

BELONGING AND IDENTITY COHORT

FINAL REPORT

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INTRODUCTION

Our cohort investigated the overarching question: “What is the current landscape of belonging and identity in STEAM ISL?” We initiated our work by defining the constructs of identity and belonging:

Identity: Seeing yourself as a particular kind of person (this could be a mother, father, sister, brother, science or art person, for instance) and/or as part of certain groups. Identity is complex, intersectional, and situational. People have multiple social identities, including based on their roles, their work, social groups to which they identify or are seen by others to be part of, including, but not limited to, racial/ethnic/cultural identities, gender and socioeconomic status.

Belonging: Seeing yourself as fitting in, feeling safe and understood, having agency in a space. “Belonging” generally means the sense that one fits in, is welcomed, and is valued. It can vary from setting to setting. Belonging may unfold differently for different communities and identities.

KEY FINDINGS

Implications: Building a culture of belonging is not the same as simply removing barriers. We must also organize our spaces, our structures, and our policies to do the work we need to build the world we want to live in. Providing opportunities for educators to develop cultural competencies is crucial to this process. We have to work together to build a well-developed ecosystem that supports our work. We need research and analysis, we need inclusive narratives, and we need organizing, which is about building power. And we need all these things activated and in alignment—and all of these move

through culture. Belonging is related to identity in that a sense of belonging can help support learners on identity pathways. To foster identification with STEAM, we need an approach that centers personal relevance and learner's own cultures, lived experience, traditional ways of knowing, and concerns within supportive learning environments that are rich with material, social, and ideological resources, both relating to disciplinary knowledge and landscapes of becoming, or who a learner can be within those landscapes. Educators play a crucial role in creating spaces where learners can share their identity to build a sense of belonging.

PRIORITIES FOR FUTURE WORK

We put forward two main findings with respect to these questions, based on our conversations, examining the literature, and delving into models that inform practice-based work:

1) the conception of STEAM itself within ISL settings varies tremendously. Some use STEAM in ways that refer to the deliberate blending of art and science, or use the concept in ways that leverages frameworks of natural intersections between art and science. Others use the term “STEAM” as an overarching term to refer to work done in any one of the fields in the acronym (e.g., science OR art, etc., rather than referring to intersections).

2) the literature and the field with respect to STEAM specifically (limiting this to examples where both art and STEM are featured) often invokes the concepts of identity and belonging either explicitly or implicitly. Many are equity-focused, but not all consider intersectionality in an explicit way.

CASE STUDIES

Case Study 1: Fostering STEAM Case Study: PD for ISL Educators

Our PD series focused on preparing ISL educators (and later, in-school educators) to embed a practice-based, identity-centered approach into their work with learners. The series consists of in-person workshops, online PD, follow up coaching, and development and delivery of STEAM programming by the participating educators. These activities centered around a set of STEAM practices articulated by our team. The PD model involved educators working through a set of five art/science activities

previously developed in our work. In addition to incorporating the STEAM practices, each activity also used a different strategy to promote a STEAM mindset and to support identity work. We asked the educators to participate in each of the investigations as learners, but also to observe and reflect about how the activities might impact the learners that they work with. The end of the workshop, as well as the follow-up Canvas-based course, allowed for time to start designing STEAM lessons, as well as diving further into the practices. The Canvas course consists of six sessions, each 1-2 hours long, for a total of 8 PD hours, along with a short orientation module. The sessions focus on key STEAM practices and facilitation approaches for fostering STEAM mindset and STEM identity among learners. The course is active, with participants completing assignments such as posting photos about their personal connections to STEAM, engaging in drawing activities, and redesigning a STEM lesson into a STEAM lesson, using a STEAM activity design starter that we developed. Participants submit materials in response to embedded prompts, and participate in discussions with others through online discussion boards. The course also includes a series of short videos delivered through EdPuzzle, which allows users to pause during key points in the video to reflect and respond to content and ideas. We made the intentional decision to adopt a playful style with the graphics and a conversational tone during the modules in order to reflect the importance of a sense of play found in informal environments.

