Connecting Children's Literature and Science Education through Writing

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Abstract

K-8 teachers who do not consider themselves as scientists may have difficulty connecting literacy development to science standards. However, with effective tools and experience, teachers can integrate literacy skills with scientific inquiry fostering dynamic learning for students. The implications can be a deepening of students' competence with communicating science concepts, while cultivating curiosity about the world around them. The purposes of this paper were to emphasize the importance of children's literature that connects nature to scientific processes; highlight the accessibility of informal science education providers in the community; and offer ideas for extended writing activities that integrate nature and science with students' personal experiences.

Keywords: *writing, reading, STEM, inquiry, outdoor education*

Introduction

> Scientific inquiry is not easily described apart from the context of particular investigations. There simply is no fixed set of steps that scientists always follow, no one path that leads them unerringly to scientific knowledge. There are however, certain features of science that give it a distinctive character as a mode of inquiry. (Rutherford & Ahlgren, 1990, p. 5)

Teachers often act as the gateway for knowledge through curriculum and instruction, bringing their own experiences and understandings of the world to lessons. According to Wilson (2013), teachers are challenged with implementing a science curriculum that calls for more emphasis on inquiry and exploration. Teachers often work with limited resources and grapple with adjusting their instructional practices and mindsets concerning how to teach science. However, when robust professional

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development is provided for emerging science teachers, students have demonstrated high levels of success and achievement with science learning (Luft et al., 2011). The same also holds true for veteran teachers if they are given access to student-oriented scientific literature and effective writing tools that help them teach science concepts.

According to the National Research Council (NRC, 2012), science should not be reduced to a rigid set of experimental steps, but is instead a "set of practices" (p. 43). Science is a process and includes a set of practices that incorporate ways to observe, gather data, and process information in order to share findings. By writing scientifically, one is able to use a set of standards to collect information and then use sound scientific principles to discuss, interpret, or present information. Using a dynamic blend of scientific processes with reading and writing, teachers can connect students to the natural world in creative and authentic ways that facilitate meaningful interactions. Teachers can implement this process simply by providing learners with experiences to interact with nature, such as through a hands-on science lesson or a school-sponsored field trip to an informal education provider (Hammerman, Hammerman, & Hammerman, 2001).

One should not assume that creativity is minimized when writing or reading through the lens of science. Instead, teachers should be encouraged to infuse writing and reading in science with a sense of wonder and enthusiasm. There are many ways to engage with writing in science by incorporating effective writing strategies. Processes of natural phenomena are understood best and better explained through experience. Thus, integrating interactions with nature into classroom lessons with writing activities can deepen science content understandings among students.

Students who use methods of inquiry are also better able to understand and use new information to enrich their lives and be better informed about the world around them (Luft, Bell, & Gess-Newsome, 2008). Learning through experience involves discrete elements of inquiry, such as exploration, observation, investigation, research, and experimentation. Goals of this paper were to describe a variety of effective writing strategies, provide children's literature recommendations, and illustrate how informal science education providers enhance science inquiry learning for students.

Science Learning and Standards

Outdoor education provides teachers with the opportunity to engage students in active learning while guiding them through a process of inquiry that uses scientific processes, such as exploring and investigating, to transcend into all areas of learning (Lieberman, 2013). In addition, students can gain new knowledge from active learning experiences, such as developing an appreciation for nature through a walk in the woods, capturing observations through drawings and words in a nature journal, or having an opportunity to touch and learn about artifacts brought by a visiting science presenter (Hammerman et al., 2001). In other words, connecting with nature can be an exciting experience that leads to rich, lifelong learning.

A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas was developed as an in-depth resource for education policy makers and science educators (NRC, 2012). This framework was instrumental in the development of the *Next Generation in Science Standards (NGSS),* which delineated specific performance expectations aligned to science, technology, engineering, and mathematics (STEM) content (NRC, 2013). In the NGSS framework, the topic of life science was divided into four major sections: From Molecules to Organisms, Ecosystems, Heredity, and Biological Evolution. In the Ecosystems section, there are a number of life science concepts that can be addressed through writing using nature studies.

