FOSTERING A GREATER UNDERSTANDING OF SCIENCE IN THE CLASSROOM THROUGH CHILDREN'S LITERATURE

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ABSTRACT

The purpose of this article is to provide preservice and new STEM teachers with an understanding of the benefits of using science trade books to foster comprehension of the science content in the classroom and explain how to supplement science instruction with children's literature. By using children's literature in the science classroom, students have an opportunity to make connections between science content and reading and writing. In this article, tools for selecting children's literature to use in the science classroom are discussed and ways to incorporate literacy skills and strategies alongside science standards are provided.

In 1985, James Rutherford established Project 2061, which called for all Americans to be literate in science, mathematics, and technology. It also challenged them to meet this goal by the next appearance of Hailey's comet. For much of its history, STEM, an acronym used to describe science, technology, engineering, and mathematics, has been divided into two categories: STEM education and STEM workforce (Gerlach, 2012). It was first introduced as "the next big thing" because there was a growing concern that the United States was not preparing enough students, teachers, and practitioners in the STEM fields. By 1996, STEM standards were reevaluated and changes were made to ensure students were ready for careers in STEM. The National Science Education Standards emphasized a higher value a more student-centered approach to science instruction, calling for inquiry-based learning as a core philosophy. It was in the 1990s when the National Science Foundation (NSF) finally framed science, technology, engineering, and mathematics as STEM.

STEM education is defined by the National Science Teachers Association (NSTA) as an interdisciplinary approach to learning, where rigorous academic concepts are coupled with real-world lessons as students make connections between school, community, and work. According to NSTA (2014), the initiative for the Next Generation Science Standards (NGSS) was to ensure a sound foundation of science knowledge embedded in the K-12 science curriculum. Each standard

has three dimensions: disciplinary core ideas (DCI) (content), scientific and engineering practices (SEPs), and cross-cutting concepts (CCs). Currently, most state and district standards express these dimensions as separate entities, leading to their separation in both instruction and assessment. The integration of rigorous content and application, however, reflects how science and engineering is practiced in the real world (NSTA, 2014).

One tool educators can use to supplement learning various STEM concepts both in and out of the classroom is children's literature. As an educator, it is important to remember that each classroom is made up of a unique set of students. These students have varying degrees of background knowledge, reading levels, and even learning styles. It is because of these many differences among students that teachers utilize a plethora of tools to meet the needs of all of their students.

For the purpose of this paper, children's literature will be used interchangeably with informational text and trade books. As defined by Duke (2000), informational texts are used to "communicate information about the natural or social world, typically from one presumed to be more knowledgeable on the subject to one presumed to be less so," and having the features and structures of such texts, e.g., "factual content," "timeless verb constructions," "technical vocabulary," "classificatory and definitional material," "topical theme," and "graphical elements" (p. 205).

Informational trade books appeal to children because of their interesting formats, text arrangement, descriptive language, and intriguing illustrations and captions (Galda, Cullinan, & Sipe 2010; Kiefer, 2010; Moss, 2005). Through the use of trade books, students can gain background knowledge and critical thinking skills that will help them as they continue their education and strengthen their ability to comprehend. The purpose of this article is to provide preservice and new STEM teachers with an understanding of the benefits of using science trade books to foster comprehension of science content in the classroom and explain how to supplement science instruction with children's literature. To ensure successful incorporation of national science standards through the use of children's literature, the authors analyzed a wide range of literature with a focus on science instruction.

Benefits of Using Science Themed Children's Literature

According to Barclay, Benelli, and Schoon (2012) and Wells and Zeece (2007), children's literature has the potential to generate interest and motivation, provide context, invite communication, and connect science information in ways that students can relate facts to their world. Incorporating children's literature, more specifically science trade books, provides a situated perspective that results in cognitive functions, such as reasoning, remembering, and thinking critically (Carr et al., 2001; Monhardt & Monhardt, 2006; Sackes, Trundle, & Flevares (2009). By incorporating this type of literature, teachers can introduce different contexts, concepts, and cultures that can initiate discussion about a science topic. Using trade books with students not only help them make connections to their world, but also helps build reading comprehension. According to Broemmel and Rearden (2006), studies have shown that integrating science and literacy not only results in higher performance scores; it also boosts enthusiasm for science.