The Practices

In our view, an authentic enactment of STEAM requires use of both science and art practices, but in a selective fashion that overlaps with identity-building practices. Thus, the six STEAM practices that are part of our model are a subset of the full range of science and art disciplinary practices that deeply incorporate scientific and artistic thinking, making, and experimentation in ways that intersect with learners' interests. Activating interest and personal relevance among youth is the first step on a pathway towards deeper identification with science, which is central to developing life-long science engagement (National Research Council, 2009), and thus, is also central to broadening participation in science. One who identifies with science goes beyond "liking" science, but instead identifies as a person who is comfortable with, and uses, science in their everyday life. We posit that practices that build science identity should thus be at the forefront of thinking when considering a STEAM approach that can broaden participation in science.

The six practices of our STEAM model are: 1) engage in close observation; 2) focus on personal meaning; 3) conduct open exploration; 4) communicate about process and outcome; 5) design with intention, and 6) iterate throughout. Both artists and scientists engage in close observation of nature and phenomena in order to generate questions, ideas, products, and models. Personal meaning comes to the fore as learners

personalize artifacts for their own purposes or identities (Qi et al., 2016). Although a product is created in a STEAM activity, the disciplinary focus is on process, rather than the product itself, which acknowledges that the meaning in art emerges from engaging in the process rather than being limited to the product. This focus on process over product also helps promote self-compassion, rather than self-judgment, around the act of creating (e.g. Neff et al., 2005; Zabelina & Robinson, 2010). It has long been recognized that youth become extremely self-critical of their own art around late elementary school age, and can stop participating as a result (Lowenfeld, 1957; Burton, 2009). Our STEAM practices have the potential to quiet the inner negative voice and allow youth to fully engage in the activity. Similarly, open exploration in concert with intentionality around design is critical in order to build a sense of agency, which is core to building a science identity (Murphy & Hall, 2008) and can also serve to counteract negative self-judgment. This intentionality includes the use of genuine disciplinary tools from both art and science, as well as making choices about medium, technique, and composition in support of an artistic vision. Iteration is another core STEAM practice. As Peppler and Hall (2016) argue, “trying to understand why designs fail and making changes so that it ultimately succeeds creates an opportunity for the learner to refine their understanding of the concept being modeled” (p. 143). Finally, communication to audiences in ways that convey the personal and scientific meaning of the artwork is another critical STEAM practice. This act of creating and communicating allows students to connect their science/art making with everyday life, which is also important for building identity (Basu & Calabrese Barton, 2007). We argue that the motivation for communicating a message or meaning through artwork also pushes learners to refine and iterate their designs, reinforcing this core practice of both science and art.

We studied the impact on educators through a design-based research approach. Our research demonstrated the fundamental importance of materials as individuals work through various meanings of STEAM and engage in the process of building personally relevant products that are the outcomes of engaging in the six practices. Materials are powerful in part because they serve as connecting points to cultural practices and histories, which is an integral part of developing disciplinary identities as part of a larger, intersectional identity. By materials, we refer to *material resources* from Nasir & Cook (2009), which includes the *stuff* of making in STEAM (construction paper, paints, etc.) and the meanings they take on in STEAM learning settings. Ingold (2011) argues for a focus on materials and their properties as a way to understand the meaning of objects. In the process of creating or making, we draw out the potential of materials (out of many possible potentials) through our interactions and relations with them (Ingold, 2013). Therefore, it is our experiences and connections to the materials themselves--as part of final objects--from which we can draw meaning and relations. Our work illustrated the ways that educators made connections with land, cultural/family histories, and aesthetics through engaging in authentic STEAM activities, allowing them to better

support their learners through culturally sustaining pedagogies. Our work also illustrated the ways that working across art/science boundaries in ways that blurs such boundaries can support engagement in experimentation and observation. Finally, we characterized the practice of iteration in new ways, showing how iteration emerged as “microcycles” of interactions, specifically as adjustments, additions, and negotiations in both material artifacts and the narrative. This moves the field forward by describing the ways in which deep engagement in foundational art/science integrated practice can occur, which in turn can help educators support such practices with their learners.

