

Exploring STEM Identity and Belonging in Minoritized Girls at a Summer Camp

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Abstract: This study explores STEM identity among Underrepresented and Underserved Racially and Ethnically Minoritized (UUREM) middle school girls within informal learning settings. Focusing on micro-level interactions, we explored a single-gendered STEM summer camp where UUREM middle school girls comprised 81% of the participants ($N=59$). Guided by ecological systems theory as a methodological approach to developing well-designed informal STEM activities, we sought to positively shape UUREM middle school girls' STEM identity. STEM identity is complex, multi-layered, and inseparable from the intersectionality of their racial and gender identities. This approach is particularly salient in affective factors such as self-efficacy, ability-belief, and a sense of belonging during their pivotal middle school years. Critical implications include (a) single-gender spaces, like STEM camps, provide affirming, safe environments for authentic discussion and belonging in STEM, and (b) role models of similar racial and gender backgrounds support positive STEM identity formation for UUREM middle school girls.

Introduction

Gender equity in STEM has long been a concern, particularly regarding Black and Hispanic girls and women. Despite strides in STEM workforce representation, significant equity disparities persist across education stages, exacerbating underrepresentation issues (National Center for Science and Engineering Statistics [NCSES], 2023). For instance, Black and Hispanic K-12 students have less access to high-quality teachers (Goldhaber et al., 2015) and advanced math and science courses (NCSES, 2023). It becomes evident that specific systemic issues contribute to the underrepresentation of these students in STEM over their trajectories. Therefore, we retire the terms “underrepresented” and “minority” when describing this study’s participants, using the contemporary term Underrepresented and Underserved Racially and Ethnically Minoritized (UUREM) to emphasize the marginalization and subordination of people of color in American systems and institutions (McGee, 2020). Our focus shifted to informal learning environments, nuancing affective factors among Black and Hispanic middle school girls in these settings to leverage social interaction and collaboration across STEM domains (Brown et al., 1989). STEM summer camps, like the one in our study, provide authentic activities and offer underrepresented racially minoritized (UUREM) opportunities for peer and role model engagement (King & Pringle, 2019). Thus, we aimed to understand certain affective aspects of STEM education – namely, STEM identity comprised of ability beliefs, efficacy, and belonging – in an informal setting during UUREM girls’ transformative middle school period. Our research design and implementation aimed to provide participants with a safe space to be creative, curious, and culturally authentic as they engaged in STEM activities. Toward this end, the research questions guiding this study were:

1. How does participating in a week-long informal STEM learning camp influence the development of UUREM middle school girls’ STEM identity?
2. How do UUREM girls narrate the interaction of their intersectional identities with their developing STEM identity?

Theoretical framework

This study is grounded in *STEM Identity* and *Intersectionality*. Firstly, we define STEM identity as encompassing what individuals express and do while engaging in STEM activities (Calabrese Barton et al., 2013; Harper & Kayumova, 2023; Pinkard et al., 2017). Kang et al. (2018) elucidated STEM identity “as a young person coming to see both her current and possible future selves in STEM” (p. 420) and viewed STEM identity “as manifested through youth’s positive relationship with, positioning and expressed interest toward STEM and STEM-related career” (p. 420). Moreover, a secure STEM identity extends beyond just an affirmation of self-capacity; it encapsulates the nuanced interrelations of race and gender (Calabrese-Barton et al., 2013; Fouad et al., 1997; Ireland, 2018). Furthermore, the life, education, and professional experiences of a woman of color are distinct from those of a White woman or a Black man. Instead of viewing these factors in isolation, researchers recognize their intertwined and inseparable nature, which leads to an opportunity and achievement disadvantage in STEM

education, as highlighted by McGee (2020). This notion of *intersectionality* is where all aspects of a student's identity (e.g., race/ethnicity, culture, gender, and related issues of power and privilege) are considered to understand their lived experiences (Cole, 2009; Crenshaw, 1991). Acknowledging intersectionality is paramount in deciphering the obstacles UUREM girls face in STEM education (McGee, 2020). With the theoretical underpinnings of intersectionality with STEM Identity, educators and researchers can comprehend the complex challenges UUREM girls face in STEM education, especially during middle school (Avraamidou, 2019). Going further, researchers and practitioners can design learning environments that support youth who learn along racialized, gendered, and class-influenced pathways.

