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Creating STEAM with Design Thinking: Beyond STEM and Arts Integration

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Abstract

This article suggests the value in a broad view of STEAM beyond arts-integration, as well as the potential of design thinking for STEAM. Despite much interest in STEAM it is often challenging for many teachers to integrate into their teaching of school subject matter. I suggest that as an interdisciplinary crossroads, design thinking provides a natural bridge between the arts, sciences, and other subjects. In this it can offer guiding flexible structure and in-road for teachers to design STEAM-based lessons, and to incorporate as an integrated aspect of students' STEAM learning. I discuss an example of an elementary Spanish teacher, who, as a student in a graduate-level design thinking and education course, used design thinking to design an interdisciplinary STEAM project for her students. This example illustrates how design thinking can guide teachers' STEAM curriculum design, and be interwoven into elements of STEAM curricula, to open up more interdisciplinary, creative and project-based opportunities.

Keywords

design thinking, STEAM, creativity, interdisciplinary teaching, teaching practices, real-world learning, project-based learning

Cover Page Footnote

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Creating STEAM with Design Thinking: Beyond STEM and Arts Integration

Danah Henriksen

Introduction

Recent years have seen intensive interest in the concept of STEAM (Jolly, 2014). Despite this, STEAM remains challenging for many teachers to integrate in school subject matter (Herro & Quigley, 2016; Mote, Strelecki, & Johnson, 2014). This may be due to the fact that popular discourse around STEAM has often viewed it narrowly, as simple arts-integration into the sciences. While readers and editors of this journal present STEAM in rich and dynamic terms, much popular commentary has been more limited. The acronym of STEAM itself may suggest to some that the approach is as simple as plugging the "a" into STEM (Piro, 2010). That is not to criticize the value of arts integration, which has immense benefits. But arts integration is one facet of STEAM. STEAM as a paradigm can go farther, to reflect a view of education with an emphasis on creative, interdisciplinary, real-world, and problem- or project-based teaching and learning (Kim & Park, 2014).

Viewing STEAM as solely about arts integration is problematic, as many science teachers may not have artistic training, or may be uncertain about how to put the "a" into STEM. Arts instructors similarly may lack a lens to understand where or how to build STEM into the arts. What we need is a broader and more inclusive view of STEAM that spans disciplines, with entry points across contexts. This suggests a view of STEAM which, while it includes arts integration, focuses more broadly on several tenets: interdisciplinarity, creativity, authentic or real-world learning, and

project-centered thinking. To apply STEAM in this way, we must give teachers support or structures for enacting messy creative practices within the already messy and challenging contexts of teaching.

Design, or design thinking, may provide a guiding framework to support an expanded view of STEAM teaching. Design thinking provides structure for uncertain teachers to develop more creative and interdisciplinary practices—as a framework to guide their thinking, and as a part of their students' STEAM experiences.

Design is a process for creating something (artifacts or knowledge), which is both an art and a science for human-centric problems (Buchanan, 2001). The term "design thinking" refers to thinking skills or practices designers use to create new ideas and solve problems (Cross, 2001, 2011). Recently, there has been heightening discussion about design thinking and its potential for teaching and learning (Norton & Hathaway, 2015). Scholars and practitioners stress the need for applications of design in learning (Kirschner, 2015). But this discussion has remained vague, with little specifics or clarity about how design and education connect in teaching—I suggest one key way they connect, is in STEAM.

Design and STEAM for practice

Educational policy is often constraining and unsupportive of teacher creativity for STEAM lesson/curriculum design (Cohen, McCabe, Michelli, & Pickeral, 2009). Teachers, like many people, often feel uncertainty about their own individual creative potential (Cropley, 2016). This makes it difficult to identify and enact good STEAM solutions. Design offers guidance and structure to equally engage the analytical and intuitive, the artistic and scientific (see Figure 1).