Choosing Science Themed Children's Literature to Supplement Science Curriculum

Selecting appropriate books to supplement teaching a new concept can sometimes be a challenging task for teachers. According to Hug (2010), many teachers feel their knowledge in science is not sufficient to determine if the content represented in a book is accurate or inaccurate. Donovan and Smolkin (2002) state that there are three major categories to consider when selecting children's literature for science, which include genre, structure, and content. Paying close attention to these three categories, most importantly content, is key to selecting appropriate books to supplement science instruction.

When selecting fiction books, it is important to ensure the content is accurate, without bias, and with realistic illustrations to avoid any misconceptions (Mayer, 1995). However, Ansberry and Morgan (2010) mention that scientifically inaccurate children's books can be helpful when students analyze them after they have gained a complete understanding of a scientific concept. Opportunities to correct the misconceptions transport students to a higher level of thinking (Ansberry & Morgan, 2010). The selection of books is an imperative process when weaving them into the science curriculum.

Illustrations are also an important consideration when selecting books. The illustrations in texts provide learners with a more comprehensive way of reading by providing more information related to unfamiliar words or concepts (Carr Buchanan, Wentz, Weiss, & Brant, 2001). This visual representation of concepts can reduce frustration during the learning process and build a foundation of knowledge for further learning of concepts (Carr, et al., 2001). By using engaging illustrations, depictions of other children, and characters that draw a reader in, children's book authors create a powerful means of building understanding and offer a "situated perspective for knowledge, thinking, and learning" (p. 147). Trade books, according to Donovan and Smolkin (2002), provide readers with genre, content, and visual features that enhance science instruction and encourages young readers' interest in science-related topics. Through the fusion of text and art, the reader can integrate their own experiences and interpretations into each element and create a unique experience (Wolfenbarger & Sipe, 2007).

According to Feathers and Arya (2012), children use illustrations to help process difficult concepts or words within text. As an educator, it is important to supply students with the tools they need to understand the visual features of text in order to extract meaning from the text. Nodelman (1981) describes "visual grammar" as the way our understanding of pictures is dependent on our knowledge of the convention by which they operate (p. 57). In other words, when sharing with students a variety of text formats, they come to understand that knowledge can be represented in numerous ways. This is an important skill for students to develop, especially in science, because of the way scientists combine, interconnect, and integrate text with a variety of visual representations (e.g., diagrams, photos, graphs) (Smolkin & Donovan, 2005). By incorporating this idea of visual grammar when reading, students grasp the importance of illustrations and how to use them as a form of information within the text. Since illustrations play a significant role in both science

concept formation and the building literacy skills, they are a key factor for teachers when choosing appropriate books.

Some ways to alleviate the frustration of choosing books that are appropriate for science instruction are using checklists, selection criteria, rubrics, evaluation scales, and bibliographies. Many samples of these are widely available to evaluate fiction and nonfiction children's books for science education (Atkinson, Matusevich, & Huber, 2009; Carr et al., 2001; Donovan & Smolkin, 2002; Mayer, 1995; Price & Lennon, 2009). Mayer (1995) developed a series of 10 questions for evaluating fiction trade books for science class (Figure 1).

- ✓ Is the science concept recognizable?
- ✓ Is the story factual?
- ✓ Is fact discernible from fiction?
- ✓ Does the book contain misrepresentations?
- ✓ Are the illustrations accurate?
- ✓ Are characters portrayed with gender equity?
- ✓ Are animals portrayed realistically?
- ✓ Is the passage of time referenced adequately?
- ✓ Does the story promote a positive attitude toward science and technology?
- ✓ Will children read or listen to this book?

Figure 1: Checklist for choosing children's literature to teach science

Other resources for selecting science books include Teacher's Choices from the International Literacy Association and Children's Book Council, Outstanding Science Trade Books for Students K-12 from NSTA, and the Notable Children's Book List from the American Library Association (Atkinson et al., 2009; Brommel & Rearden, 2006). Table 1 consists of a selection of books compiled from the NSTA (2014) – Outstanding Science Trade Books for Students K-12.

