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Reconciling the Divide: Common Processes in Science and Arts Education

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Abstract
Many see the sciences and arts as two distinct fields – one objective the other subjective; however, we see the two having more in common than different. These commonalities formed the basis for a STEAM framework, which examines the intersections of five processes: noticing, wondering, visualizing, exploring, and communicating. This framed a professional development workshop on STEAM for elementary teachers. Here we define and explore these processes through both science and art perspectives, and share examples of how each of these processes were integrated to support learning. We believe that STEAM provides a well-rounded experience, allowing learners to make connections with both their minds and bodies, which ultimately enhances their learning experience.

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Keywords
science, art, professional development, STEAM, integration

Reconciling the Divide: Common Processes in Science and Arts Education

Lori A. Fulton & Jamie Simpson-Steele

Some see the sciences and arts as two distinct fields – the sciences providing an objective view of the world while the arts provide a subjective one. However, we believe the two are complimentary, with a goal of developing critical citizens who can meet the untold demands of the future. That future requires creative thinkers who can think in novel ways (Partnership for 21st Century Learning, 2011; Zhao, 2012). An education rich in both science and the arts sets the foundation for the development of such thinkers (Gurnon, Voss-Andreae, & Stanley, 2013; Root-Bernstein & Root-Bernstein, 2013).

While the integration of Science, Technology, Engineering, Arts and Mathematics (STEAM) is becoming more commonplace, what does it mean to integrate the disciplines in an elementary classroom? As teacher educators from different disciplines, one from the field of science education and one from the field of arts education, we explored how we view the world and the processes we engage with in order to understand this further. We began with the fields we know best, science and the arts, and then addressed other STEAM areas. We realized that while we may look at the world from diverse perspectives, the processes we engaged in are more similar than different. In this article, we focus on intersections of science and the arts and we present a framework to integrate STEAM in the elementary classroom.

Reconciling the Divide

The integration of the arts and science calls to mind noteworthy individuals who saw the world through both lenses. Albert Einstein, although best known for his Theory of Relativity, was also a violinist. He talked about the importance music played in helping him become a creative thinker, resulting in ideas that were intuitive and expressive as well as logical. Likewise,

Leonardo da Vinci, renowned for his artwork, had scientific interests. To understand and represent the human body in his artwork, he conducted autopsies and included details of the muscles in his sketchbooks - bringing anatomy to his art. Finally, consider a contemporary innovator, Steve Jobs. While he provided technological tools, it was his recognition of the design element that propelled his product to be so desirable. Jobs credited a calligraphy class he took in college that allowed him to consider the beautiful, artistic side of the world not often captured in science.

These individuals defy the practicalities of reality to create something great (Root-Berstein & Root-Berstein, 2013). This is the basis for STEAM – to go beyond what we can accomplish in one area alone, to innovate through the integration of STEM and the arts. In the classroom, STEAM leads to more engaging and meaningful experiences than learning in a single content area can render (Gurnon et al., 2013).

A Framework for STEAM

We see an alignment between the processes of science and art – both requiring discovery, observation, experimentation, description, interpretation, analysis, and evaluation. Based on our understandings, we developed a framework highlighting these common processes (Table 1), while respecting the differences in how these processes manifest in each.

Table 1

Common Processes in the Sciences and Arts

In the Sciences…	Common Processes	In the Arts…
Data collection	**Noticing**	Observation
Curiosity	**Wondering**	Imagination
Experimentation	**Exploring**	Rehearsal
Design	**Visualizing**	Composition
Explanation	**Communicating**	Performance/Exhibition

This theoretical framework provided the foundation for professional development experiences in which elementary teachers engaged with STEAM to develop a deeper understanding of the disciplines and how to implement them in a classroom. To expand upon this framework, we explore examples of what these intersecting practices look like as integrated teaching and learning.

Learners **notice** the world around them. In the sciences, this means collecting data, informally or formally, to understand how the world works. In the arts, this means closely observing behaviors and phenomena to recreate and represent them through the arts. In the workshop, teachers observed plants in the garden. Then, using visual arts techniques, they drew the leaves several times, using contour drawing, gesture drawing, and pastels. By examining the leaves closely, they learned about the shapes, sizes, and colors as well as what classifies a leaf as simple or compound. Teachers applied the elements of visual arts including line, shape, texture and color, to notice the properties and patterns of leaves (see Figure 1).

Figure 1. Learners compare and contrast different types of leaves using techniques of visual arts.

Learners **wonder** how the world works. Scientists ask questions, explore concepts, and cultivate curiosity. Artists improvise scenarios, imagine narratives, and generate images in the mind's eye. In our integrated example, learners explored the meaning of potential and kinetic energy through creative movement, using variations of dance elements to express ideas, such as waves in the ocean or blades on a windmill.

What's more, learners **visualize** ideas to make meaning. In the sciences, we design experiments or create models to think about the best solution to a problem. In the arts, we create visual and performed compositions to make abstract meanings concrete. In their work with us, teachers first experimented with simple machines and how they help us do work. Using dance, they explored how simple machines moved by creating a sequence of three shapes (see Figure 2). Finally, they designed a simple machine that would help them solve a problem they encountered (i.e., lifting a heavy object). Using the principles of dance, the teachers used their bodies to visualize their machine before building their model.

Figure 2. Learners created a sequence of shapes using their bodies to explore simple machines.

Furthermore, learners **explore** why things are the way they are or how they could be. Scientists conduct experiments to explore their world; artists explore through rehearsal, using trial and error to bring them closer to the idea they want to express. Our participants explored what plants need in order to grow (i.e., light vs. dark) and based on observations and results, identified stages of growth and needs of a plant. They tried using multiple musical instruments with varying timbre, dynamic, and pitch to represent their observations. They ultimately chose one instrument to create a sequence of sounds and patterns to represent the growth cycle.

Finally, learners must **communicate** what they understand. In the sciences, explanations are constructed and scientists argue with one another based on evidence. In the arts this may look like an exhibition or a performance, often with a critical response from audience members. For example, teachers studying the impact humans have on the world, sorted through bags of trash and found a high percentage of plastic waste. They recorded this data and then graphed it using strip graphs, bar graphs, and circle graphs. We introduced the teachers to two drama

strategies – Tableaux [or frozen body shapes that depict a "living picture" of a moment in time or a concept] and Town Meeting [in which participants role-play in an improvised meeting of community members looking at all sides of an issue]. Through these drama strategies, the teachers, as learners, argued a particular perspective assigned to them; they explored the impact a ban on single-use plastics would have on people with varying interests (such as small business owners, families or environmentalists). They developed a mission statement to gain perspective, and communicated that through a Tableau. Then, using the data they had collected and information gained from research, they took part in a Town Meeting to debate how such a ban would impact their group. The role-play encouraged them to explore and understand the impact their choices have on the environment through a dramatic framework that required them to think and speak through character perspective. Finally, groups created an assemblage of trash to convey the impact humans can have on the world (see Figure 3); demonstrating their ability to use repetition, balance and harmony – principles of visual arts.

Figure 3. Learners created a trash assemblage to communicate a message.

Conclusion

Even though one might think of the sciences and arts as opposites, they have much in common, and teaching them together can help learners make meaningful connections, by

promoting engagement with ideas rather than teaching of concepts (Pugh & Girod, 2007). Although the common processes we have defined might imply a linear progression, we believe that the processes could occur in any order that is meaningful, sometimes employing multiple processes at the same time or independent of one another. The idea is to recognize that both scientists and artists engage in similar practices and help learners make connections so they can access a range of possibilities for understanding and communicating about their world.

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