Case Study 2: Building for Kids Case Study: After-School Explorer Camp Programming

In 2021, Building for Kids launched its after-school Explorer Camp program. The concept around after-school Explorer Camps at Building for Kids is backed by robust, local evidence of a two-year research project that was conducted just over 10 years ago by Lawrence University and University of Wisconsin, with Building for Kids, Boys & Girls Club, and Appleton Area School District. Participating in the project were three groups of students: a group that attended school only, a group that attended school and the Boys & Girls Club, and a group that attended school, the Boys & Girls Club, and Building for Kids after school once per week. Out of the three groups, the one that attended after school programming at Building for Kids - where students engaged in art and STEM activities regularly - saw the greatest increases in social self-confidence (identity and agency) and academic performance (math, reading, and science report card grades) over the two years. These gains were seen across all students - regardless of socioeconomic status. These findings suggest that after-school programming, especially enriched programming emphasizing STEAM concepts and open exploration of the museum, is particularly helpful for children facing socioeconomic disadvantages.

Today Building for Kids' After-School Explorer Camps provide hands-on, play-based educational experiences for learners in Kindergarten through 4th grade. These experiences are designed to enhance in-school academic performance and to promote the development of necessary skills among learners. Explorer Camp experiences are:

- **Social:** Learners engage with other learners as they build connections and relationships through their shared experiences that lead to the development of communication and collaboration skills. Learners also engage with Museum Educators, building mentor relationships, where youth see grown-ups they trust leading STEAM activities.
- **Learner-Directed:** Learners make the plan for their time at the museum. Every camp offers a STEM-based learning activity and an art-based learning activity for

learners to choose from - or to do both! Making space for learners to lead and make decisions develops confidence and agency, and leads to deeper engagement in the experience.

- **Play-Based:** All activities are playful by design! During Explorer Camps, learners will engage in guided STEM and art activities, as well as open-play in the museum's exhibits. Children who have access to playful learning experiences – both free and guided – are more likely to develop skills like self-control, self-confidence, and problem-solving.

Key takeaways from Building for Kids After-School Explorer Camps and their ability to build belonging and identity in STEAM education:

- **Trust-Based:** Relationships must exist between learners and educators.
- **Choice-Based:** Learners must have the opportunity to choose their STEAM learning experiences.
- **Play-Based:** Learners must be able to find some form of joy or enjoyment in their STEAM learning experiences.

Informal learning settings, like children's museums, are ideal for these types of learning experiences.

Future studies and practice should work towards creating foundational definitions of STEAM that are authentic to both the arts and STEM, considering carefully how the two might intersect and support each other. Learners' own identities and cultures should be centered in this work.

KEY REFERENCES

Allen-Handy, A., Ifill, V., Schaar, R. Y., Rogers, M., & Woodard, M. (2020). Black girls STEAMing through dance: Inspiring STEAM literacies, STEAM identities, and positive self-concept. In *Challenges and opportunities for transforming from STEM to STEAM education* (pp. 198-219). IGI Global. "Black Girls STEAMing through Dance (BGSD)" describes a transdisciplinary partnership among four Black women professors in urban education, dance, industrial/product design, and computing who designed a program to engage Black girls in STEAM-infused activities to inspire STEAM literacies, STEAM identities, and positive self-concept. BGSD is in its third year and operates as an after-school program for 7- to 12-year-old Black girls, a co-curricular mini course program for 5th and 6th grade girls, and professional development for teachers. This chapter highlights how the program was developed, how the use of

dance to integrate STEAM is a promising platform to encourage engaged STEAM participation amongst underrepresented Black girls, and some preliminary results.

Aronson, B., & Laughter, J. (2016). The theory and practice of culturally relevant education: A synthesis of research across content areas. *Review of Educational Research*, 86(1), 163–206. Key findings from this expansive study include: 1) Culturally responsive teachers are multidimensional because they engage cultural knowledge, experiences, contributions, and perspectives. 2) Culturally responsive teachers validate every student's culture, bridging gaps between school and home through diversified instructional strategies and multicultural curricula. Snively and Corsiglia (2001) suggested the challenges of science learning may be greater for students whose cultural traditions hold ways of knowing that differ from that characteristic of Western science.

