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Cultivating Ingenuity in Art through STEAM Picture Books

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Cultivating Ingenuity in Art through STEAM Picture Books

Abstract

In what creative ways can educators cultivate ingenuity? This article features ten STEAM picture books and their possibilities in the art room and beyond. It equips educators to take on STEAM armed with engaging and inspiring picture books that foster creativity, inventiveness, and more while inspiring students to create, experiment, problem-solve, and construct. There is a focus on one substantive, integrated Art and Science lesson built on the provocative book Summer Birds: The Butterflies of Maria Merian written by Margarita Engle and illustrated by Julie Paschkis. Readers will leave with one complete STEAM challenge-based lesson plan informed by this book and nine transdisciplinary student-centered seed strategies based on nine other ingenious STEAM picture books. Each STEAM lesson has a contemporary artist connection and focuses on the Studio Habits of Mind.

Keywords

STEAM, Picture Books, Studio Habits of Mind, Creativity, Contemporary Art

Cover Page Footnote

Cultivating Ingenuity in Art through STEAM Picture Books Julia L. Hovanec, PhD. Kutztown University

Cultivating Ingenuity Through STEAM Picture Books

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Imagine a classroom with a tall wooden bookshelf filled with picture books, STEAM picture books that cultivate ingenuity through inspirational words and appealing images. Author Frank Serafini (2014), described picture books as multimodal ensembles which he defined as a text composed of more than one means of experiencing a story. He explained that a well-executed picture book is a complex entity that uses various cultural and semiotic resources to articulate, render, represent and communicate an array of concepts and information (Serafini, 2022).

As artistic storytelling, picture books offer the potential for strong integration both conceptually and the ways in which we activate physical spaces for learning that can support, bridge and scaffold modes of thinking and expression across disciplines for more holistic experiences. Picture books are usually intended for young audiences, although they have proven practical teaching tools for all age levels (Ciecierski et al., 2017). They have the potential to motivate students to become more engaged in a particular topic or lesson, using the book as a hook. Picture books create perfect opportunities for memorable connections by allowing students to reflect on images and encouraging them to talk while spurring higher-order thinking and creative problem-solving (Serafini, 2014). Students identify with the characters and develop skills holistically in reading, writing, and language comprehension while at the same time developing visual literacy skills (Marantz, 1992). Picture books appeal to reluctant and diverse learners (Ciecierkski et al., 2017) and have limitless potential in teaching and learning across disciplines. Students construct, co-construct, and communicate meaning through the interactive nature of a thoughtfully crafted picture book containing various textual and pictorial elements.

For these reasons, it makes sense to use picture books or “multimodal ensembles” that make powerful STEAM connections to cultivate ingenuity in art and science. Conceptually and physically, artistic endeavors applied in the sciences and applying the scientific method or processes in the visual arts are robust integrations. These integrations help learners of all ages to think divergently and experience learning more inclusively. In doing so, a physical environment for learning that connects artistic and scientific modes of thought and expression is created. This article focuses on bringing STEM into art through STEAM Picture books and dissolving boundaries across disciplines to produce more fluid learning experiences for students. They can make connections and readily transfer what they learn in art class to science and in science class to art.

Although STEAM has had evolving and expanding definitions since its start, most agree that it is an educational approach that uses Science, Technology, Engineering, the Arts, and Mathematics as access points to learning (Perales & Aróstegui, 2021). Through these access points, teachers guide students toward inquiry and critical thinking. The results show students who can experiment, collaborate, make meaning, take risks, and creatively solve problems (Hunter-Doniger & Sydow, 2016). Further, Rolling asserted that focusing only on STEM subjects without art-based learning will not meet the needs of students in the United States (2016). STEAM promotes project-based learning, a way of demonstrating understanding common among many subjects (Hunter-Doniger & Sydow, 2016). STEAM is a vehicle to move past traditional teaching in all subjects, especially STEM practices limited to overly transmission-oriented approaches or procedural ways of knowing and thinking that still exist. Of course, many STEM educators are applying best practices and moving from memorizing facts and figures to transferrable learning and teaching. But there are still educators, especially when assessing who fall back on rote and teacher-directed learning. Erasing the boundaries between art and science stretches

the teaching and learning process since educators and students work with multiple literacies. This is where the STEAM picture books come in, providing the perfect entryway to discovering the many magnificent connections between art and science. Students feel more motivated to learn because they are more engaged and intrigued about the content areas taught (Henriksen, 2014). When considering STEAM, words that come to mind include wonder, critique, imagination, curiosity, boundless, and innovation. Visualize an art or science classroom where these words and actions are commonplace as learners brim with excitement and energy.

