

Inspired Inquiry: Crafting K-5 STEM Lessons with Science Fiction

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Abstract

As many proponents of STEAM education have argued, the creativity and socially-grounded expressiveness of art is a naturally occurring function of science, technology, engineering, and math. No innovations could be made otherwise! Teachers can develop this essential creativity in elementary science lessons through high-quality science fiction. While largely understudied in education research, there is evidence that engaging children in quality science fiction is likely to increase engagement and interest in STEM study and potentially even STEM careers. High quality examples of science fiction have a special penchant for evoking wonder and speculation—prime ingredients for inquiry. This article offers the theory, guidance, and ideas that science teachers need to begin using science fiction picturebooks as a productive tool in STEAM lessons.

Keywords: STEM Education, K-5 Science, Science Fiction, Language Arts, Picturebooks

Background

After testing was done for the year, the authors came together to create a science fiction day in Laabs' 2nd, 3rd, and 5th grade classes. Midkiff read *Mr. Wuffles* (Table 1), a mostly wordless picturebook by David Wiesner. When she showed the cover and asked what the book might be about, the students shouted, "A cat!" "Cats playing with toys!" "Ladybugs!" When Midkiff revealed the hidden cover under the dust jacket, a photorealistic galaxy, they exclaimed: "It's space!" "Space and a cat?" "Cats on spaceships...with ladybugs!" "That can happen—they take animals sometimes!" Even from the dust jacket and cover, students were recalling knowledge, synthesizing, and speculating on the possible. This continued as they parsed the story from the pictures. When the aliens appeared, some of the 3rd graders giggled and declared that aliens were not real. A previously silent boy in the back, however, spoke up: "We don't know! We don't know what's in space." An enthusiastic discussion ensued, ranging from the size of the universe to what scientists currently do and do not know.

The discussion primed them for a Venn Diagram activity in small groups. Laabs guided them as they listed parts of the story that were imaginary in one circle, then parts that were realistic in the other. Parts that students thought were possible, but scientifically unproven, went in the center. We overheard debates about aliens, spaceship technology, insect communication, and more. The students wrangled with what was possible, what they already knew and had evidence for, and the unknown. They were thinking like scientists, leveraging previous knowledge to see what is left to study and strive towards.

Theoretical Discussion

While largely understudied in science education research, there is evidence suggesting that quality science fiction is likely to increase children's engagement and interest in STEM study—and potentially even STEM careers. Interviews with STEM professionals performed by Fleischmann & Templeton (2008) and The American Society of Mechanical Engineers (Brown & Logan, 2015) revealed that reading and watching science

fiction as a child shaped how the interviewees came to think about science and engineering overall, and even influenced their career choices. This connection between childhood science fiction reading and STEM also provides a potent way for educators to combat the negative impressions that deter women and people of color from STEM fields (Tsui, 2007; Halpern, et al., 2007; Baker & Leary, 1995). With girl-friendly and diverse science fiction books, students can see others like themselves in advanced and futuristic STEM settings. This extra component is worth the effort of searching, but Midkiff has also compiled a free, online list of high-quality science fiction, with an eye for strong female protagonists and diverse representation (<https://emidkiff.wordpress.com/recommended-childrens-science-fiction/>).

Science fiction books not only encourage students in STEM fields, but generally benefit children living in our digital age. Istvan Csicsery-Ronay, Jr. (2008) posits that science fiction stories help people of all ages cope with our modern, break-neck pace of technological change. When people encounter futuristic speculation about technology in movies and books, they develop what Csicsery-Ronay calls “**science-fictional habits of mind**” (p. 2) that help them productively think about new technologies, and the subsequent applications and consequences of those new technologies. In other words, it helps people think about technology with an analytic perspective, as though it was happening in a science fiction story.

Despite the apparent correlation between science fiction, children’s developing conceptions of science/scientists, and our technological world, very few connections to this genre appear in science classrooms. One exception, an NSF-funded program called The Sci-Dentity Project, brought together researchers, teachers, and librarians to craft a library program for young adults to connect with science fiction and, by extension, science. This program, and their publication in *Knowledge Quest* (2012), emphasized the role that librarians could play in working new media literacy, science fiction, and STEM together. **Elementary science teachers are also in a great position to take up this genre’s** potential, especially through picturebooks. Using picturebooks offers a great way to engage students and set up lessons, as indicated by The National Science Teachers Association (NSTA) **Press’s** *Picture Perfect Science Lessons* series (www.nsta.org/publications/press). They even include the occasional science fiction book.

Using science fiction picturebooks fuels inquiry and arouses curiosity by taking a story to an explorative level. Using and endorsing science fiction in the science classroom encourages children to know the facts, but also to dream beyond them. Daydreams are often all too undervalued in education, but they are essential to the real-world creativity needed for scientific innovation. Science fiction picturebooks are manageable and appropriate supplements to enrich hands-on exploration and inquiry in the classroom—and can be tied into several standards, as noted below.