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To understand the value of the NGSS framework better, one can look at how a teacher might plan a science lesson using state education standards, such as the Texas Essential Knowledge and Skills (TEKS). The TEKS establish a broad framework to guide instruction and curriculum in Texas classrooms. A teacher who is teaching a science concept, such as interdependent relationships in ecosystems, can incorporate nature journal writing as a writing activity. For a Texas teacher, the learning expectations of the writing activity are clearly aligned with both state and national standards (see Table 1).

Table 1

State and National Performance Expectation for Science Journal Activity: Grade 3

National Standards: NGSS	State Standards: TEKS
3-LS4-3	§112.14. B. 9A-C
Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. [*Clarification Statement*: Examples of evidence could include the needs and characteristics of the organisms and habitats involved. The organisms and their habitats make up a system in which the parts depend on each other.] Science and Engineering Practices: From text and drawings, analyze and interpret data in order to engage in argument from evidence (3-LS4-1). Disciplinary Core Ideas: LS2.C: Ecosystem Dynamics, Functioning, and Resilience; when the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others, move into the transformed environment, and some die (3-LS2-1). Crosscutting Concept: Cause and Effect; Knowledge and experience will provide the student opportunity to address the cause and effect relationships routinely identified and used to explain change (3-LS2-1).	Organisms and environments. The student knows that organisms have characteristics that help them survive and can describe patterns, cycles, systems, and relationships within the environments. The student is expected to: (A) observe and describe the physical characteristics of environments and how they support populations and communities within an ecosystem; (B) identify and describe the flow of energy in a food chain and predict how changes in a food chain affect the ecosystem such as removal of frogs from a pond or bees from a field; and (C) describe environmental changes such as floods and droughts where some organisms thrive, and others perish or move to new locations.

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The NGSS framework provides useful details that give teachers a guide for improving planning and instruction, authentic assessments, and promoting deeper understanding of science content with students. A teacher in any state with specific content standards is able to follow the strategy demonstrated above to address learning expectations with their own students. Once the state science standards have been identified, then the teacher aligns performance expectations from the NGSS framework.

Accessing Nature Sites

Learning through the outdoors provides an opportunity to explore more deeply the relationships between living organisms (Hammerman et al., 2001). Outdoor education can be achieved in every community in places like the school playground, the classroom, or a field trip to a park or nature center. Teachers can use many resources with their science curriculum. Organizations such as Project WILD and Leopold Education Project share creative ways that teachers may address science content through nature. Project WILD includes a suite of activities that are developmentally appropriate for K-8 grades (Association of Fish and Wildlife Agencies, n.d.). For example, *Growing Up WILD* is a guide filled with activities that incorporate music, art, science, and math to teach science concepts using early childhood education methods.

The Leopold Education Project curriculum guide was inspired from the scientific writings of Aldo Leopold, a land management scientist who wrote a series of essays in *The Sand County Almanac* and other well-known works (Aldo Leopold Foundation, 2018). Students use methods of scientific writing to collect information from qualitative and quantitative modes of observation. Writing activities from the Leopold Education Project curriculum guide are designed to coincide with the essays in *The Sand County Almanac*, which take students on a journey through the seasons of the year. (Refer to Appendices A & B for a list of suggested community organizations within Texas that provide support for teachers to connect reading and writing with science standards through nature and a list of suggested classroom texts that connect K-12 students to the natural world.)

Extended Writing Activities

Science can serve as an inspiration for writing in a variety of modes and genres, including descriptive texts, procedural texts, character descriptions, and letters. In teaching science concepts, a learning environment that includes authentic experience in the natural world contributes to a deeper understanding of the complex nature of science and authentic writing tasks (NRC, 2012). Science encompasses patterns, models, investigations, explorations, arguments, evidence, and interpretations. Learning these aspects of science can be done through writing (Zissner, 1993). Below are four ways that nature may spur authentic writing in the K-12 classroom.