This article features ten STEAM picture books that inspire students to create, experiment, think and build. The notable and carefully selected STEAM picture books encourage creative exploration and cultivate ingenuity while celebrating Science, Technology, Engineering, Art, and Mathematics. They reflect a diverse range of artists, scientists, and thinkers with the aim of all learners being able to see themselves mirrored in the stories that are shared. For one of the books there is a complete STEAM lesson. The nine others, spark standard-aligned lesson ideas focusing on integrated art and science learning and highlighting verbal and visual literacy as a vehicle in which to teach content in meaningful and purposeful ways.

The showcased STEAM lesson is entitled: Inventive Butterfly and focuses on the picture book, *Summer Birds: The Butterflies of Maria Merian,* written by Margarita Engle and illustrated by Julie Paschkis (2010.) This three-day lesson designed for second graders can be adapted to any grade level. The big idea centers around the importance of being observant and inventive, within the content areas of Science and Math. Important to note is that for each lesson, clear connections are made to the Studio Habits of Mind (SHoM) which is a framework established by Lois Hetland and her team that classifies and names eight studio habits including, develop craft, engage and persist, envision, express, observe, reflect and stretch and explore (Hetland, et al., 2013). Inventive Butterfly concentrates on envision and observation, essential STEAM skills. Imaginative and observational drawing as the Visual Arts focus connect directly with contemporary artist Victoria Horkan also known as “The Butterfly Artist.” In Horkan’s latest work, she concentrates on butterflies and metamorphosis as well as how they adapt to climate change. Maria Sibylla Merian, who the picture book is about, was a scientific illustrator and one of the earliest European naturalists to observe insects directly (Paschkis, 2010). Merian is the historical artist/scientist studied.

In this lesson, students will invent a butterfly species after exploring and observing butterflies and learning about the art and life of historical and contemporary "butterfly" artists. Students learn important concepts such as why the skill of observation is necessary to see more deeply in art and science and using one's imagination in helps us envisioning what’s not there but could be (Hogan, et al). Students also discover that when artists observe nature, they become inspired to create. Lastly, students realize that they can engage in studio thinking and creative inquiry when independently creating a butterfly species they invent.

The lesson begins with the book as a motivational tool. After listening to the story and engaging in a discussion, the students will carefully observe butterflies (ideally in nature, but photographs will suffice, either actual or virtual) with magnifying lenses while taking notes and sketching different views or features of butterflies in their notebooks. The teacher introduces the concept of symmetry, and the students collect soil samples in a specimen jar to be used later in the lesson. Students will label their soil specimens with their name. They will be told that the soil will be used later in the lesson. Learners will complete an exit ticket to review content, demonstrating their understanding of the Studio Habits of Mind, “*art communities”* and reflecting upon the experience (Hogan et al. 2018).

On the second day, the teacher introduces the impressionistic butterflies of Victoria Horkan. Students will use watercolor paints to create their impressions of butterflies based on their sketches and from memory. On the third day, the students will watch the Free School video on YouTube about metamorphosis (2015). https://www.youtube.com/watch?v=TvmQiWpgX5c. They will compare the realistic and expressive styles of Maria Sibylla Merian and Victoria Horkan. The teacher will lead the students in a discussion about why it was important for Merian to work realistically and why contemporary artists like Horkan might work expressively. A gallery walk will conclude that day.