Methodology and analysis

Applying a convergent mixed-methods approach (Creswell & Guetterman, 2019), our study delves into changes in STEM identity among UUREM girls. We used *ecological systems theory* (Bronfenbrenner, 1977) to guide our research design as it provides a valuable framework for designing informal STEM learning programs to observe adolescent girls' identities (Bevan, 2016). Emphasizing dynamic and supportive connections among students, peers, and adults, this theory delineates five concentric circles of influence on child development: the *microsystem*, *mesosystem*, *exosystem*, *macrosystem*, and *chronosystem*. In our project, activities were meticulously co-designed (with the nonprofit's constituents) to address these levels, with a focus on the microsystem's direct engagement of girls within the university environment, the mesosystem's intersections between individual elements, and the broader impacts of the chronosystem and macrosystem, including the effects of the COVID-19 pandemic and societal movements like "Black Lives Matter." To support girls' intersectional identities and foster a sense of belonging, we implemented tailored activities and a comprehensive pre-camp family orientation. Daily activities were led primarily by a combination of hired and volunteer staff from the nonprofit, including state-certified teachers and counselors working during the day, as well as university women in STEM and high school peer mentors who served as residential workers. Additionally, researchers and local STEM professionals facilitated several activities during the week.

Girls were recruited by the nonprofit from diverse educational settings and community venues, including co-ed and all-girl public schools, public libraries, Black churches, and community cultural centers. Other strategies encompassed social media campaigns aimed at relevant online groups. Hosted at a large private university in the Southwestern U.S., 59 middle school girls participated (54% Black, 27% Latina, and 19% other). Utilizing Qualtrics®, we administered pre- and post-camp questionnaires, employing statistical instruments (Aschbacher et al., 2010; Fouad et al., 1997) to measure six outcomes: *STEM identity*, *overall efficacy*, *STEM beliefs*, *ability belief*, *math-science efficacy*, and *STEM belonging*. The analysis included paired *t*-tests and a deductive coding method, aligning with our STEM Identity and Intersectionality framework. In addition, four virtual post-camp interviews triangulated the data, applying a collaborative coding approach by all three authors to mitigate bias. In the subsequent section, we present our findings and discuss future implications.

Selected findings

Due to space constraints, this proposal includes select findings. The ICLS presentation will consist of a complete description of the findings.

STEM Identity

As defined by Harper and Kayumova (2023), STEM identity encompasses girls' actions in micro-level STEM activities and their narratives about experiences and self-perceptions within these activities. Paired *t*-tests showed a statistically significant increase in UUREM middle school girl participants' STEM identity scores with an effect size of $d=0.631$ (3.43 to 3.61, $p=0.001$). Also, the narratives of interviewed girls, exemplified by Kiara, a Black 7th-grade girl whose reflection vividly illustrated positive STEM identity development during her time at the camp. Kiara emphasized the transformative impact of camp engagement, particularly for Black and Latina girls, stating, "It is really helpful...to have something that our camp had, like [the] emerging technologies or science, and learning [about the] things around us." Her direct quote underscores the substantial role of such experiences in shaping her self-perception as a STEM-abled person and solidifying her STEM identity.