Learning Park Etiquette

A motto used by outdoor enthusiasts to protect natural environments so future generations can enjoy them is: Take only pictures, leave only footprints. Texas' English Language Arts state standards require K-12 students to read and write expository texts that share specific ideas to specific audiences for specific purposes. Combining these standards with outdoor exploration of natural spaces creates real-life scenarios for the composition of authentic expository texts. When visiting natural spaces, such as conservation areas, state parks, local parks, and national recreation areas, students can analyze the impact that their visit has on the ecosystems of the natural world, a theme present in the Earth and Space strand of Texas' state standards for science. As students venture through outdoor spaces, encourage them to consider the following:

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- What tools does the park service use to encourage people to remain in specific areas?
- Why does the park do this?
- How is trash collected inside the natural area? What responsibilities do park-goers have in regard to their trash?
- Are any activities forbidden in the park? Why do you suppose this is so?
- How do the actions of one person, such as picking a flower, impact the environment when multiple people echo the same act?

After returning to the classroom, students can collaborate to compose a Park Etiquette Guide, which is similar to the Texas Parks & Wildlife's *Park Rules* website, for future nature-goers. Students can also discuss ways in which parks can improve the communication and enforcement of park etiquette so the beauty of natural spaces remain intact for years to come.

Nature Journaling

Nature journaling is the process of keeping place-based, personal records of events, observations, and experiences in the outdoors (Scarce, n.d.). Students can use nature journaling to document changes in the environment over time, generate ideas for creative writing and scientific investigations, and draw connections between academics and nature. The U. S. Fish and Wildlife Service (n.d.) provided resources for introducing nature journaling to students in K-6th grade and detailed which topics to cover on various field excursions. Table 2 is an excerpt from this resource with added science TEKS connections for kindergarten.

After the field excursion, students can then take excerpts from their nature journals through the writing process to turn those excerpts into detailed descriptions about the flora and fauna they encountered or provide an analysis of environmental problems such as plant damage, drought, or invasive species. Students may also draw a diagram of the life cycle of a creature they observed. By connecting data collection in the outdoors to writing topics, students can engage in yet another authentic writing experience where they write like real-life scientists.

Table 2

Excerpt from the U. S. Fish and Wildlife Service's Nature Journaling Lesson Plan

Topic	Field Activity	Materials	Kindergarten TEKS
Invertebrate organisms	Collect, measure, examine, describe, measure, sketch, and release prairie or wetland bugs	Nets, hand lenses, bug boxes, colored pencils, keys/cards	(A) ask questions about organisms, objects, and events observed in the natural world; (B) plan and conduct simple descriptive investigations such as ways objects move; (C) collect data and make observations using simple equipment such as hand lenses, primary balances, and non-standard measurement tools; (D) record and organize data and observations using pictures, numbers, and words; and (E) communicate observations with others about simple descriptive investigations.

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Developing Characters with Inspiration from a Natural Space

Prior to visiting a chosen natural environment, invite students to: (1) research why the space was created and for whom it was created, (2) investigate who or what once used the land and who currently uses the land, and (3) explore significant events that took place in the natural setting. Using these prompts as a guide, invite students to create character descriptions, utilizing their imagination and author's craft to fill in the blanks. Students can choose to write about real or imagined people, take the perspective of flora and fauna, or even become omniscient narrators telling the tale of the land (see Figure 1).

> I live my life in cycles. My body continuously plumped and shrunk, fed by the falling and then evaporating rain. Sometimes, I serve as a haven to sojourning waterfowl, offering them a place to rest and quench their thirst. During harsh winters, however, I give no refuge. My sea of droplets frozen by the cold, hurricane-force winter winds. I am a *playa*. A disappearing lake, gulped in the ground by water-starved soil.

Figure 1. An original composition from the point of view of a Panhandle playa lake. Facts used to compose this text were pulled from the Texas Parks and Wildlife's (n.d.) web page on Panhandle Playa Lakes.

