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Engaging Underrepresented Adolescents in Reimagined Learning of Integrated STEM

Rachel A. Sparks

Will Lewis

Ashley L. Waring

Allie High

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Rachel A. Sparks
Illinois State University
raspar1@ilstu.edu

Will Lewis
Illinois State University
wlewis2@ilstu.edu

Ashley L. Waring
alwarin@ilstu.edu

Allie High
ajhigh2@ilstu.edu

ABSTRACT

It is well-documented that there are large gaps in STEM achievement and degree attainment among women and racially minoritized groups (hereafter referred to as PEERs, People Excluded due to Ethnicity or Race). While there are a multitude of hypothesized reasons for these gaps, there remains a clear need for research exploring resources and programs to foster substantially increased representation of women and PEERs in STEM. Educational interventions in the form of out-of-school programs such as summer camps have shown promising gains in affective STEM outcomes in girls and PEERs. This paper builds upon this literature to describe a research study taking place during a one-week summer camp at a mid-sized university designed to increase STEM identity, self-efficacy, and sense of belonging among women and PEERs, with the goal of yielding an increased likelihood of pursuing STEM careers.

Keywords

Diversity, equity, inclusion, STEM, identity, sense of belonging, career, women, minority, STEM intervention, summer camp

INTRODUCTION

Increasing representation of women and PEERs (Persons Excluded due to Ethnicity or Race; (Asai, 2020)) in STEM has been an overarching goal of research, education, and policy for decades. However, large gaps remain, with less than 30% of bachelor's degrees in computer science, engineering, and physics awarded to women in 2018 (National Center for Science and Engineering Statistics, 2021). Similarly, only 24.0% of all science and engineering bachelor's degrees in 2018 were awarded to PEERs (National Center for Science and Engineering Statistics, 2021). These gaps are especially stark when viewed from an intersectional lens, as only 13.92% and 10.13% of science and engineering bachelor's degrees were awarded to PEER women and men, respectively (National Center for Science and Engineering Statistics, 2021). Thus, there is a clear need for substantially increased representation of women and PEERs in STEM and research exploring resources and programs fostering such representation.

Myriad factors contribute to the underrepresentation of women and PEERS in STEM fields, including systemic inequalities in STEM related education programs and disciplines (Dou and Cian, 2022), lack of exposure to women and PEERS in STEM fields (Kricorian, Seu, Lopez, Ureta and Equils, 2020), lack of access to mentors that model STEM self-efficacy and STEM identity (Dou and Cian, 2022; Godwin, Potvin and Hazari, 2013; Hazari, Sonnert, Sadler and Shanahan, 2010), and limited family exposure to STEM fields (Prasad et al., 2022; Sha, Schunn, Bathgate and Ben-Eliyahu, 2016), thus hampering "science talk" in the home (Cian, Dou, Castro, Palma-D'souza and Martinez, 2022). Further, STEM is largely viewed as Eurocentric and male-dominated, with girls beginning to question their sense of belonging and self-efficacy in STEM as early as 5th and 6th grades (Roberts and Hughes, 2019). Education experts have long identified grades 6-8 as an important time for children in determining their career aspirations (Vedder-Weiss and Fortus, 2012). This crucial period has also been associated with a significant drop in interest in certain STEM fields, leading many STEM educators to focus on early intervention initiatives in their attempts to find effective mechanisms for change (Dasgupta and Stout, 2014; Vela, Pedersen and Baucum, 2020).

Further, recent research demonstrates the importance of family science talk, encouragement of science identities from caregivers, and family involvement in STEM fields in fostering positive outcomes in STEM (Cian et al., 2022; Dou and Cian, 2022; Prasad et al., 2022). However, this type of familial support is often most prevalent in families already well-represented

in STEM rather than PEERs (Prasad et al., 2022). Scholars suggest this discrepancy may be due to historic marginalization, intergenerational low self-efficacy, and lack of accessibility to STEM resources (Cian et al., 2022; Prasad et al., 2022). Additionally, there is currently a lack of comprehensive exploration of STEM resources in our local community, and in particular, the barriers to accessibility. This project will gather data from community members and caregivers specifically, inquiring about perceived availability and accessibility of STEM programs in our city. This will provide a more thorough understanding of how students from all backgrounds might utilize and take advantage of such resources.

Finally, informal science education programs, such as summer camps, are potential influences in cultivating improved STEM identities, self-efficacy, and sense of belonging among girls and students with marginalized identities (Calabrese Barton et al., 2013; Roberts and Hughes, 2022; Vela et al., 2020). Notably, there is a lack of research on the effects of summer STEM intervention programs on girls in late elementary/early middle school (Prasad et al., 2022). Recent work has suggested that STEM summer camps should focus recruitment on girls and PEERs to determine how such programs can be structured to foster greater representation in STEM (Prasad et al., 2022).

