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# Full STEAM Ahead: Creativity in Excellent STEM Teaching Practices


## Abstract

This article emphasizes the value of creativity and arts-based learning in the sciences (STEAM education), using one example from a recent research study of creative and effective classroom teachers. The future of innovative thinking in STEM disciplines relies on breaking down the distinction between disciplines traditionally seen as "creative" like the arts or music, and STEM disciplines traditionally seen as more rigid or logical-mathematical (Catterall, 2002). The most exceptional thinkers in fields like science or math are also highly creative individuals who are deeply influenced by an interest in, and knowledge of, music, the arts and similar areas (Caper, 1996; Root-Bernstein, 2003; Dail, 2013; Eger, 2013). In light of this, STEAM must become an essential paradigm for creative and artistically infused teaching and learning in the sciences. I recently conducted a study of creative teaching practices among highly effective teachers (winners/finalists of the National Teacher of the Year program). This article looks at a single case drawn from this study, and considers the arts-based science teaching/learning employed by one of these teachers, Michael Geisen, the 2008 National Teacher of the Year award winner, and a middle school science teacher.



## Keywords

transdisciplinary thinking, creativity, STEAM, STEM disciplines, arts-based learning, creative teaching, science, art



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## Cover Page Footnote

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# Full STEAM Ahead: Creativity in Excellent STEM Teaching Practices

*Danah Henriksen*

The value of the arts in STEM disciplines has long been recognized. Pythagoras characterized his fellow mathematicians with the comment, "we are poets" (Riley, 2012, p. 31) – and Max Planck, the father of quantum theory, commented that pioneer scientists must have "a vivid intuitive imagination, for new ideas are not generated by deduction, but by artistically creative imagination" (Planck, 1950, p.109). In the historical accounts of many great scientists and mathematicians, it is clear that the boundaries between art and science or music and math are more fluid than conventional learning paradigms suggest (Root-Bernstein, 1999; Shlain, 1991). As the readers and editors of this journal understand and appreciate, the field of education must begin to exemplify this boundary-breaking reality through the tenets of a STEAM, rather than a STEM approach.

The multifaceted issues and complex problems served by scientific thinkers today require 21st century professionals who go beyond disciplinary content, and are also creative thinkers who can work between disciplines (Mishra, et al., 2013; The Partnership for 21st Century Skills, 2007). Teaching and learning that connects the arts and sciences is essential, because historical evidence demonstrates that these connections are already innate for the most effective and innovative STEM practitioners (Mishra, Henriksen, & the Deep-Play Research Group, 2012; Root-Bernstein, 1999).

Yet, arts-infused instruction in STEM disciplines is often times not the norm in the U.S. educational system, and educational policies often make it difficult for teachers to teach this way without deviating from standards-driven curriculum (Fusarelli, 2004).

The future of innovative thinking in STEM disciplines relies on breaking down the distinction between disciplines traditionally seen as "creative" like the arts or music, and STEM disciplines traditionally seen as more rigid or logical-mathematical (Catterall, 2002). The most exceptional thinkers in fields like science or math are highly creative people across disciplines, who are deeply influenced by an interest in, and knowledge of, music, the arts and more (Caper, 1996; Dail, 2013; Eger, 2013; Root-Bernstein, 2003).

In light of this, STEAM has become an essential paradigm for creative and artistically infused teaching and learning in STEM disciplines. The Deep-Play Research

Group (a group I work with at Michigan State University) focuses on creativity and trans-disciplinary thinking. A recent study I conducted there focused on creative teaching practices among exceptional teachers, specifically through in-depth interviews with teachers who had received the National Teacher of the Year award (Henriksen, 2011; Henriksen & Mishra, 2013). Some key findings of this study indicated that arts-based teaching leads to more motivated, engaged, and effective disciplinary learning in STEM areas. Student achievement was increased through these arts-based practices. More importantly, students not only strengthened their learning within the disciplines, but between disciplines through the opportunity to explore and make connections between art, music, mathematics, science, and more. In this paper, I provide a brief case study of one National Teacher winner, Michael Geisen, to show how arts-based STEM teaching can be conducted.

**Example in Action: A Case of Arts-Based Teaching**

Mr. Geisen, the 2008 National Teacher of the Year recipient and a middle school science teacher in Oregon, has an intrinsically arts-based view of teaching in the sciences. During my conversation with him, the blending of art and science that is integral to his teaching philosophy was clear. As he noted,

> Most people tend to simply equate creativity with a particular art form. If you can draw, you're creative. Or if you're musical, then you're creative. But it's much more broad than that…the best scientists are highly creative. The best mathematicians are extremely creative.