Writing Elected Officials

Advocacy is a reflective exercise in self-efficacy (Bandura, 2010). As knowledge and understanding through experience evolve, individuals promote change by taking action to protect and preserve wellbeing of the community and environment. Each generation encounters challenges to the efficacy of scientific principles through shifts in the public perception and understanding of current events. Cultivating a greater understanding of the world promotes a deeper appreciation of the personal connection between an individual and the environment. In other words, one can appreciate a healthy interdependence that can exist between humans and the natural world.

Teachers should encourage students to explore changes or recommended changes in policy or legislation that have recently occurred, as well as how implementing these changes would locally and globally affect the environment (Schunk & Zimmerman, 2006). Example topics include how actions by the government expand or reduce the current size of national parks, protect the water supply, and promote alternative energy technologies. Using facts from research conducted, students can write letters to their local, state, or federal government officials, persuading them to stick with current legislation, go back to the way things were before, or revise existing laws.

Conclusion

To think scientifically and make decisions using scientific reasoning, one must come from a place of science (Kuhn, 2012). Tools and information about science are available through many avenues for teachers, beginning with their own knowledge and experiences. Teachers are members of a wider network that includes organizations in the community who provide science resources and literature to deepen learning experiences for

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students. This network includes local organizations, such as museums, zoos, and libraries; governmental agencies; and informal science education providers. With the support of this network, teachers can continue to improve learning outcomes while fostering a greater relationship for their students with science through nature using effective reading and writing practices.

The science classroom is a dynamic space that goes beyond the physical room to include the outdoors, thus enhancing learning experiences for students through engagement with the natural world. Teachers and students together have the ability to bridge curriculum with natural spaces, thereby fostering rich and authentic experiences with which to build scientific inquiry skills. By fusing writing activities and appropriate literature with scientific exploration in natural spaces, teachers can create an environment ripe with authentic writing experiences. Learning that occurs in one's own backyard fosters a greater appreciation and long-lasting relationship with nature, all while building literacy and inquiry skills that can be used throughout K-12 education and beyond.

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Appendix A

Science Curriculum Resources

Resource	Source	Description
Project WILD	https://www.projectwild.org	A suite of curriculum guides that address water and terrestrial biota.
The Leopold Education Project Curriculum Guide	https://www.aldoleopold.org	A series of 20 activities aligned with the essays from *The Sand County Almanac.*
Texas Parks and Wildlife Department: Outdoor Education	https://tpwd.texas.gov/	A series of service programs designed for diverse groups, such as Texas Aquatic Science.
Texas Wildlife Association: Conservation Legacy	https://www.texas-wildlife.org/program-areas/category/conservation-legacy	The Conservation Legacy lineup of programs empower and educate Texans with knowledge of fundamental, science-based ecological principles, foster a connection to the land, and facilitate natural resource literacy by creating tangible relationships with the outdoors.
Texas Project Learning Tree	https://www.plt.org/network/texas/	Project Learning Tree uses trees and forests as windows on the world to increase students' understanding of the environment and actions they can take to conserve it.
Informal Science Education Association of Texas	https://texasinformalscience.org	Connection to regional informal education providers and information related to state and national initiatives in K-12 STEM education.