On the final day of the lesson, the teacher asks the students to recall their discoveries from the last two classes to inspire a natural and symmetrical work of art. The teacher assigns students to take on the role of a scientist. Their assignment will be to discover a new butterfly species they create from imagination, requiring their designs be symmetrical, detailed and colorful. Learners will sketch ideas in their notebooks and complete an activity sheet to flush out all of their ideas, reflections and observations. To begin the actual work, students will apply all they learned so far in the lesson, by drawing a new butterfly species with crayon, pressing very hard on watercolor paper. Next, they will color in some shapes, leaving a few uncolored. The uncolored shapes then get painted with only water, and finally the collected soil sample and watercolor paints are precisely applied. The soil is mixed with the watercolor to give a natural, earth-tone appearance to the final piece. The teacher will model how to carefully use the dirt sample to mix with the watercolors to color in the rest of the shapes as to not create mud. Finally, learners will name the butterfly and write one sentence to describe it. The students will complete the checklist self-assessment and present their new butterfly species to the class.

Standards:

- NCAS.#VA:Cr2.1 Organize and develop artistic ideas and work.
- NGSS. 2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.
- CCSS.MATH.CONTENT.4.G.A.3 Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry.

The rest of this article will focus on nine picture books that each offer a seed strategy (Cornett, 2011) to spark STEAM lessons that cultivate ingenuity in art and science.

Animal 911 - ***The Girl Who Thought in Pictures: The Story of Dr. Temple Grandin***, written by Julia Finely Mosca and illustrated by Daniel Rieley, 2022. After listening to this courageous true story, students will invent a machine to help an animal after researching their chosen animal and its associated plight. Their invention can be drawn or built using found objects. This seed strategy features Science, Art & Engineering, and the contemporary artist connection is Steven Laurie, an interdisciplinary artist and designer who builds thoughtful machines and more. Students are encouraged to "stretch and explore" as well as "engage and persist" when building their supportive machines (Hogan, et al., 2018).

Standards:

- VA:Cr2.1.3.a Create personally satisfying artwork using a variety of artistic processes and materials.
- 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

- 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Deep Dive - *Shark Lady: The True Story of How Eugenie Clark Became the Ocean's Most Fearless Scientis*t, written by Jess Keating and illustrated by Marta Álvarex Miguéns, 2017. After listening to an intelligent and courageous true story, the students will dive deeply into research and the ocean to discover information about a chosen ocean animal. They will take notes, make sketches, and then draw their animal as realistically as possible, coloring with oil pastels and adding watercolor to put the creature deep in the ocean. This seed strategy features Science, Art, and Technology. The contemporary artist connection is Lily Simonson who works closely with researchers to create large paintings of ocean organisms evoking the captivating encounter of exploration. Students are invited to "stretch and explore" while researching and creating their ocean creatures (Hogan, et al., 2018).

Standards:

- VA:Cr2.3.3.a Individually or collaboratively construct representations, diagrams, or maps of places that are part of everyday life.
- TS: 3.1 A student must use digital tools and resources for problem solving and decision making.
- 3-LS1 From Molecules to Organisms: Structures and Processes

Woven Numbers - *Who Says Women Cannot Be Computer Programmers?: The Story of Ada Lovelace*, written by Tanya Lee Stone and illustrated by Majorie Priceman, 2018. In this book, a key quote talks about Ada being familiar with how the Jacquard loom worked, and because of this she had an understanding of machines, in general. This knowledge combined with what she called the "fair white wings of imagination," made it possible for Lovelace to "envision" unseen worlds (Hogan, et al., 2018). She understood that the machine would be able to weave random and/or patterned numbers. After listening to this story, students will identify numbers in their everyday lives and explain why numbers are important to humans. The teacher will ask the students to consider their favorite numbers, and they will input them on the computer applying prior computer knowledge. The numbers will form personal and imaginative calculations that the students will print. Following they will cut their number patterns into strips which will be woven on a loom the student creates, making decisions about shape and size. The numerical creations will be shared with the rest of the class. This seed strategy features Technology, Science & Art. The students are asked to reflect on the experience and write about their process (Hogan, et al., 2018). Daniella Woolf who is a mixed media artist who manipulates and weaves various materials using mathematics and repetition is the contemporary artist connection.