Barajas-López, F., & Bang, M. (2018). Indigenous making and sharing: Claywork in an Indigenous STEAM program. *Equity & Excellence in Education*, 51(1), 7-20. This article describes an ArtScience participatory design project with Indigenous youth, families, community artists, and scientists in a summer Indigenous STEAM program designed to cultivate social and ecologically just nature-culture relations grounded in Indigenous ways of knowing, being, and making.

Best, M., Best, R., & Dickter, C. (2019). STEAM Programming as a Pathway to Foster Positive Academic Self-Efficacy and Positive Self-Concept. *Journal of Research in STEM Education*, 5(2), 100–118. Thirty-eight students from multicultural backgrounds at a medium-sized community center participated in STEAMtrix, a STEM out-of-school time (OST) education program that incorporates the arts for kindergarten through 12th grade (K-12) students and explores whether STEAMtrix leads to the formation of positive STEM-specific self-efficacy and self-concept. The study also examined whether STEAMtrix improved multicultural students' interest and awareness of careers within the STEM pipeline. Explicit measures of STEM self-efficacy and both explicit and implicit measures of self-concept were collected before and after programming. Results demonstrated that the STEAMtrix curriculum increased STEM self-efficacy in some domains and improved implicit self-concept.

Ellington, R., Daniels, B., Orozco, F., Santiago, A. & Arnold, A.L. (2021). Transformative Transmedia Framework for Early STEM Learners: Harnessing the Power of Science, Literacy, and Media. *Journal of Educational Multimedia and Hypermedia*, 30(1), 5-34. Waynesville, NC USA: Association for the Advancement of Computing in Education (AACE). The Twin Cities PBS Ready to Learn project focuses on the building of science and literacy skills of diverse students ages 5 to 8. It

also promotes equity for historically underrepresented children in science (race-ethnic minorities, low-income children with disabilities, English Language Learners). This paper outlines the following: (1) addressing the intersectionality of racial, class, cultural, and STEM identities for young learners and dispelling negative stereotypes; (2) grounding “real world” STEM experiences in the lived realities of diverse learners; (3) recognizing and integrating social and cultural assets in STEM learning experiences; (4) integrating equity within Science and Engineering practices; (5) understanding STEM as literacy; and (6) strategies for integration in multimedia contexts.

Hill, K., Allen, C. D., & Keifert, D. T. (2024). The Beauty in Science: Understanding the Role of Art in Youth STEAM Identity Development. In *Proceedings of the 18th International Conference of the Learning Sciences-ICLS 2024*, pp. 1215-1218. International Society of the Learning Sciences. ArtScience provides a space for youth and adults in a STEM project setting to honor the appreciation of aesthetics within science practice and further our understanding of STEAM identity development. This paper discusses how STEM identity can make space for including discourse on creativity, art, and making within science spaces and further normalize the use of STEAM (STEM plus Art) in academic discourse.

Hughes, R., M., Nzekwe, B., & Molyneaux, K. J. (2013). The Single Sex Debate for Girls in Science: A Comparison Between Two Informal Science Programs on Middle School Students' STEM Identity Formation. *Research in Science Education*, 43(5), 1979–2007. This study focuses on the influence of camp activities within two informal science education programs: particularly the provision of role models and authentic STEM research activities as means to improve STEM identity and make these fields relevant to the lives of middle school students. The results indicate that both camps improved girls' STEM identities. These findings suggest that the single sex environment is not as important to STEM identity as the pedagogy used within the program.

Johnston, K., Kervin, L., & Wyeth, P. (2022). STEM, STEAM and makerspaces in early childhood: A scoping review. *Sustainability*, 14(20). The review found that early childhood experience with STEM, STEAM and makerspaces is an emerging field of research. Findings suggest that STEAM holds more relevance to learning and experiences in the early childhood years, and perhaps across the lifespan. The review also highlights the need to shift the starting point to the earliest of years and create greater intentionality in STEAM experiences with infants, toddlers and preschool aged children, recognizing the relevance of STEAM and maker mindsets in the lives of young children.