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Appendix B

Suggested Book List for Encouraging Science Writing in K-12

Science Concepts	Title/Year	Author (A) & Illustrator (I)	Description	Ages
Solving environmental problems; How environment influences culture	*The Water Princess* (2017)	A: Susan Verde I: Peter H. Reynolds	This book provides a beautiful backdrop to model Georgie Badiel's life without water and the shortage of water in her village in South Africa.	5 to 8
Reusing and recycling materials	*Recycled Science* (2017)	A: Tammy Enz A: Jodi Lyn Wheeler-Toppen	This fun and engaging book show how to have fun making things while recycling in innovative ways.	9 to 15
Intrinsic value of nature; Highlighting nature in our communities	*Maybe Something Beautiful* (2016)	A: F. Isabel Compoy A: Theresa Howell I: Rafael López	This book looks at the beauty of art and nature as a young girl begins to create mosaic borders around trees to change nature.	5 to 7
Explore processes in the water cycle as connected to weather; Identify the importance of weather conditions on clothing and transportation activities	*Extreme Weather (2017)*	A: Teacher Created Materials	Weird trivia and unbelievable facts test the reader's knowledge about storms, climate, meteorology and more.	6 to 8
Scientists investigate things in the natural world	*Shark Lady* (2017)	A: Jess Keating I: Margaret Alvarez Miguens	The true story of how Eugenie Clark became the ocean's most fearless scientist.	4 to 8

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Science Concepts	Title/Year	Author (A) & Illustrator (I)	Description	Ages
Using scientific instruments; Characteristics of solar bodies	*50 Things to See with a Telescope--Kids and Parents Too* (2017)	A: John A. Reed	This book gets families involved in the great outdoor exploration of the night sky.	5 to 8
Organisms and environments	*National Geographic Kids: Weird but True 4* (2016)	A: National Geographic Kids	This book described a variety of natural facts phenomena.	8 to 12
Scientific inquiry; Problem solving	*What Do You Do with a Problem?* (2014)	A: Kobi Yamada I: Mae Besom	This book investigates problem solving and nature.	5 to 8
Identify the importance of weather in making choices in clothing, transportation, and activities	*Sunshine and Snowballs* (2013)	A: Margaret Wise Brown	Two characters take the reader through the four seasons of the year.	4 to 5
Flow of energy in a food cycle; Observe the way organisms live	*Pond Walk (2011)*	A: Nancy Elizabeth Wallace	A small bear and his mother explore all the great life found in a pond.	3 to 6
Organisms and environment	*The Great Outdoors: A User's Guide* (2017)	A: Brendan Leonard	This book helps make exploratory outdoors fun, safe, and practical.	12 to 18
Structure of insects	*My Awesome Summer by P. Mantis* (2017)	A: Paul Meisel	This book takes the reader on a journey to discover important facts about the praying mantis.	4 to 8
Characteristics of solar bodies; Effect of moon on ocean	*If You Were the Moon* (2017).	A: Laura Puride Salas I: Jamie Kim	Amazing illustrations provide insights for all the ways the moon affects the earth.	5 to 8

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Science Concepts	Title/Year	Author (A) & Illustrator (I)	Description	Ages
Scientific investigation and reasoning	*Outdoor Science Lab for Kids: 52 Family-Friendly Experiments for the Yard, Garden, Playground, and Park* (2016)	A: Liz Lee Heinecke,	This book provides ways to explore science in new and fascinating ways.	7 to 10
How humans use nature for enjoyment	*Microadventures: Local Discoveries for Great Escapes* (2015)	A: Alastair Humphries	Picture landscapes filled with rivers, hills, trees, and campsites mixed in with a great outdoor escapade.	12 to 18
The writing process; Revising thoughts; Using failure to improve; The scientific process	*The Most Magnificent Thing* (2014)	A: Ashley Spires	A young girl and her dog, get outside to find creativity can come from outdoor inspirational walking.	5 to 7
Intrinsic value of nature	*Sky Color* (2012)	A: Peter H. Reynolds	In this book, Marisol searches for the perfect color and goes to nature to find it.	4 to 7
Adaptations of animals to environment	*Birds Art Life* (2017)	A: Kylo Maclear	This book describes how to look at birds and make a life of art from outdoor excursions.	12 to 18
Humans responsibilities to the environment	*The Gold Leaf* (2017)	A: Kirsten Hall A: Matthew Forsythe	This book is a story about animals in the forest and living and learning about the futility in trying to own a piece of nature.	4 to 8
Structures of organisms	*For the Love of Insects* (2003)	A: Thomas Eisner	This text provides fascinating facts and great photographs about how insects live in the world.	12 to 18

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