The STEAM Journal

Volume 4
Issue 1 *Metaphorical Cities*

Article 11

December 2019

Lessons in Process: Similarities between Scientific and Artistic Creative Practice

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STEAM is a bi-annual journal published by the Claremont Colleges Library | ISSN 2327-2074 | http://scholarship.claremont.edu/steam

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Abstract

This paper describes the similarities between scientific and artistic processes and explains why both are valuable in the STEAM classroom. This is important because students who understand that struggle is an inherent part of process develop growth mindsets and become better learners. The paper explores the connections between STEM and art. STEAM educators use the experiences of great scientists and artists, along with students personal experiences working through creative process to guide students to understand that learning is an experience. The best learning happens when we persist through challenges.

Keywords

art, science, education, STEM, STEAM, process, growth mindset

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The act of producing is inherently a process. For both artists and scientists, whether they consciously spend time thinking about process or not, it is the foundation of great, and not-so great discoveries. STEAM educators have the opportunity to teach students about process - its inherent challenges and moments of growth. By thinking about process, students will find that no matter where their curiosities lie, learning is an experience, that takes patience, practice, and active participation.

As a science educator and an artist, I've been fascinated by the idea of process for years. In art, it isn't the clean, perfected works of art that intrigue me, but the slightly messy ones that give hints about how they were made: paintings with thick, expressive brushwork; behind the scenes videos; and sculptures and mixed media that use found objects that manifest their history. In science too, I've most loved reading the history of great scientists and their discoveries. For every eureka moment, there has been a well-prepared mind to make sense of that discovery. Leonardo Da Vinci's creative processes are visible on the pages of his notebooks (British Library). In Marie Curie's life, scientific discoveries are intertwined with personal and political struggles (Des Jardins, 2011).

Process matters to STEAM educators because a student's ability to make mistakes and learn from them is critical. (Hong, & Lin-Siegler, 2012). We can consider this through the lens of psychologist Carol Dweck's mindsets. Learners with a *fixed mindset* believe that intelligence and ability levels are immutable and unchanging. Those with a *growth mindset* see learning as the result of effort, and believe talents and ability levels can grow (2016). Students with a growth mindset are more successful learners (Dweck, 2016). When students understand that motivation

and effort are integral parts of education, they are more likely to succeed (Lin-Siegler et al., 2016). In the study by Hong and Lin-Siegler (2012) students who read a history of a famous scientist that focuses on struggle over achievement were more interested in the subject of science, had improved recall, and improved their abilities to solve complex problems. Exposure to an example of a famous scientist with a growth mindset helped students to develop a growth mindset themselves (Lin-Siegler et al., 2016). Students must learn persistence, because when a task becomes challenging, they cannot rely solely on ability.

In The Art of Scientific Investigation, an older book with a very modern take on the creative process of science, Beveridge offers some gems to consider when thinking about the processes of STEAM learning. Consider the importance of chance and intuition, "a good maxim for the research man is 'look out for the unexpected'' (Beveridge, 1957). Science is not just about dry facts, but the creative ability to put facts together in new ways, "Facts and ideas are dead in themselves and it is the imagination that gives life to them. But dreams and speculations are idle fantasies unless reason turns them to useful purpose" (Beveridge, 1957). Educators can use these ideas to inspire students to be careful observers who are motivated by their own curiosity.

We generally say that artists create, but scientists discover. Artistic creativity seems like the more subjective process that makes something that had never existed before. In science, researchers discover and make sense of objects or facts that already exist (Weisberg, 2006). But there is more similarity between the two processes than one might think. Both artistic and scientific processes are creative pursuits. The evolution of human creativity has its roots in human survival. It was our big brains that led to problem solving, tool making, and social complexity (Lefebvre, 2013; Hare, 2011). If we consider science to be a planned, rigorous series

of tests, one could argue that our pre-literate, prehistoric ancestors were not doing science, per se, but they certainly were engaging in a process of observation and discovery. It has been suggested that even the arts, our aesthetic abilities to imagine images and scenes not immediately in front of us, stems from a neolithic need to collaboratively envision and plan complicated actions like collective hunts (Ramirez, 2009).

If problem-solving is innate, how can teachers guide students to work through the struggles of learning? Setting the expectation that learning takes effort, and all of us can become better learners is the first step. When artists and scientists go through the process of doing their work, they embark on similar paths. Artists are struck by an idea, gather information, and reflect. They test ideas, and work on details, and then find a way to share their work with the outside world, taking in feedback and separating themselves from their creation (Botella, et al. 2013). By making art, students develop critical thinking skills like looking past preconceptions and envisioning new solutions (Weiner & Hetland, 2008).

Whether you consider the rigidly systematic Scientific Method as taught in schools (observe, develop a question, devise a hypothesis, conduct an experiment, analyze data, express conclusions, and generate new questions) or a more fluid system of scientific inquiry, it is possible to see that both artistic and scientific processes share similar steps: observation, questioning, testing, and a sharing or communicating of ideas. In both art and science, and many other subjects, the process of learning involves challenges and failures. Students with a growth mindset find learning in the failures and develop the persistence to keep working. The scientific process has more cognitive, rigid structures, and for some artists their work comes from emotional places. For the STEAM educator, there is value in finding overlap between the two subjects, and in relishing their differences.

Scientific and artistic processes have similarities, but are not the same. Both types of creativity spring from intelligent minds that make connections between ideas and synthesize information in new ways. But the artist has more room for freedom and creativity in their work - their tools are suggestive, emotional, and can be abstract. Scientists have a more rigorous path, they rely on logic, clarity, and evidence (Simonton, 2008). Educators can use both creative processes to show students that learning itself is a process. Learning can be a struggle. But we learn more if we persist through the process (Lin-Siegler et al., 2016). Scientists and artists work in similar ways; STEAM educators and STEAM learners have the opportunity to bring these processes together - through trial, error, and trying again.

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