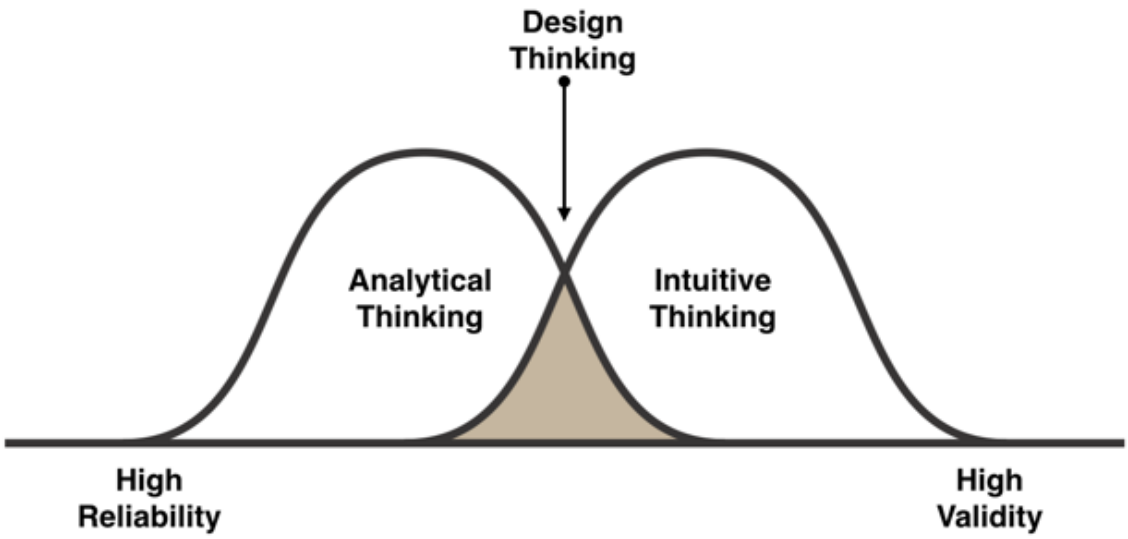

Figure 1.

Creativity, interdisciplinarity, real-world, and problem/project-driven emphases, are central to STEAM, and to design as well. Despite the open-ended nature of design, one reason the term "design thinking" has become popular, is due to the flexible model it provides. It highlights clear process phases and practices, that scaffold between creativity and analysis. A multitude of different "design thinking models" have arisen in recent years—most with common fundamentals (Watson, 2015). For example, the Stanford 'd.school' model (pictured in Figure 2) is one example that has popularized design thinking (Plattner, Meinel, & Leifer, 2010).

Figure 2.

There are numerous ways design could play out in teachers' thinking or classroom practices. But within the confines of this article I offer one example, simply to provide a sense of how design thinking can work for STEAM.

A case in point: Design in the creation of a STEAM class project

In a graduate in-service teacher education course I designed and co-taught, teachers use design thinking models to address classroom problems of practice. In this course, we used the Stanford design thinking model, but I do not assert that the Stanford model is the only or best approach. There are dozens or more variations of freely-available design thinking models. But having a model is valuable as it provides educators with a guiding approach, as "a way to intentionally work through getting stuck" (Watson, 2015, p. 16).

The students (who are also teachers) use design thinking to address a significant teaching problem of their choosing. Often, these problems involve the struggle of creating curricula that is engaging, creative, project-based, and inter-disciplinary in nature—or, STEAM based curricula.

Not all are traditional science or arts teachers, but their work spans science, art, and more, showing the range in STEAM.

For example, Katherine was an elementary Spanish teacher in the course, who felt her teaching becoming uninspired and subject-matter bounded. Her problem of practice focused on designing an in-depth STEAM project for students. Her subject matter was Spanish language, and Katherine extended her teaching to create a project about water crisis, a major community concern in some Spanish speaking countries.

Through this, students analyzed the importance of clean and safe water usage. Her initial aim was to introduce her students to new Spanish words, with water as the emphasis of conversation. Through the design process, she identified interdisciplinary STEAM connections. This led her to create a project where students spanned disciplines creatively. In it, they conducted their own research on scientific and social dimensions of water usage, considered complex problems that occur across countries, learned the science of the water cycle, designed artistic posters, diagrams, and presentations to communicate their work, and found ways to teach others about the intersection of these issues.