Table 1.
A Selection of Books Related to STEM Topics

Book	NGSS science and engineering practices	Science content
Boy, Were We wrong About the Solar System by Kathleen V. Kudlinski	Engaging in argument form evidence; obtaining, evaluating, and communicating information	Earth and solar system
Energy Island by Allan Drummond	Engaging in argument form evidence; constructing explanations and designing solutions	Alternative energy sources
Ladybugs by Gail Gibbons	Engaging in argument form evidence; constructing explanations and designing solutions	Food chains and adaptations
Next Time You See a Spiderweb by Emily Morgan	Constructing explanations and designing solutions	Inherited and acquired traits
Papa's Mechanical Fish by Candace Fleming	Planning and carrying out investigations; constructing explanations and designing solutions	Engineering design process
Star Stuff by Stephanie Roth Sisson	Engaging in argument form evidence; obtaining evaluating, and communicating information	Astronomy
The Boy Who Harnessed the Wind by William Kamkwamba	Constructing explanations and designing solutions	Alternative energy sources
The Inventors' Secret by Suzanne Slade	Planning and carrying out investigations; constructing explanations and designing solutions	Engineering design process; Contributions of scientists

Connecting Literacy Skills to Science Content

In their book *Picture Perfect Science Lessons: Using Children's Books to Guide Inquiry*, Ansberry and Morgan (2010) explain ways to model and explicitly teach reading comprehension strategies within the science curriculum. The teacher explains the strategy, demonstrates how and when to use the strategy, explains why it is worth using, and thinks aloud to model mental processes. Using these techniques with children's literature in the science classroom reinforces the strategies students learn during reading instruction and helps them apply those skills to a variety of texts and curricular areas (Ansberry & Morgan).

Ansberry and Morgan (2010) suggest several reading comprehension strategies that can be taught while using children's books during an inquiry-based science lesson. Some of the strategies include: making connections, questioning, visualizing, inferring, determining importance, and synthesizing. By using children's literature in the science classroom, students have an opportunity to practice making connections, which can help them comprehend text and relate their background knowledge to what they read. Students should be taught how to ask themselves questions while reading as a tool to build meaning and eliminate confusions as they read. Since asking questions is also an important skill in science instruction, understanding how to transfer these strategies can help them be successful reading across any content. Ansberry and Morgan further mention that when readers ask questions, it is a sign that they comprehend what they are reading.

Teaching students to visualize the text can engage them in the lesson and may provide them with a memorable learning experience. Making inferences is another important science skill that can be reinforced during reading instruction (Ansberry & Morgan, 2010). When using books that feature science concepts, students show gains in reading comprehension, vocabulary development, and enthusiasm for reading (Wallace & Coffey, 2016). Each lesson provided in the *Picture-Perfect Science Lessons* series has appropriate reading comprehension strategies for the book that is suggested. Examples of activities and graphic organizers that may be used to improve science and reading comprehension include anticipation guides, Observe – Wonder – Learn (O-W-L) charts, and Venn diagrams, just to name a few.

The use of trade books in early education is quite common and has shown to be useful in developing language, reading, and writing skills (Bishop & Hickman, 1992). Teachers can also help students build reading comprehension skills by modeling the strategies during read-alouds of both fiction and nonfiction books (Ansberry & Morgan, 2010).

According to Olness (2007), picture books are rapidly gaining popularity among older readers. Reiker (2011), states, "there may be a perception among educators and administrators that picture books do not meet the level of rigor required in a high school setting." Beckman and Diamond (1984) similarly point out that secondary teachers may avoid using picture books for fear their administrators might not consider them appropriate for adolescents. However, along with helping students process difficult concepts, reading science books also helps them develop content specific terminology, which then provides a foundation for future science learning (Kurtz & Bartholomew, 2012). By helping students develop these skills, they become more comfortable discussing their understanding of scientific content (Price & Lennon, 2009).

Implementing children's literature to enhance science curriculum captures students' interest in learning and aids in the development of literacy skills. Wilson and Bradbury (2016) conducted several lessons in which they integrated the use of informational texts in an inquiry-based science unit about plant parts and their functions. Some of informational texts the students used to guide them through their investigations included *The Vegetables that We Eat* by Gail Gibbons and a book series of plant parts by Melanie Waldron. According to Wilson and

Bradbury, the use of informational texts in a science context can be leveraged to review text features, read for information strategies, and address English Language Arts Common Core or state standards.

