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Cases on STEAM Education in Practice

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INTRODUCTION

Why use the form Science, Technology, Engineering, Arts, and Mathematics (STEAM) when its professional name is transdisciplinary teaching? First, yes, it is transdisciplinary teaching and what we have found in groups outside of education is a "glazed-eye" when using the formal education terminology. To us, that means the terminology matters if we want practices in schools to be understood by the broader community. While groups of non-educators may not know what STEAM teaching is they do seem to understand it when it is described. Second, we also work with the business community often. They too, find the words transdisciplinary teaching meaningless and confer the dubious title of "education jargon" on the practice. This seems to set up a bias toward transdisciplinary teaching. Again, when we use the word STEAM and describe it the response is far more positive.

The book that Judy Bazler and I edited has many chapters that describe practices that the authors have conducted (or are conducting) in their classrooms that illustrate STEAM teaching practices. In our book, we note:

STEAM is a teaching model that is emerging in the United States through initiatives which focus on a perceived global need for individuals skilled in utilizing both divergent and convergent thinking. The reasoning behind these initiatives may be related to U.S. economic strategy, namely the need to continue the high rate of patents in the U.S. People in the U.S. invent the next generation of product and the remainder of the world buys the patent(s) and produces the good(s). However, the rate at which other countries are producing patents is increasing while the rate at which the U.S. is creating patents is decreasing (Bazler and Van Sickle, 2017, p. xviii)**.**

In education, historically, the term STEM was initiated when discussions about the lack of career ready students from the U.S. for high-tech jobs became the norm (Jolly, 2014). Many jobs in the U.S. that use science and mathematics knowledge, combined with the ability to integrate and apply that knowledge in fields such as technology and engineering are the new norm. To integrate the knowledge across disciplines, critical thinking, creativity, communication, entrepreneurship, and collaboration are all skills needed. Thus, the power of STEM was deemed to be higher learning outcomes through the integration of the disciplines versus separating the disciplines.

WHY ADD THE "A" TO STEM

Changing the model from Science, Technology, Engineering, and Mathematics (STEM) to STEAM focusses on challenges a person's internal challenges are a dialogue between the eyes, mind and hands of a student. In our book, we note:

> STEAM fully integrates the arts to give students opportunities to employ critical thinking, creativity and communication in new ways by pulling elements of each and using them in a cross-cutting manner. For example, the general concept of design is a feature of all the disciplines. How design is used in each varies to a degree, but equally sets criteria for all the work produced. If one takes the design principle of "space" then the manner in which space is used in all the disciplines becomes the criteria for the lesson. An example across the disciplines in the design of a product could be, math: area, science: scale, engineering: dimensions or "fit", technology: graphic positioning, and art: perspective. Each discipline is using space within the lesson and each use is important to the outcome (Bazler and Van Sickle, 2017, p. xiv)**.**

> STEAM as an integrated approach to teaching has many merits in the form of discipline specific content in particular (Maeda, 2012, Pomeroy, 2012, Jolly, 2014) and we are using a visual metaphor: that one is teaching using capital and non-capital letters to illustrate which is considered the leading content. "Thus, steAm would be the teaching model where art for art's sake is the leader. Mathematics teachers approach to such a lesson is steaM, technology teachers focus on sTeam, engineering teachers model stEam, and finally, science teachers would use Steam (Bazler and Van Sickle, 2017, p. xxi)**.**

Thus, we have a visual metaphor for each of the disciplines being the lead for a lesson. While the editors of this book propone that individualism is a highly regarded social value in the U.S. approaches in a classroom that a teacher might choose to address a personalized approach *begin* with a lesson plan. The intent of this session is to talk about STEAM teaching as a way to reach the largest number of students in a class. The aesthetic beauty is in allowing each child to enter the study through their love/strength and yet ultimately attain all the goals or standards of a lesson.

> Sizer, (1996) notes that students learn differently because they are different and they grow more distinctive as they mature. An early work in educational learning theory, Vygotsky (1928) noted, because students cannot begin at the same place, they cannot end at the same place, no matter how intentional or well-designed their school may be. Thus, we note, "the general pattern is that high scoring students often have a reason to learn more academic material, students scoring in the middle may see no obvious reason for focusing their mental energy on class work, and students scoring at the bottom often have a long history of school failure. It seems that success generates success and that learning is often based on the individual (Bazler and Van Sickle, 2017, p. xxi)**."**

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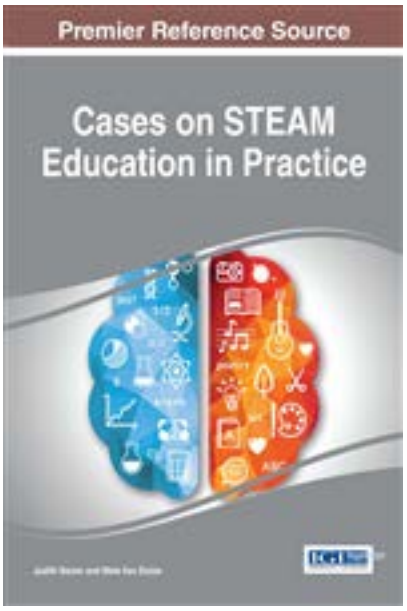
A THINKING MODEL FOR TEACHING USING A STEAM APPROACH TO TEACHING

The following is a list of ideas that become clear about the STEAM teaching practices as you read through our book.



- Profound acts of care require the teacher to reveal his or her own vulnerability.
- The teacher positions the materials and the students in physical spaces so that an effect can be accomplished.
- The teacher is the translator. The teacher using a growth mindset establishes a connection and interaction when teaching. These connections and interactions are based on the belief that the students can and will learn.
- If we teach mostly through talking, telling, and reading we lose or marginalize, at a minimum, 20% of the students.
- The teacher must constantly communicate that her or his students are expected to engage with and deeply explore a concept.
- It takes a lot of noticing to develop a good question.
- It is important to ensure students understand the importance of persistence.
- Students claim to want instant success but brain science shows us that hard work creates a larger pleasure effect. Remember to say you're not there yet.
- Through practice understanding occurs.
- Context is essential.
- Make sure the language you are using does not seem foreign (like reading a page from a technical manual) and is relevant to the lives of the children.
- Flow happens in a classroom. Flow happens when emotions are aligned with the challenge at hand.

- The creative process is not linear, inorganic, or prescriptive. Creativity does spiral outward through chaos and cacophony. The result of the process is not always harmonious.

We believe that the STEAM process requires: Creative problem solving, Critical thinking, Communication, Collaboration, Critique (that is Caring), and GRIT (perseverance and hard work).

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