A Note on Choosing Books

When considering science fiction for the classroom, it is important to distinguish between science fiction, nonfiction science books, and realistic science stories. Less obviously, science fiction theory attests that it is also essential that the book not just be a grand adventure, but that it asks a question about STEM and its consequences (Nodelman, 2015; Hastings, 2011; Mendelsohn, 2009; Levy, 2006). Science fiction literary theory refers **to this concept through the terms “extrapolation”, when a story extrapolates** from hard science to ask about what STEM will look like in the future, **or “speculation” when it speculates** about what will happen to humans when we have different technologies (Landon, 2014). Extrapolation requires a good basis of science concepts, and so its usefulness in the classroom is obvious. Less obviously useful, **speculation allows for “imaginary science,”** as it is called by Csicsery-Ronay. He uses this term to refer to stories that move away from **known science, into ideas that can’t be proven with our current understanding. This science**

begins to look like magic or make-believe, because it relies on humanity's incomplete understanding of the world and the guarantee that our current scientific understandings will shift and grow in the future.

These less grounded (and sometimes outright inaccurate) speculative stories with **"imaginary science" are still important for developing a sense of how STEM can impact** people in different ways, and frees children to stretch their inventive potential by dreaming up ideas that may not rely on detailed science. For instance, when we were evaluating science fiction picturebooks, we struggled with one called *The Crimson Comet*. It is a beautiful book with a steampunk aesthetic that draws on popular current trends and allows **for exploring machinery. However, this book's titular spacecraft** flies to a moon that is lit from within by an elaborate steampunk engine. This, Laabs asserted, was not helpful. Students already had trouble with misconceptions that the moon is self-lit. This book risked perpetuating incorrect ideas about the moon. After some discussion, we realized that *The Crimson Comet's* **apparent flaw could be useful. Students are always going to bring their** preconceptions to the classroom, and addressing them head-on is far more supportive than avoiding the opportunity for pitfalls. It turns out that this picturebook provides a prime chance for discussing the fiction part of science fiction: how it sometimes mixes fact with make-believe to make a story that is pretty and interesting to think about, but not true. This book, it turns out, is great for distinguishing between moon facts and moon misconceptions, offering practice that students need to separate other facts from fiction.

Ultimately, science fiction relies on both realistic and wild dreams about what STEM can do, and these are both important to inspiring innovation. Early science fiction author **Jules Verne is often quoted as saying "Anything one man can imagine another man can make real."** In fact, Verne's flying machine in the 1886 science fiction novel *Clipper of the Clouds* inspired Igor Sikorsky to invent the helicopter in 1939 (Ryan, 1995). This example is only one among many science fiction stories that seemed wildly improbable at the time, but later inspired real inventions (see <http://www.smithsonianmag.com/science-nature/ten-inventions-inspired-by-science-fiction-128080674/?no-ist>). One would not tell a young child **with a beginner's grasp on energy sources** to invent a new engine, and that it must be 100% accurate. It would only stifle their inventive and creative potential with details that they do not yet have. Similarly, little tolerance for fiction—with clear guidance—goes a long way.

Future Teaching

No matter how much we argue for science fiction picturebooks in the STEM classroom, we are well aware that there are very few resources and examples for teachers to begin with. Therefore, we wanted to conclude this article with a concrete starting point. In Table 1, we propose lessons for capitalizing on the potential of science fiction picturebooks in the science classroom, using several picturebooks that we have already identified as high-quality science fiction using criteria from science fiction scholarship. Since these activities are best for modification rather than pre-formed lesson plans, we wanted to offer seeds rather than full-grown curricula. **We have organized Table 1 to offer the book's** publication information, and then the seeds of STEAM activity ideas along with relevant Next Generation Science Standards. Additionally, the last column includes potential ways to use the book across other subjects, reflecting the integrated nature of STEAM education. While it is sometimes a struggle to find time to fit such recommendations into the curriculum, this integration of inquiry-based science through science fiction is rewarding.



Table 1

Topics and idea seeds for STEAM activities paired with high quality science fiction picture books and Next Generation Science Standards.

<u>Book Information</u>	<u>Science</u>	<u>Technology</u>	<u>Engineering</u>	<u>Math</u>	<u>Other</u>
Pinkney, B. (2000). <i>Cosmo and the Robot</i> . New York: Greenwillow Books.	Using tools. <u>Standards</u> ESS1- Earth's Place in the Universe	Design items for a tool belt.	Reverse Engineering- taking something apart and reassembling it. <u>Standards</u> ETS1- Engineering Design	Measurement tools.	Social Studies: Map out Cosmo's Mars landscape and adventures.
Wiesner, D. (2006). <i>Flotsam</i> . New York: Clarion Books.	Observation/tools: microscope.	Evolution of cameras. <u>Standards-</u> ETS1- Engineering Design	Have students take pictures of pictures to replicate and examine with microscope.	Estimate a timeline for the photographs. Talk about magnification power.	Art: Create a surreal sea picture. Writing: Write a story to explain one of the pictures. Writing: Add dialogue to the wordless panels.
Beaty, A. Ill. by Roberts, D. (2013). <i>Rosie Revere, Engineer</i> . New York: Abrams.	Connect to wind power and wind as force. <u>Standards</u> PS2- Motion & Stability: Forces & Interactions PS3- Energy	Explain how the inventions on the last page work.	Make a flying machine that can fly for 20 seconds in wind from a fan. Discuss stress and not quitting before the "improve" step of engineering. <u>Standards-</u> ETS1- Engineering Design	Create priced list of supplies Rosie uses for different inventions.	Social Studies: Introduce Rosie the Riveter poster and historical character, and discuss the connection to this book.

