International Society of the Learning Sciences

# Intertwining art and STEM: An analysis of STEAM activities

Blakely K. Tsurusaki, University of Washington Bothell, btsuru@uw.edu
Perrin Teal Sullivan, University of Alaska Fairbanks, pptealsullivan@alaska.edu
Carrie Tzou, University of Washington Bothell, tzouct@uw.edu
Priya Pugh, University of Alaska Fairbanks, pkpugh@alaska.edu
Mareca Guthrie, University of Alaska Fairbanks, mrguthrie@alaska.edu
Laura D. Carsten Conner, University of Alaska Fairbanks, ldconner@alaska.edu

**Abstract:** The integration of Art with Science, Technology, Engineering, and Mathematics (STEAM) has been growing in popularity, however, there are a variety of conceptualizations of what it looks like. This study explores images of STEAM by examining activities created by informal educators. We found that STEAM activities were conceptualized as using one discipline in the service of another, intertwined, or parallel. This provides concrete images of what STEAM can look like in educational settings.

## Introduction

STEAM, or the integration of Art with Science, Technology, Engineering, and/or Mathematics, has become increasingly popular, for various reasons. STEAM is important for the economy, leading to increased creativity and innovation (Allina, 2018; LaMore et al., 2013) and job preparation (National Academics of Sciences, Engineering, and Medicine, 2018). Others argue that integrating art with STEM broadens participation of those traditionally underrepresented in STEM (Buechley & Perner-Wilson, 2012; Mejias et al., 2021; Peppler, 2013). Many argue for the importance of STEAM as it leads to new perspectives and ways of understanding that would not occur through disciplinary thinking (Bevan et al., 2020; Quigley & Herro, 2016; Siler, 2011). With burgeoning interest in STEAM, there is a need for more concrete images of what STEAM looks like in educational settings. We aim to add to the developing body of STEAM work by exploring the STEAM activities that informal educators created as part of their participation in a STEAM professional development program. We investigate the question: What are the qualities of participants' STEAM activities?

## Theoretical framework and methods

We drew from a variety of conceptions of STEAM from the literature for our analysis. For example, in an interdisciplinary conception, two or more disciplines can work together without changing each other (Siler, 2011). Peppler and Wohlwend (2018) argue that STEAM should be transdisciplinary, where "…new understandings and artifacts emerge that transcend either discipline" (p. 88). This offers a view of STEAM integration where the disciplines not only support each other, but also work together in ways that move beyond the learning that could happen through disciplinary approaches. Mejias and his colleagues (2021) theorize STEAM along pedagogical and instrumental axes in four major quadrants (Mejias et al., 2021, p. 218). Their conceptualization of STEAM, including one-sided and mutually instrumental rhetoric, supported our analysis of how integrated the STEAM fields were in practitioners' activities.

The study's context was a STEAM professional development program developed for informal educators, (e.g., librarians, afterschool art and science teachers). It consisted of a two-day, in-person workshop followed by a mini-online course. The culminating project was to design a STEAM activity. The program was enacted with five different groups from geographic locations across the U.S. We analyzed 48 STEAM activities from all 47 participants who submitted written activity plans (one participant submitted two activities). We analyzed the data using emergent coding (Strauss & Corbin, 1998), looking for what images of STEAM the educators portrayed through their activity plans. From our analysis, three categories emerged: 1) In service of another discipline, which included STEM in the service of art and art in the service of STEM; 2) Intertwined; and 3) Parallel. These will be described in the findings.

## Findings

We found three images of STEAM in the activities the educators developed. The first category was *in service of another discipline,* where one discipline was used to inform another discipline, but not vice versa (e.g., art in the service of STEM, where art was used to help learn STEM (thematically, materially, and/or conceptually). An example of *art in the service of STEM* was an activity where youth created a diorama of a rainbow to communicate their understanding of what causes rainbows. In this case, the focus was on learning about the science of how rainbows form and then art was used to help the students communicate their understanding of rainbows.

 

The second category was *intertwined*, where the activity showed feedback between art and STEM, where the learning of Art and STEM depended on each other, continually informing each other throughout the activity. An example of *intertwined* was an activity where youth were given a problem to solve, in this case they were commissioned to design a wheelchair accessible ramp at a county fair. The ramp needed to be large enough to fit the needs of the people in the wheelchairs and also contain design elements relevant to the ideas and values of the members in the community. The activity positioned youth as architects so they could, according to the activity designer, "see how art and design both have a place in the STEAM content area" and identified various aspects of the activity as science (how the materials worked together), technology and engineering (how to assemble the materials), art, math and technology (how to design the solution), and math (determining the cost of the project and how to make it cost effective.

The third category was *parallel*, where the art and STEM explorations could be done separately and did not rely on, or inform, each other. An example of this was an activity where the youth learned STEM concepts in order to create a kite. The activity designer identified the following STEM concepts the youth would learn as they created their kites: forces (science), measurements (math), and how the shape and materials affect the kite's ability to fly (engineering). Once they created a kite, the youth could decorate it using crayons, pencils, or chalk with designs that were personally meaningful. In this activity, the art (decorating the kite) did not depend on understanding of STEM concepts, nor did it interact with these concepts in the functional design of the kite.

## Conclusions and implications

We believe that there are places and times for a variety of types of STEAM activities, depending on the learning goals and needs of the youth. The purpose of this analysis was to explore a spectrum of images of STEAM, as there is much need for more concrete examples of STEAM in educational settings. As educators are increasingly being asked to consider designing and implementing STEAM, whether as a means to broaden participation in STEM, deepen engagement and understanding in STEM, or encourage creativity and critical thinking, we need to have a better understanding of the possibilities, as well as the constraints and affordances of varying approaches.

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## Acknowledgements

This work was supported by the National Science Foundation under Grant Numbers 1713155 and 1713276. Any opinions, findings, conclusions, or recommendations expressed are not those of the National Science Foundation.

 