Standards:

- TS: 3.1 A student must use digital tools and resources for problem solving and decision making.
- VA:Cr2.1.3.a Create personally satisfying artwork using a variety of artistic processes and materials.
- 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

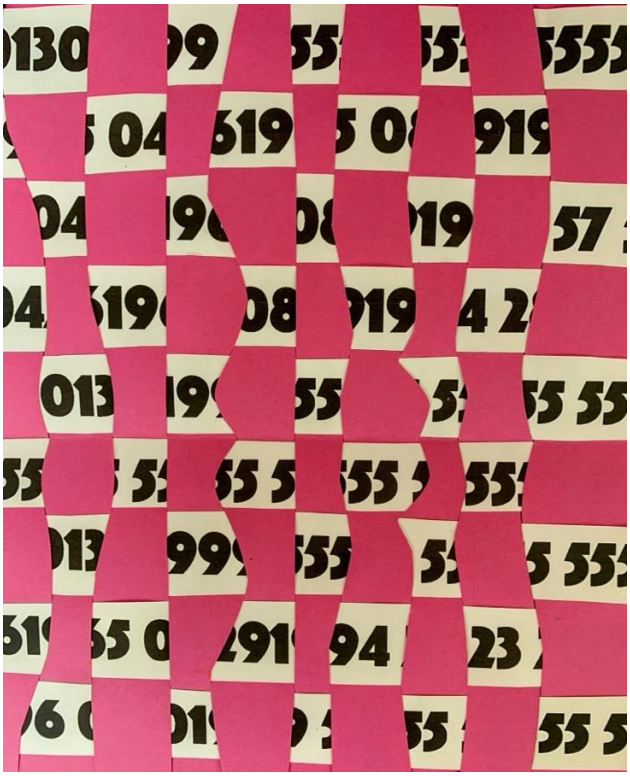

Figure 1. Woven Numbers Student Work

Selfie Robot Explorers - ***Doug Unplugged***, written and illustrated by Dan Yaccarino, 2016. After listening to this humorous technological tale, students discover that the best way to learn about the world is to go out and be in it. The teacher will ask if they could explore any city in the world, what city it would be and why. First, they will explore their chosen place online,-gathering information from research by responding to prompts. Next, they make sketches and draw their place on a piece of paper, referring to their research. Students engineer robots out of tin foil and found objects that represent themselves, and add the robot to their cityscape. This seed strategy features Technology, Art & Engineering and students will demonstrate an "understanding of art communities" (Hogan, et al., 2018) by learning about the art and life of the contemporary artist, Eric Joyner who makes art about robots.

Standards:

- VA:Cr1.2.3.a Apply knowledge of available resources, tools, and technologies to investigate personal ideas through the art-making process.
- 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- TS: 3.3 A student must apply digital tools and skills with creativity and innovation to express his/herself, construct knowledge, and develop products and processes.

Magnificent Machines - ***The Most Magnificent Thing***, written and illustrated by Ashley Spires, 2022. After listening to this story of determination and perspective, the teacher will ask students to think about a machine that could help them with daily tasks such as homework, making the bed, brushing

their teeth, and more. Then they will be asked to "envision, "engage and persist" while designing, sketching, doodling, brainstorming, and taking notes in their journals while conducting research online (Hogan, et al, 2018). The teacher will lead a discussion about how some designers create ways to help humans who have difficulty doing daily tasks on their own. Finally, students will build a model of their magnificent machine out of wood shapes and found objects. This seed strategy features Engineering, Art & Technology. The teacher will lead a discussion about how designers create ways to help humans who have difficulty doing daily tasks on their own. The contemporary artist connection is Arthur Ganson who is an inventor and makes moving sculptures that have a purpose.

