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Abstract

This article traces a history of STEM and STEAM from the perspective of someone involved in arts integration research for the last 35 years, and proposes a vision for the next steps. It also provides an assessment of the risks inherent in current trends of STEAM roll-out in schools, from the lack of resources for professional development to the burgeoning market in STEAM kits and activity books that do not lead to the original learning goals of STEAM.

Author/Artist Bio

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Keywords

STEAM, STEM, creativity research, arts integration, NELS data

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The Past and Future of STEM and STEAM, from an inadvertent insider

Lisa Catterall

The Program for International Student Assessment. Terrifying words. People who have the power to fund education love Big Data. Meaning, they love test scores!

The Program for International Student Assessment is a body whose goal is to mathematically compare the achievements of fifteen-year-olds in sixty-five developed nations around the world. Throughout the history of the United States of America, and the history of the tests, we've ranked somewhere in the middle of the pack when it comes to science and mathematics. No one paid much attention to this statistic, after all, Americans are hard-working and innovative. Why should we care what some test says? But in the mid-nineties, the word got out. And of course, got media attention. Why aren't we first?? We're *Americans*, darn it. Never mind that we are the clear leaders in actually publishing meaningful science in juried journals, or that we did invent the SmartPhone, and blue jeans, and many other things that have been taken-up by the global community with great enthusiasm and economic gain.

Thus began a long conversation about STEM, or Science, Technology, Engineering, and Mathematics. Fun fact: the acronym was originally SMET, but "SMET" was found to be pretty hard to rally-around.

If there was any part of the STEM conversation that rang true and continues to do so today, it's that there wasn't, and isn't, equitable opportunities to engage in STEM across our school systems. All students are not given equal opportunities to experience STEM subjects during their school years. Moreover, students who want to pursue higher learning in STEM fields encounter deep institutional bias. Last year, the percentage of engineering degrees awarded to women fell

from 19% to 18%. This number is abysmal, and headed in the wrong direction, especially for majors representing four of the top five highest-paid degrees. Finally, at the elementary level, homeroom teachers in America tend to be language arts specialists, and at the middle school level, even specialist teachers were really not teaching the “E” in STEM at all (engineering). For younger students, the “E” in STEM has never really been part of the traditional cannon.

This problem was addressed by funding, which was soon taken-away for “underperforming” schools through the 2002 *No Child Left Behind* act. Still, if your child’s school today has a computer lab and your child gets-to play in there weekly in some way, that opportunity originated alongside the first conversations to address America’s perceived deficit in STEM subjects.

In 1993, my father and I were sitting in his new hot-tub in Topanga Canyon, California, sipping beer and talking about data. This was a frequent topic of conversation for us, right up until his untimely death last month. Throughout my teenage years, he was involved in a project that brought artists to schools all over the country to show teachers how to use the four arts domains (dance, theatre, music and visual art) to create engaging lessons about history, science, and math. Instead of babysitting for pocket money, I got paid to sit in his office at UCLA and enter test scores into a rudimentary version of Microsoft Excel to look for patterns and gains in his education research projects.

Back to the hot tub. 1993 saw the deepest cuts to arts education in the US since art had been funded in the first place. We were very upset over this. As we mulled it over, we came up with the question, *how do you convince law-makers that the arts are important in school?* This was clearly the critical question about saving art in school. Teachers see the magic of art in the

classroom every day, but how could you translate that into something really convincing to those in charge?

The answer had to come from Big Data. At that time, schools across the nation were involved in a study that aimed to represent complete data packages on students who were representative of all Americans, from eighth grade through entering the work force. The National Center for Education Statistics was just collecting data over twelve years, for 12,000 students. Anyone could use the data; the survey described their socio-economics, their schools, their grades, their class choices, their afterschool activities, and even their community involvement. It was called the NELS:88, because it started in 1988, and in 1993 some big data was about to be collected as the students in the study were getting ready to decide whether to go to college.