Taken together, these bodies of literature indicate:

- elementary and middle school are critical stages for interventions to foster STEM identity, self-efficacy, and sense of belonging in girls (Roberts and Hughes, 2022) and PEERs (Talafian, Moy, Woodard and Foster, 2019);
- identification of systematic barriers to participation in STEM within families and communities may reveal how these aspects of underrepresentation can be addressed (Dasgupta and Stout, 2014);
- and STEM summer camps show potential in improving affective STEM-related outcomes in girls and PEERs (Prasad et al., 2022; Roberts and Hughes, 2022).

This study will attempt to answer the following questions:

1. To what extent do summer STEM camps targeted to girls and PEERs foster students' STEM identities, self-efficacy, and sense of belonging?
2. To what extent do caregivers and students engage in STEM activities and discussion outside of the classroom?
3. What STEM resources are currently available in the local community, and how are these resources perceived and accessible by students, parents, caregivers, teachers, and community partners?

This presentation describes the development of a one-week overnight STEM camp for thirty incoming middle-school students (ages 11–15 years old) from the local community. This camp is offered through a collaboration between the STEM Center and the School of Information Technology at a mid-sized Midwestern R2 university in partnership with a local community center (hereafter referred to as LCC), which serves a part of the city identified in the 2020 census as having greater than 50% PEERs. LCC runs a summer-long personal and professional development program for incoming eighth-grade students. Previously, this programming has taken place at LCC; however, we believe that providing an immersive week-long STEM-focused experience on campus would increase the reputation and visibility of the School of IT, STEM center, and other STEM disciplines, and subsequently motivate students to pursue STEM majors at the host university when they graduate high school. This will also significantly impact how local communities view STEM fields and the accessibility of STEM resources at the host university. The camps will be recurring annually, pending continued funding.

METHODS

Population and Setting

During this camp, students will be mentored in small groups by undergraduate education majors, a framework which was successful in a pilot program offered in 2022 and in other STEM Center programming. Throughout the week, students will experience life on campus by living in dorms, eating at dining halls, and engaging in structured evening activities facilitated by student organizations at the host university (e.g., one student organization has committed to providing salsa dance lessons one evening). Each day will be composed of a morning and afternoon session. Morning sessions will consist of students engaging in hands-on integrated STEM activities designed by the STEM Center's Camp Co-Directors, while afternoon sessions will include tours of campus facilities (e.g., research labs, design and fabrication facilities) and activities around campus (e.g., scavenger hunt through campus arboretum). Through immersion in STEM activities on campus, we hypothesize that students will develop increased STEM self-efficacy, STEM identity, and a sense of belonging in STEM and at the host university.

Data Collection and Analysis

Data collection will be carried out in accordance with the university's Institutional Review Board (IRB) requirements, and data will only be collected from students whose caregivers have consented to their student's data being used for this study. To address **Research Question 1,** surveys will be distributed to students at the beginning and end of camp. These surveys will include demographic data and peer-reviewed instruments assessing STEM identity, self-efficacy, and sense of belonging. Data about school districts will be drawn from publicly available databases to inform analyses. These quantitative data will be analyzed using descriptive and inferential statistics to answer the research question. These quantitative analyses will be supplemented by ethnographic observations of summer camp activities and selected interviews with students. Semi-structured interview protocols will be developed to expand upon the quantitative instruments. Interviews will be transcribed using an online transcription service and all qualitative data will be analyzed in a data analysis program (e.g., Nvivo) using open coding methods.

To address **Research Question 2,** surveys will be distributed to caregivers at the beginning of camp. These short-answer surveys will ask about parents' perceptions of STEM fields, their students' STEM education, and how their student engages with STEM at home. These surveys will be composed by the research team and will be qualitatively analyzed as described in RQ1 above.

To address **Research Question 3,** questions in the caregiver survey and student pre-surveys will inquire about perceived access to STEM resources in the community, including what resources participants are aware of, what resources they utilize, and what resources they would like to see in the community. If deemed appropriate by the research team, these may be supplemented by interviews with students. LCC partners will also be asked to complete surveys about STEM resources in the community, which will provide a holistic view of how various stakeholders perceive and engage with community-based STEM resources. This will result in more extensive knowledge of current available resources and allow us to share these findings with the general public in a manner that is not currently present.

CONCLUSION

Women and PEERs continue to be underrepresented in STEM fields in higher education. This project will help address this issue and inform research in this area, specifically the effectiveness of summer camps on outcomes shown to be important to fostering increased representation in STEM (Calabrese Barton et al., 2013; Cian et al., 2022; Dou and Cian, 2022; Kricorian et al., 2020; Prasad et al., 2022; Roberts and Hughes, 2019, 2022). This project will include a significant local impact through identifying how our communities view STEM fields and accessibility of STEM resources, including identification of accessibility gaps in the area. In turn, this will contribute to the development of STEM resources offered in future years and impact STEM in our communities for years to come. This presentation will contribute to conversations surrounding diversity, equity, and inclusion in information technology and related disciplines and will provide an example of a summer camp designed to alleviate barriers to inclusion in STEM disciplines. While we have not yet held the camp or collected the data outlined above, this presentation provides a unique opportunity for the MWAIS community to discuss early interventions to foster STEM identity and interest in underrepresented youth.

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