Standards:

- VA:Cr1.1.3.a Elaborate on an imaginative idea.
- TS 3.3 A student must apply digital tools and skills with creativity and innovation to express his/herself, construct knowledge, and develop products and processes.
- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

Paper Engineer - *Rosie Revere, Engineer*, written by Andrea Beaty and illustrated by David Roberts, 2013. After listening to this story about overcoming failure, the students will be asked to recall a time when they overcame failure. The teacher will lead a discussion about the importance of trying things that are new and difficult ("engaging and persisting") and then charge the students with the difficult task of becoming paper engineers and fold a paper airplane (Hogan, et al., 2018). After experimenting, the teacher will lead in folding a paper airplane, focusing on geometric shapes and angles. Finally, they will decorate and add to their creations to make them their own. This seed strategy features Engineering, Math & Art. The contemporary artist connection is Jiangmei Wu, an interdisciplinary artist, making art and design projects out of paper that involve Engineering, Math and Science.

Standards:

- VA:Cr2.1.3.a Create personally satisfying artwork using a variety of artistic processes and materials.
- 3.G.A.1 Understand that shapes in different categories.
- 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Figure 2. Paper Engineer Student Work

Radiant Collage - *Radiant Child: The Story of Young Artist Jean-Michel Basquiat*, written and illustrated by Javaka Steptoe, 2016. After listening to this raw and authentic true story about the genuinely gifted artist Jean-Michel Basquiat who often used mathematical concepts in his work, students will create a mathematical collage. They will divide the paper into 12 sections using a ruler and then collage visual elements considering motifs and symbols that represent and "express" who they are and drawing inspiration from natural objects such as bones and shells (Hogan, et al., 2018). This seed strategy features Art, Math & Science. The contemporary artist connection is Jean-Michel Basquiat.

Standards:

- VA:Cr3.1.3.a Elaborate visual information by adding details in an artwork to enhance emerging meaning.
- 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3.MD.B.4. Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units-whole numbers, halves, or quarters.

Math Mission - *Math at the Art Museum*, written by Group Majoongmul and illustrated by Yun-ju Kim, 2015. After discovering how Math can be found and used in famous works of art by listening to this story, students will "engage and persist" to create a digital or actual 2-D work of art based on a mathematical concept they choose from a list (Hogan, et al., 2018). This seed strategy features Math, Art & Technology, and the contemporary artist's connection is Henry Segerman who is a mathematical artist who works mostly in 3-D geometry, topology and printing.

Standards:

- VA:Cr2.3.3.a Individually or collaboratively construct representations, diagrams, or maps of places that are part of everyday life.
- 3.OA.D.9 Identify arithmetic patterns (including patterns in the addition table or multiplication table), and explain them using properties of operations.
- TS: 3.1 A student must use digital tools and resources for problem solving and decision making.

Figure 3: Math Mission Student Work

Imagining Infinity - ***Infinity & Me***, written by Kate Hosford and illustrated by Gabi Swiatkowska, 2012. After listening to this infinitely incredible story about infinity that seeks to answer scientific questions and more, students will depict how they "envision" infinity on a Mobius strip (Hogan, et al., 2018). This seed strategy features Math, Art & Science. Yayoi Kusama is the contemporary artist connection who explores the idea of infinity in her work.

Standards:

- VA:Cr2.1.3.a Create personally satisfying artwork using a variety of artistic processes and materials.
- 3.G.A.1 Reason with shapes and their attributes.
- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

Integrating the visual arts in science and science in the visual art has the capacity to pave the way for a more complete approach to how humans engage and interact with the world. Picture artists and scientists working together to address the current and emerging global issues. Memorizing facts and

figures is not enough for creative (and collaborative) problem-solving that real world issues require. Meaningful opportunities to think divergently and creatively across disciplines are necessary in today's world. These opportunities will pay dividends where everyone benefits as they come well-equipped to help create a better tomorrow. The ten resourceful STEAM picture books shared in this article inspire and cultivate creativity in art and science classrooms. The multimodal ensembles also provide opportunities to nurture Studio Habits of Mind, teaching children to think like artists and develop skills as problem finders and problem-solvers applicable to Art, Science, Math, Technology, and Engineering. Picture books are sophisticated in approach and subject matter, and relatable at the same time. Students will be afforded opportunities and taught skills to peel back many layers to reveal and recognize the nuances and relationships of the content and make substantive personal, powerful STEAM connections and real-life applications.

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