Sitting in the hot tub, I watched Dad have a sudden epiphany. How can we show lawmakers the importance of art in school? “We could use the NELS: 88 data! THAT’S EXACTLY WHAT IT SHOULD BE FOR!” He was gleeful about this plan.

The plan turned into a publication, which turned into a book, which turned into a career. Three years ago I was studying for my Masters’ degree, and found myself going over textbooks on the brain science behind learning that included multiple references to his work on the importance of integrating art into academics.

His lightbulb popped about using the NELS data when he was busy hiring artists to show elementary and middle school teachers how to teach science infused with art techniques. Eventually, people took this work and other work, and began calling it STEAM. Science, Technology, Engineering, Art, and Mathematics.

There are still two schools of thought about why STEAM is important. One is that we should be doing it because it leads to innovation, which leads to a strong economy. This thought

path, just like using the NELS data to prove art makes people better citizens, is an easy sell. In China, they are grasping all the expertise they can concerning STEAM education because they believe it will allow the labels of the future to say “invented in China” rather than “made in China.” It’s a cash cow, having your citizenry trained via STEAM!

A more interesting way to look at, or justify, building STEAM programs in schools is that STEAM modes of learning actually make students more creative, and more empathetic. Creativity, and empathy, lead to happiness. Who cares about the money? Educators working on the ground, in classrooms, tend to take this view. Clearly, education is not a field travelled by people who are mainly interested in money.

WHOA! Where does empathy come into this?

It’s true. The same brain pathways that light up when students feel empathy light up when students are using art in school.

On December 15, 2015, President Obama signed the *Every Student Succeeds* act into law. The law includes mandates, and funding, to provide STEAM education in schools. My masters’ degree cohort from 2015 included four teachers who were at “STEAM-mandated” schools. *Not one of them knew how to do it.* They had been provided with no professional development, no training, and no way of implementing STEAM. They had no idea what it even meant to them on a daily basis.

Now, the idea of STEAM is certainly being taken-up by those wanting to sell kits, or books, or robots, or blog-advertising, and recently, certificates for graduates (San Diego State now offers a certificate in STEAM; there are actually three graduate level classes involved).

I had no idea, five years ago, that building a STEAM program was something no one knew how to do. I grew-up steeped in the concept, and it seemed obvious to me. I had spent six years

before that in a classroom watching what types of projects produced creative excitement and gave the kids juice for learning. I wanted to try building curriculum that worked with the natural creative propensity of the ages of students in the room. I started with a group of my colleagues' children in a summer camp, and an old locker room on our campus, and we got to work inventing exciting projects. The advent of the Makers' Movement was inspiring to the effort. Today, we have successful STEAM programs for 3rd-8th graders.

As I'm watching STEAM education pop-up everywhere, I'm concerned about the loss of the original goals of pure creativity, if not happiness in the classroom, as teachers are bogged down with multiple demands to implement trendy new things. I see people making money on kits in which the entire class ends-up building virtually the same project. I see robotics systems that allow students to create code, with only a few options, and coding websites that look remarkably like video games. This isn't really STEAM, and it certainly is not creative. I see blogs, books, and websites with "STEAM" projects that are easy for teachers to access, but do nothing to build equity and identity in students being offered the experience. The original motivators for STEM are even missing in the curricula cropping-up everywhere.

When students are allowed to express their own individual creativity and what is really true for them through their work, they begin to identify with it. The true magic of STEAM education is that it allows all students to identify with science, technology, engineering, and mathematics. It takes those subjects out of the deep dark closet of incomprehensible textbooks, role models with no resemblance to any role any kid would want to play, and in the worst and darkest part of that closet, feelings of deep inadequacy. If a child can build a project using motion and engineering that expresses something about themselves and their personal context, they have suddenly discovered their inner engineer. If they can use the concept of fractions to choreograph a dance

that shows something about how they feel inside, they will learn that math can be creative and exciting. STEAM can do that.

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