Kant, J., Burckhard, S. & Meyers, R. (2018). Engaging High School Girls in Native American Culturally Responsive STEAM Activities. *Journal of STEM Education*, 18(5), Laboratory for Innovative Technology in Engineering Education (LITEE).

The purpose of the study was to explore the impact of STEAM culturally responsive activities, embedded with Dakota/Lakota values and traditions, in a partnership between a mainstream college of engineering and a population of high school girls at a Federal Native American boarding high school. For a majority of participants, results showed a movement in attitudes from negative to positive for STEM studies as a result of “being part of STEAM Girls.” This study demonstrates a link between culturally relevant activities and increasing interest in STEM studies and STEM careers in this situation at this place. Results suggest that indigenous relevancy of activities matters, even if not tribally specific.

Lewis Ellison, T., & Qiu, T. (2023). From Black Girl Exclusion to Black Girl Empowerment: Understanding one Black girl’s digital and STEAM literacy practices as empowering, liberatory, and agentic. *International Journal of Qualitative Studies in Education*, 36(3), 465-486. In this article, we use the framework knowledgeable agents of the digital to understand the agentic experiences of one adolescent Black girl’s digital and STEAM literacy practices. After discriminatory acts deterred Star’s interest in exploring STEAM literacy practices in school, her involvement in a digital application workshop for Black girls and their fathers and a robotics club for Black girls reshaped her understanding of herself as a leader and innovator. Through qualitative data sources, including surveys, interviews, observations, photos, audio/video recordings, focus groups, vision boards, and digital app making, we explore her actions as a knowledge maker, creator, and producer. These roles (re)affirmed her interests in STEAM and her racialized and gendered identities as a Black girl. This study is important for rethinking collective educational efforts to disrupt systems that discourage and marginalize Black girls and women of varying identities in digital and STEAM literacies.

Lindberg L, Fields DA and Kafai YB (2020) STEAM Maker Education: Conceal/Reveal of Personal, Artistic and Computational Dimensions in High School Student Projects. *Frontiers in Education*, 5:51. In this paper we share findings from a project in which high school students created electronic-textiles-based art representing features of a community important to them as a part of an elective high school computer science class. We addressed the following research questions: (1) What kinds of personal and community meanings did students convey through their maker projects? (2) How did students engage with artistic dimensions in their projects? (3) How did coding interactive features support students’ artwork? Findings reveal how

making became a means of personal, artistic expression with quite literal layering of coded meanings, and how maker activities can integrate art.

Migus, L. (2011). Shifting Paradigms - Embracing World Multiple Worldviews in Science Centers. *ASTC Dimensions*. The values of Western science and traditional knowledge systems are often contradictory; however, science can play a powerful role in advocating for diverse ways of understanding while still promoting scientific thought. Key recommendations are: 1) Don't rush to the content. Taking time to understand cultural norms can lead to more successful programs. 2) Move beyond a deficit mindset. Traditional knowledge systems are complete ways of knowing. 3) Create true partnerships. Successful cross-cultural work is a two-way endeavor, and learning should not just be in one direction.

Nixon, J., Stoiber, A., Halverson, E., & Dando, M. (2021). Making Makers: Tracing STEM Identity in Rural Communities. *Journal of Pre-College Engineering Education Research (J-PEER)*, 11(1), Article 12. In this article, we describe efforts to reduce barriers of entry to pre-college engineering in a rural community by training local teens to become maker-mentors and staff a mobile makerspace in their community. Through a longitudinal case study, individual trajectories of five maker-mentors are traced over two years. Our research suggests that the maker-mentors who facilitated events in the community, taught younger community members about making, and co-facilitated with other maker-mentors were more likely to have inbound trajectories. A key affordance of the maker-mentor program was that it allowed teens to explore areas of making that were in line with their interests while still being a part of a larger community of practice.