Katherine came up with more ongoing, interdisciplinary aspects to this project than could be described here. As one small example, her fourth graders did a poster session, where they researched the water science, to design visuals that communicated it with Spanish words. They learned the basic science and the Spanish vocabulary, but also had creative freedom to design their works. A few examples are shown in the Figures 3 and 4:

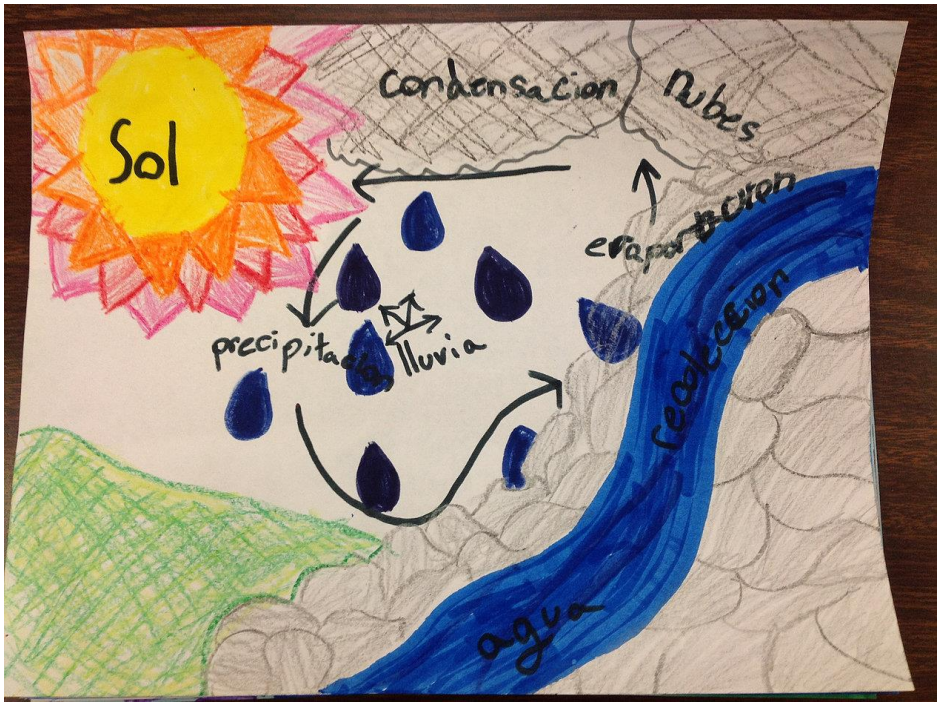

Figure 3.

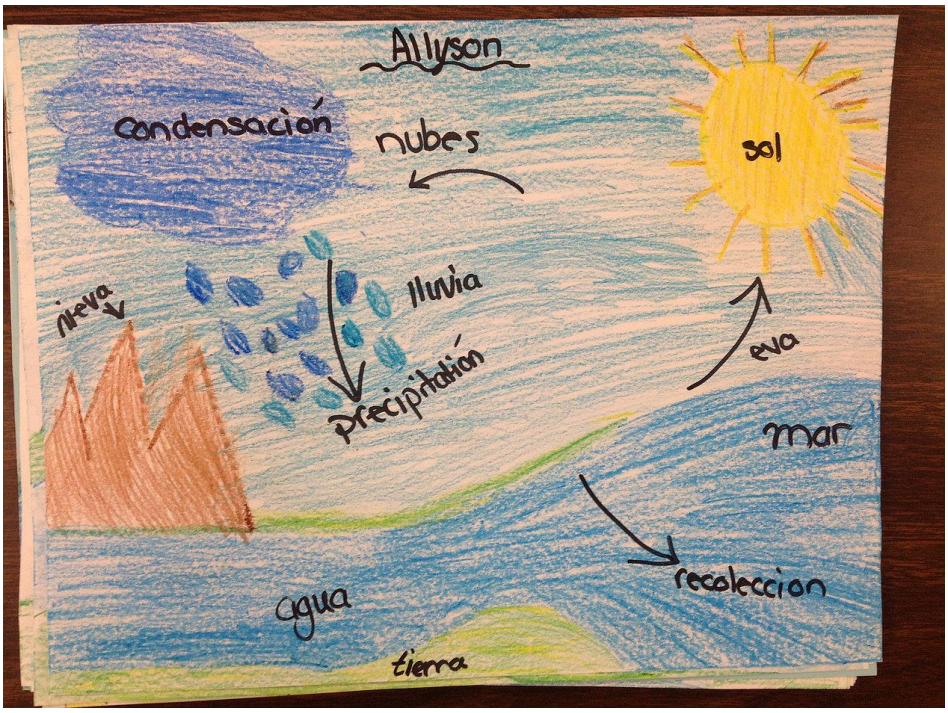

Figure 4.