<p>Fleischman, P. Ill. by Hawkes, K. (1999). <i>Weslandia</i>. Somerville, MA: Candlewick Press.</p>	<p>Observe different types of seeds and hypothesize how that seed travels.</p> <p><u>Standards</u> LS1- From Molecules to Organisms: Structures & Process LS2- Ecosystems: Interactions, Energy, & Dynamics LS4- Biological Evolution and Diversity ESS2- Earth's Systems</p>	<p>Identify plant inventions as technology, and use to discuss early technology and the definition of technology.</p>	<p>Bioengineering- Solve a problem through inventions created from plants.</p> <p><u>Standards-</u> ETS1- Engineering Design</p>	<p>Make a simple sundial and use for another perspective on measuring hours/minutes.</p>	<p>Art: Use recycled materials to sculpt a new type of plant.</p> <p>Social Studies: Plan your own civilization.</p> <p>Social Studies: Make a map of Weslandia.</p> <p>Writing: Develop an 88 letter alphabet.</p>
<p>Morrissey, D. (2006). <i>The Crimson Comet</i>. New York: HarperCollins Children's Books.</p>	<p>Create Venn Diagrams of what is real/not real about the moon. Use the middle for ideas that are possible, but can't be proven.</p> <p><u>Standards</u> ESS1- Earth's Place in the Universe</p>	<p>Discuss benefits and limitations of technology, specifically safety.</p>	<p>Design an alternative way to light the moon.</p> <p>Design a safer way to land the Crimson Comet, using balloons, tissue paper, etc. Place an egg in a cup to test your soft landing.</p> <p><u>Standards</u> ETS1- Engineering Design</p>	<p>Discuss the distance to Moon, and try to estimate how long and how fast the Crimson Comet may have been traveling.</p>	<p>Writing: Discuss and use poetry and rhyming to make your own poem about a real or imagined rocket.</p>



Oakley, G. (1986). <i>Henry's Quest</i> . New York: Atheneum.	Discuss types of Alternative Energy. <u>Standards</u> PS3- Energy ESS3- Earth & Human Activity	Examine the uses of old and new technology in the detailed illustrations.	Imagine/Design alternative way to power the king's cars (hydro, solar, biofuels, steam, wind, mechanical.) <u>Standards</u> ETS1- Engineering Design	Calculate cost comparison of various energy resources.	Social Studies: Discuss ways to protect the Earth's resources and environment. Writing: Individual choices impact on Earth
Wiesner, D. (2013). <i>Mr. Wuffles</i> . New York: Clarion Books	Create Venn Diagrams of what is real and not real in the book. Use the middle for possible, but unproven ideas.	View a simple circuit board and discuss how the various components are dependent on each other. Compare to alien's disks. <u>Standards</u> PS1- Matter and Its Interactions	Design 5 replacement disks with materials "left by insects" (provided by teacher) to power the alien's engine. Constraints: different dimensions, textures, etc. Design a toy that Mr. Wuffles would like	Measurement of disks.	Art: Create your own cave drawings on a brown paper bag. Writing: Decode the alien and insect language symbols.

We recommend that teachers start with a whole-class read-aloud, encouraging interactions and questions. Many of the activities listed for each book link well together, and could be combined into a multi-phase activity or scheduled into a string of activities. Additionally, the use of a science fiction picturebook is a great way to integrate a STEM lesson with a Language Arts genre lesson about science fiction, through pairing the science fiction picturebook with a nonfiction picturebook that matches one of the STEAM concepts fictionalized in the former. This pairing emphasizes correct science concepts and deters misunderstandings, while also demonstrating the speculative strength of science fiction and how it can spark ideas for new discoveries and inventions.

Science fiction and the STEAM classroom are a natural match, and one that we believe should be capitalized on more often by elementary teachers. These idea seeds are just a starting point, and we encourage teachers to build on these paired activity ideas, **modify them for your learners, or look through Midkiff's list of books linked above to find your own inspiration.**



Emily Midkiff recently earned her PhD in children's literature and literacy from the University of Minnesota. Using interdisciplinary mixed methods, she researches speculative fiction, mythology, and children's and YA literature. Dr. Midkiff's upcoming book-length project focuses on diverse, girl-friendly science fiction for children under 12 years old.



Bonnie Laabs earned her PhD in curriculum and instruction from the University of Minnesota. Dr. Laab's research interests include STEM identify and STEM learning, specifically trauma and resilience in the STEM classroom as it relates to closing the achievement gap, and animal assisted learning.

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