Belonging in STEM

Belonging in STEM is defined as a girl's belief that she is an accepted member of the STEM community and that her presence and contributions are valued (Hoffman et al., 2002). Paired *t*-test results, measured on a 5-point Likert scale, did not yield a statistically significant increase in girls' sense of belonging in STEM ($d=0.328$, 3.37

to 3.53, $p=0.08$). However, in her interview, Kiara explicitly used the term “belong” to characterize her camp experiences. She shared how her perception of belonging in STEM improved directly through her participation:

Some parts of me felt like I didn’t belong because I didn’t think that I was all that smart or could do things like this. Before participating in this camp, I was a little bit nervous because I thought I wasn’t going to be able to actually achieve or succeed in anything that we were going to be learning there. I thought there was going to be like other smarter girls than me or, [that] they would be even better at the things that I could do. *But participating in this camp definitely made me feel like I belong there* (emphasis added) and that everyone’s learning everything, and everyone makes mistakes.

Kiara’s narrative illustrates a transformative shift in her STEM identity, with her sense of belonging as pivotal. Initially grappling with fear, anxiety, and imposter syndrome, she confronted these self-limiting beliefs. Witnessing her peers make mistakes during shared activities strengthened her perseverance.

Gender and STEM Identity

During the interviews, participants openly discussed gendered perspectives. A group summative task where participants interviewed local professional STEM women was particularly insightful. Ivy’s account of her interaction with one such woman sheds light on gender dynamics in the STEM workforce:

What is it like being in a workplace with mainly men? And she [the woman] explained to me how hard it was and how difficult it was to work with men because of the way they treated her [the woman], the way they [men] took her work, and the way that they [men] did things, and she said that she [the woman] couldn’t do it. She [the woman] elaborated to me [Ivy] about how we’re totally different and how they [men] didn’t treat her [the woman] the same.

Ivy’s reflections are profound, acknowledging the pervasive gender dynamics at play and underscoring the importance of gender representation in STEM, “Black and Latina women coming from different companies, and speaking to us, so we can really see what it’s like.” Relevant to gender in informal STEM learning environments, Ivy initially said that being in an all-girl camp was “okay” but quickly shifted to “the concept of that because girls and boys have a different way of learning.

Intersectionality of Race and Gender and STEM Identity

The narratives of our interviewees, particularly Bella, vividly showcased the intersectionality of race and gender in their STEM experiences at the microsystems level:

This was my first year participating. And I applied to it because I thought it would be a good experience to meet more girls like me, that are like Black and Latina. And so, there’ll be a difference because, at my school, I didn’t really have a good connection with girls that were my ethnicity...There aren’t many Latina girls in my school. And I’m the only one that is in orchestra and honors. So, I thought that it would be a good idea to meet other girls.

Regarding her feelings about the camp being all-girls, Bella seamlessly intertwined gender and race, offering insights into the gendered realities of the STEM workforce:

It’s kind of proven that in middle school, girls’ confidence lowers, while boys’ confidence rises in the majority of cases. Having a club or camp, especially for girls and especially for colored girls, coming in as a group, I think that’s a good idea.

Emphasizing the importance of representation, Bella stressed, “...having more examples of Black and Latina women in STEM really helped me because they don’t really show that as much in the world. I think it’s very inspiring and encouraging.” Our findings underscore the profound impact of racial and gender intersectionality on the STEM identities of UUREM middle school girls. The summer camp ecology served as a backdrop and a crucible for enriched interactions between UUREM middle school girls and mentors of similar backgrounds.

Discussion

This study explores the inseparable connection between STEM identity and intersectionality among UUREM middle school girls in a single-gender STEM summer camp, where they form the racial and ethnic majority.

Ecological theories inform STEM learning environment design, unveiling multifaceted influences on identity formation. Micro-level interactions demonstrate the positive impact of camp participation on UUREM girls' STEM identity, specifically affecting *self-efficacy* and *ability beliefs* within racial and gender contexts. Our findings highlight two critical implications: first, single-gender camps with a UUREM majority facilitate authentic discourse and foster STEM belonging; second, role models sharing racial, ethnic, and gender backgrounds are crucial for informal STEM activities. Notably, residential university camps serve as robust pillars of support and inspiration, transcending their role as mere mediums for engagement.

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Acknowledgements

This work was supported by the National Science Foundation under DRL 2115393. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.