Using children's literature offers benefits that support oral reading and understanding (Feathers & Arya, 2012). According to Feathers and Arya, teachers need to read authentic literature to students, and children need many opportunities to read independently in order to be exposed to different ways that visual and verbal texts are used to create a story. During an interview with author/illustrator Gail Gibbons, Smolkin and Donovan (2005) gathered that pictures not only maintain children's interest but also help present science concepts accurately. When teachers take the time to learn about the authors and illustrators of informational text, along with the features of nonfiction texts, they will be better prepared to foster children's comprehension of informational texts (Smolkin & Donovan). According to Ansberry and Morgan (2010), students are usually more familiar with reading narrative text, which explains why they skip over some text features (e.g., captions, headings) when reading. Explicit instruction on how to interpret the information in these types of texts is crucial when helping students understand the content.

With the growing popularity of informational texts, trade books are an easy and creative way to incorporate children's literature as a means of teaching concepts in the content areas. The use of science-themed children's literature can improve the understanding of science concepts in the classroom. In primary education, read-alouds using nonfiction text can be an effective way to familiarize children with expository text. According to Daisey (1993), read-alouds bolster literacy at any age, and it provides teachers with "a reading strategy to promote an intergenerational continuity of lifelong reading to others" (p. 437). Routman (1991) explains, "reading aloud should take place daily at all grade levels, including junior high and high school" (p. 32). Trade books are designed to appeal to children. They focus on specific science concepts and are often more up-to-date and have a higher production quality than textbooks (Ford, 2006). When selecting books to supplement a science lesson, it is important to remember that, although non-fiction trade books are the most widely available, fiction books can also enrich science concept instruction (Mayer, 1995). By incorporating narratives, students are able to "make sense of individual and collective experience and construct knowledge through story-telling" (Arizpe, Farrell, & McAdam, 2013, p. 245).

IMPLICATIONS

From the research gathered, it is evident that by incorporating children's literature, teachers can foster learning and reading comprehension in the K-12 science classroom. As a preservice or new teacher, it may be overwhelming to imagine having to incorporate children's literature purposefully apply national and state standards, all while keeping students interested in learning. Since the state and national standards are the basic guidelines of what students need to know, one way to ease into the process of incorporating children's literature is to find books using checklists (see Figure 1). Checklists can help teachers identify books for each of the major categories of science concepts, which then allows the teacher to make more informed decisions in incorporating these books into STEM instruction.

Many science teachers may not be aware of strategies used to teach reading comprehension strategies or how to teach students to use visual representations; however, they should have opportunities to plan with other teachers and participate in professional development to develop these skills. In a study conducted by Wallace and Coffey (2016), the preservice teachers indicated that they achieved a new understanding of how science and literacy can be integrated when they took time to collaborate with each other.

More research is needed to show the connection between student academic performance and science instruction using children's literature. Possible studies may include both quantitative and qualitative methods to determine academic achievement, to foster efficacy of the teaching and learning of science content, and to promote an interest in STEM careers.

Conclusion

According to the National Research Council (2012), reading and writing skills are essential to science instruction. By using an array of books to link content learning with literacy, teachers can help students learn to "read the world" by providing them with literacy learning tools that will last a lifetime and allow them to thrive in the technological age and encourage them to pursue STEM careers (Moss, 2005). When teachers select appropriate books and model reading strategies during science instruction**,** students develop reading comprehension skills relevant in the science classroom. Picture books are invaluable for teaching reading comprehension strategies because they engage readers and provoke them to use higher order thinking (Ansberry & Morgan, 2010). Using a checklist such as the one provided in this article may help teachers who find it difficult to choose the appropriate literature to foster learning and promote an interest in science. It is important to remember that students of all ages enjoy exploring science through children's literature. When teachers take the time to teach science through the use of children's literature, students of varying degrees of background knowledge, reading levels, and even learning styles will be more capable of developing a better understanding of science concepts.

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