Mr. Geisen's artistic personal interests and avocations play a major role in his thought processes, both within and outside of the classroom. He is a musician who plays guitar and piano, is interested in the visual arts (drawing, sketching, graphic arts), and he is a serious amateur photographer who has worked both in his own darkroom and with digital photography. He frequently carries these interests over into the classroom to teach science concepts in a way that connects the arts and STEM disciplines.

For instance, Mr. Geisen sometimes has his students create visual advertisements to describe a science idea, or a concept, organism, and so on. He described this as relatively simple visual arts work with science concepts, in which students design combinations of images, concepts, text, etc., to communicate a science idea:

> For example, the idea might be for cell parts, the difference between plant and animal cells. That's one of the standards we teach…so I have students create an advertisement, trying to sell cell parts that plant cells have that animal cells don't have. For instance, chloroplasts for photosynthesis. Animals don't have them, but what if you could sell those to an animal cell? How would you approach that? How would you try and convince an animal cell that it needs chloroplasts? Or a cell wall? Animal cells don't have them, but why would it be beneficial?

This type of an activity is one (of many) interesting examples of the benefits of STEAM-based learning. Students learn the content in more engaging and meaningful ways, while also strengthening their disciplinary knowledge across another domain (in this lesson example, graphic arts/design/advertising). The result is that the two subject matters strengthen each other in a learning scenario with trans-disciplinary connections. As Mr. Geisen framed it,

> Ultimately, what students will gain from your class is not necessarily only the content knowledge or the concepts. Often times, it's also how you approach it; that's where they will pull away those bigger lessons that they will take into the real world, which is pretty essential in this day and age.

His teaching practices incorporate a variety of approaches that draw different aspects of the arts into the science classroom. Mr. Geisen sometimes uses his musical interests and skills to write songs about science concepts for his students, as a technique that is "fun and creative and a good way to review". Or, he draws upon theatre techniques that help his students understand science concepts through embodied cognition or empathy:

> We do a lot of theater and kinesthetic movement, where students might represent different creatures in an ecosystem or they might represent different elementary particles in an atom…they're moving and demonstrating what they know or coming up with their own little science theater pieces.

Ultimately, one of his key goals in implementing many of these STEAM-based approaches, is not only to help teach the scientific concepts more fully, but also to have students work and think across the arts and sciences, inspiring them to be more divergent, creative thinkers across disciplines. As he noted, "ultimately that's my real goal – to show them some of these creative ideas that I might come up with, and then allow them to create their own."

Mr. Geisen's description of teaching with the arts in a science classroom cuts to the core of how STEAM methods can translate into powerful learning experiences. In his classroom, the results of this arts-based approach has meant better science achievement scores, but also that his students are excited about science; they are more motivated and curious about the discipline as they head to high school. He described the measurable impact:

> One of the things that I feel really strongly about is that our science scores have been steadily going up and up over the last several years, but what I'm more excited about is the fact that kids are actually coming out of our middle school excited about science, and enjoying it and wanting to learn more. We met with our high school teachers and they said it's a huge difference, that eight or 10 years ago kids would come to the high school and walk into science class and look at that science teacher and say, "I hate you. I hate science." But now they come in and not only do they have some skills and some knowledge to go with it, but they're excited about learning science because it's cool.

**Conclusion**

As we move into a complex 21st century world, it is clear that STEM disciplines can benefit from an artistic infusion that connects disciplines in ways that are powerful and motivating for learning. Yet, U.S. educational policy has increasingly and unfortunately tended to devalue the arts in education overall. In the city of Lansing, Michigan, recent education cuts have included the loss of close to 90 teachers, almost all from music, art, and physical education. This situation is not uncommon; it has been occurring in recent years in K-12 education nationally (Caughlan, 2008; Heilig, Cole & Aguilar, 2010; Leachman, Williams & Johnson, 2011; Neimark, 2013; Picus & Odden, 2011; Sabol, 2013). Mr. Geisen also reflected on a similar situation in his district in commenting on the benefits of arts integration in science:

> It involves integrating a lot, and it does take time…but I think it teaches science in a more effective way. And we (the district) don't have an art program anymore. It was cut several years ago. So we've got to do this in our core classes or it doesn't happen.

His concern as a science teacher, over the cutting of arts programs, is significant. Though traditional classrooms and policies have sequestered the STEM disciplines, it is clear that excellent STEM thinking needs the arts. This is clear not only in this example of Mr.

Geisen's science teaching, but as an inherent aspect of great scientific minds (Shlain, 1991). Leonardo Da Vinci affected the course of human knowledge by combining art and science, aesthetics and engineering; such polymathic blending of disciplines is needed from the next generation of creative STEM professionals (Shneiderman, 2003). In keeping with the tenets of STEAM education, policymakers might heed the words of the great scientist and science educator Carl Sagan, "it is the tension between creativity and skepticism that has produced the stunning and unexpected findings of science" (Sagan, 1986, p.73).

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