STEAM and design processes for teachers and students

Through design thinking processes, Katherine integrated two different ways of redesigning her curriculum, having students engage their problem solving and creativity—which harkens back to design processes as a creative/analytical mix.

To develop this STEAM project, Katherine used the Stanford design model cycles of empathy, problem definition, ideation, prototyping, and testing. For empathy research, she did informal interviews, observations, and surveys of students to understand their motivations and interests. This helped her define the problem, around creating curricula that let kids spend in-depth time with issues to make connections between disciplinary ideas and their own lives. To ideate on possibilities, she kept an ideation journal to jot down ideas over a period of time, and used this to stimulate a brainstorm session with other teachers. All of this led her to prototype a first run of the project, then test it with students to observe, and iterate on improvements.

Design processes supported her thinking, toward building a more STEAM-based lesson with multiple artistic, scientific, and social/humanities related project facets (a few described above). She also started weaving aspects of design thinking into the students' work itself. For example, she found ways to use empathy to help students understand water crisis. She performed a hands-on water experiment where students were given a limited amount of clean water, and had to decide how to use this water. While students performed the experiment, she collected observations on their reactions, their choices, and their reactions to using dirty water for bathing, drinking, and cooking. As Katherine noted in her teacher-designer reflection:

> *This gave insight about students' reactions and emotions towards water issues in their own home and community…they developed deep answers about solutions to changing water issues, including: drilling more wells to access clean water, using filters, stopping pollution*

of peoples' water supply, routing more rivers towards civilization, and not using chemicals on food/plants that go into groundwater. In a social dimension, during the hands-on water experiment, my students started bargaining with each other for clean water tokens and started sharing them among the class to avoid anyone using the dirty water tokens.

Activities like this, among others she did, allowed students to go beyond the confines of just learning the Spanish words, or the scientific or artistic or social dynamics of the project. They were able to see how different disciplines come together in real-world problems. As Katherine described it, her students "were highly motivated to research, create and learn because of the connection to their own life. Students learned about where water comes from, how we use it every day, and the impact of living somewhere without clean water."

Creative, interdisciplinary, research-based, artful, and real-world connections are at the core of STEAM, and at the core of design too. When Herbert Simon (1969) laid down the tenets of design as a field, he emphasized it as human-centered problem solving, and design as an interdisciplinary crossroads. Here, through design Katherine worked towards a more STEAM project-based approach, in her own and her students' work. While the sciences were represented in students' learning of the water cycle, they also were using the arts to visually represent ideas, as well as learning Spanish vocabulary, engaging with real-world social dilemmas and other dynamics—in a complex interweaving of disciplines.

Conclusion

I have noted the value in a broad view of STEAM beyond arts-integration, suggesting the potential of design thinking for STEAM, both as a guiding structure and in-road for teachers to design more STEAM-based lessons, and as an integrated aspect of students' STEAM learning.

Katherine's example is one of many, in which design thinking helps teachers create more STEAM-based curricula. It might be argued that teachers can do creative curricular work without such a process. And for some that may be true, depending on teacher backgrounds and skill sets, and their experience working across disciplines. Yet, making STEAM connections remains a challenge for many, and our disciplinary lenses can get in the way of seeing where disciplines or real-world contexts connect.

Design, as an interdisciplinary crossroads and creative process of problem-solving, may help teachers through these barriers. This may be best summed up in Katherine's own words, as she reflected on the process of seeing herself as a teacher and designer of STEAM content:

> *Learning about design thinking came at a great moment in my teaching career. It allowed me to feel like a designer. I believe this process of design is a motivating way to promote creative thinking, collaboration, and student ownership and responsibility of their learning. There were irregularities and problems that came up along the way for me, however I felt like I was developing problem-solving skills to tackle these issues…I also think you could take many different paths through and modify this process as needed. Without it, I think I would have struggled creating this project for my students and would have been overwhelmed or frustrated. As a designer, it was exciting to see the development and changes in my project from the beginning to the end.*

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