Salehjee, S., & Watts, M. (2023). 'STEAM success stories': refocusing the framework of intersectionality. *London Review of Education*, 21(1). In this article, the metaphor of *wearing culture*, drawn from the work of Anne Phillips, challenges some of the precepts underpinning theories of intersectionality. Data is used from three cases – Fatima, Su-Li and Anna-Maria – to illustrate adult re-engagement with elements of STEAM.

Sochacka, N. W., Guyotte, K. W., & Walther, J. (2016). Learning together: A collaborative autoethnographic exploration of STEAM (STEM+ the Arts) education. *Journal of Engineering Education*, 105(1), 15-42. Drawing on the first two authors' engagement in an interdisciplinary design studio, this study develops an expanded view of how STEAM might enrich engineering education in ways that more closely align with the pedagogical commitments of the arts. The study is grounded in the educational philosophy of arts advocate Maxine Greene, who views learning as an

active, collaborative search for meaning 'wide-awakeness,' and social change and reveals the potential for STEAM to provide students and educators with opportunities to explore personally relevant connections between materials, design, society, and the natural environment and to critically engage with implicit and explicit facets of disciplinary identity.

Stone, B. (2022). Holistic identity development in STEAM. *International Journal of the Whole Child*, 7(1), 75-83. A broader conceptualization of identity in STEAM can influence the creation or progression of STEAM curriculum, environments, and programs to support the unique, organic construction of a child's identity development across multiple disciplines. Suggestions for creating optimal conditions for holistic STEAM identity development include using an interactionist approach, developing meaningfully integrated and relevant real-world explorations, utilizing inquiry, interest, and play, and using a flexible curriculum that allows for divergence and creativity.

Tsurusaki, B. K., Tzou, C., & Carsten Conner, L. (2023). Exploring the integrative nature of STEAM through material objects. *Pedagogies: An International Journal*, 1-16. We argue that an explicit focus on how art and STEM overlap in the world, and how these overlaps connect personally to learner's interests and concerns, is a way to support the development of STEAM-related identities. We developed a "STEAM objects" pedagogical activity aimed at explicitly surfacing the ways that art and STEM are intertwined in everyday objects, as well as the ways that STEAM is connected to learners' own lives. We piloted the activity with educators, asking what they took up from the experience. Our results show how the educators made connections to land, historicity, their professions, function, aesthetics, and agency of materials during the activity. The STEAM objects served as boundary objects that illustrated the integrative nature of art and STEM in the world, as well as bridging important aspects of their lives and STEAM. We discuss the importance of recognizing and leveraging the multiplicities of meaning and ways of knowing, as well as implications for the classroom.

Tzou, C., Conner, L., Pompea, S., & Guthrie, M. (2014). Colors of Nature: Connecting science and arts education to promote STEM-related identity work in middle school girls. In *ICLS*. Art and science share many overlaps in terms of both common practices and habits of mind. In this study, we focus on middle school girls who strongly identify with art and ask the following questions: (1) how does an art-focused approach to science instruction (STEAM) support engagement in scientific practices such as experimentation, observation, and communication of scientific information? and (2) how does a STEAM approach support STEM-related identity shifts in middle school girls?

Walan, S. (2019). The dream performance – a case study of young girls' development of interest in STEM and 21st century skills, when activities in a makerspace were combined with drama. Research in Science & Technological Education, 39(1), 23–43. This study focused on a project with a unique combination of makerspace activities and the use of drama. The research questions investigated the outcomes that could be identified from combining drama and activities in a makerspace, with regard to the development of interest in STEM and twenty-first-century skills. Ten girls aged 7–11 years participated. A project leader, a drama teacher and three female engineering students supported the activities. The project lasted 3 months. Data was collected in the form of interviews and observations with video-recordings and field-notes, as well as documentation of props made by the girls. Analyses were conducted using thematic coding and discussed through the lens of Activity Theory. Results showed that some of the girls developed an interest in science and technology. The girls also developed twenty-first-century skills, in terms of creativity, problem-solving and cooperation. Positive outcomes were found in this project, blending drama and making in a makerspace learning environment.