sleeping ogre, who lives at the top of the beanstalk, gold and silver coins, a goose that lays golden eggs, and a harp that plays melodic music.

In a second grade STEAM lesson, the preservice teacher's lesson plan inventively redesigned Jack's escape from the ogre by not climbing down the beanstalk but by speedily sliding down a rainbow from the ogre's towering house in the sky to the ground. The preservice teacher in what she called her most 'out-of-the-box-thinking' lesson plan highlights the impact of air pollution on our planet's atmosphere; air pollution accentuated by the use of fossil fuels visually blocks the appearance of rainbows. The sun makes rainbows when white sunlight passes through rain drops. The raindrops are like tiny prisms that bend the rainbow's seven different colors –red, orange, yellow, green, blue, indigo and violet in white light so the light spreads out into a band of

colors that can be reflected back for a person to see. The visual art component of the lesson engaged students in assembling the spectrum of colors in the rainbow with numerous multicolored pipe cleaners. The mathematical portion of the lesson altered the arc of the rainbow into a diagonal line/the hypotenuse of a triangle so that the students could readily measure the constructed pipe cleaner rainbow/slide. The preservice teacher's lesson plan predicted the second graders would want to draw the ogre's house at different elevations on the beanstalk adding to the excitement of Jack's escape; thereby, enabling measurement of various diagonal/hypotenuse lengths based on the varied elevations of the ogre's house.

Water vapor accumulates in the atmosphere which causes rain, part of nature's precipitation cycle that also causes rainbows. The use of Smartboards showing YouTube videos of rainbows and dissipating mist after a rain storm is a visual reminder for the second graders of actual rainbows. How to diminish air pollution and therefore more readily see rainbows was the scientific quandary of the lesson. Knowing that solar and wind are alternative energy sources instead of the use of fossil fuels promotes proactive thinking on air pollution.

Collaborative resource-based brainstorming of additional uses of alternative energy sources to fuel our everyday needs is to be addressed against a meaningful sculptural backdrop of pipe cleaner constructed rainbows.

Conclusion

The Next Generation Science Standards/NGSS frame science learning in the preservice teachers' STEAM lesson plans for elementary school students with attention to real life environmental issues such as endangered species, deforestation and air pollution. Technology is utilized to conduct research in content areas, document student interdisciplinary learning and

establish family/school connections of shared information. Curiosity, engagement and exploration are essential components of the collaborative lesson planning process where aesthetic flexibility was a pedagogical imperative. Arts-integration interdisciplinary experiences require students to assume greater responsibility for their learning through a wider repertoire of communication than in a non-arts integrated classroom (Lynch, 2007).

Mentoring of exemplar lesson plans and participation in creative discussion nurtures the human potential of problem solving in the elementary classroom. The challenges of preservice STEAM lesson planning explicates an emergent understanding of interdisciplinary teaching and learning. University and school-based classroom experiences in STEAM lesson planning and implementation can be a harbinger of collaborative interactions empowering civic action to confront critical environmental issues.

Appendix I

Next Generation Science Standards, Math and Visual and Performing Arts Standards

The Science Standard below aligns with the following three preservice teachers' problem solving environmental lesson plans.

NGSS Humans can change natural habitats in ways that can be helpful or harmful for the plants and animals that live there. Communicate ways that humans protect habitats and/or improve conditions for the growth of the plants and animals that live there or ways that humans might harm habitats.

The Math standard below aligns with the fractured fairy tales of the first two preservice lesson plans, The Three Little Bears and Hansel and Gretel.

Common Core Math Standards – Measurement and Data in grades 3, 4 and 5 require students to represent (chart/graph) and interpret data. In grade 4 students generate and analyze patterns. In grade 5, students graph points on a coordinated plane to solve real world problems.

National Art/Music Standard for The Three Little Bears - improvise rhythmic patterns and modify melodic patterns using selected notes and/or scales to create expressive ideas. Blend unison and harmonic parts and utilize dynamic levels in vocal production.

National Art/Theater Standard for Hansel and Gretel – Portrays characters in specific circumstances demonstrating logical story sequence. Interprets the relationship between actors' physical and vocal choices and an audience's perception of character development (conflict resolution) by identifying examples of vocal variety, concentration and focus.

The Math and Visual Art standard below aligns with the fractured Jack and the Beanstalk fairy tale.

Common Core Math Standard – Measure and estimate length in standard units in grade 2 and work with distance, time –read an analog and digital clock to the nearest five minutes, and denomination of money.

National Art Standard –Create two and three dimensional works of art using the basic elements of color, line, shape, form, texture and space, as well as a variety of mediums and application methods.

References

Alexenberg, M. (2005). From science to art: Integral structure and ecological perspective in a digital age. In M. Stokrocki (Ed.), *Interdisciplinary art education: Building bridges to connect disciplines and culture.* (pp. 170-182). Reston, VA: National Art Education Association.

Heald, R. (2008). Musicality in the language of picture books. *Children's Literature in Education 39*, 227-135.

Lynch, P. (2007). Making meaning many ways: An exploratory look at integrating the arts with classroom curriculum. *Art Education, 60* (4), 33-38.

Rolling Jr., J. H. (2016). STEAM locomotion. *Art Education 69* (6), 4-5.

Ulbricht, J. (2005). Toward transdisciplinary programming in higher education. In M. Stokrocki (Ed.), *Interdisciplinary art education: Building bridges to connect disciplines and cultures.* (pp. 17-30). Reston, VA: NAEA

Websites

www.eie.org   Engineering is Elementary

www.corestandards.org/Math Common Core Math Standards

www.nationalartstandards.org National Visual and Performing Arts Standards

www.nationalgeographic.com   National Geographic Society

www.nextgenscience.org Next Generation Science Standards

www.nrdc.org   Natural Resources Defense Council

www.worldwildlife.org World Wildlife Association