Exploring Issues of Gender Equity in Girls' Out-of-School Time STEM Engagement

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***Abstract*- Inequitable STEM participation among minoritized girls is a current and critical problem. Prior research has highlighted the importance of the middle-school age years as an important time for youth for interest identity development in science and math. Middle-school is often the stage at which youth begin their journey towards STEM careers. However, girls' STEM participation can be thwarted by gender discrimination, lack of external support, and socio-economic factors. Out-of-school-time (OST) activities are often designed to overcome these barriers. While the research on the barriers and challenges to participation are clear, less is known about how program designers and researchers can act on these insights to design individual programs as well as the overall ecosystem. This paper highlights key findings from current research on barriers to broadening participation in STEM among minorized girls and explores key insights from research for engaging program designers and researchers in designing OST experiences that are affirming and inclusive for minoritized girls.**

Keywords- Out-of-school-time, equitable participation in STEM, STEM engagement, minorities in science, broadening participation

I. Introduction

Out-of-School Time (OST) programs, defined as informal learning programs that do not take place during school hours, are part of a complex learning ecosystem consisting of formal school settings, home, and community experiences [1]. Various OST providers across the country are intentionally focused on increasing middle-school aged girls' participation in STEM [1,2]. Despite girls achieving better grades in science and math, and higher scores in standardized tests [19,36], these achievements do not necessarily translate to persistence along STEM pathways and women continue to be underrepresented in mathematically intensive fields in STEM [3,34]. Many cultural and sociological barriers prevent girls from engaging in STEM, with patterns of disengagement starting to show as early as middle school (self-reports of confidence in science and math, course-taking behavior, STEM intent) [3, 4]. Girls of color face greater challenges as racial and gender biases intersect [6,16,35]. Science identities, confidence and interest formed in middle school years are crucial to future pathways [24,33]. OST providers are in a key position to: (a) help minoritized girls who are disengaged from science and math gain confidence and interest in STEM, and (b) build a social support system to encourage caring adults' and community members' active engagement in decision-making around STEM [1,2]. In this paper, we sought to understand: (a) what socio-technical barriers may affect middle school girls' STEM engagement, and how, and (b) how might OST programs address these barriers towards girls' increased engagement. This paper focuses on insights that may apply to the design of OST STEM program offerings.

We highlight key findings from current research on barriers to broadening participation in STEM among minorized girls, and share key insights from studies that examine programs targeting minoritized girls. Using an integrative literature review methodology, we explored research in education, sociology, psychology, and learning sciences to form themes based on overlapping findings. To explore barriers to learning, we used keywords such as "equity in education", "gender differences in learning", "gender barriers", "STEM participation", "racial, ethnic inequities", "discrimination in science education", "Intersectionality in STEM", "women in STEM", "STEM careers, pathways", "girls of color", "gender gap in education", "minorities in science", "perceived barriers". We explored equity interventions using terms such as "OST gender equity", "equitable science learning", "after school", "informal learning", "science identity", "agency in STEM", "minorities in science", "STEM interest", and "strategies for STEM motivation".

II. Barriers to Girls' STEM Engagement

The research literature highlights multiple barriers that may affect girls' STEM learning, engagement and interest in different ways. We organize these barriers into broad themes:

A. *Effects of stereotyping and discrimination*

Stereotypes suggest that women lack science abilities [7] and perceive STEM and engineering as masculine [8]. Assuming gender roles leads to seemingly subtle but denigrating

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invalidations and false assumptions of power [9]. Stereotyping has negative psychological effects, and affects learner's confidence and perceived support [10]. Furthermore, there is risk of conforming to stereotypes, or stereotype threat [11].

B. *Not acknowledging discrimination*

Invalidating behavior affects peers views due to the social learning embedded [9]. In one study, many students reported no perceived racial or gender barriers in their peers' experiences [9]. Educational values like "objectivity and rationalism" suggest learning accommodations to be equitable, and it is falsely assumed that these values are heeded more than stereotypical issues [12]. Assumptions about disinterest in science among gender and racial minorities are unfounded with no evidence of lack STEM aspiration yet affect learners' academic intent and outcome [3,13].

C. *Lack of external support*

Adolescents' level of STEM engagement is part of a larger process of career exploration influenced by external sources such as social support [14,32]. Parental styles and expectations may be different for girls and boys [15,19], which may discourage girls' interest. Black and Latino students tend to report lower perceived support to pursue science than whites [10]. Additionally, lack of social interaction with peers leads to cultural isolation [16], leading to loss of social support [6,14,17]. Lack of historical examples of success also discourage decision-making in a highly social environment where minoritized girls may perceive a lack of fit [16,25].

D. *Socioeconomic factors*

Students of color may have less access to highly resourced schools that may motivate science and math interests, and there may be lack of exposure to science outside the classroom [16,18].

E. *Learning and teaching styles*

Education theorist Kolb suggests that students tend to move towards fields that fit their learning styles best. STEM courses are exceedingly competitive and fail to accommodate all learning styles [21]. Women may adapt to an "expert" or "authoritative role" common in STEM teaching, but tend to perform better when educators facilitate learning [20].

III. Opportunities to Address Barriers in the Design of OST Program Offerings

Various design and research efforts are underway to raise awareness about gender and racial biases towards more equitable STEM learning ecosystems [5]. In this section, we present opportunities in research towards addressing barriers discussed in the previous section.

A. *Equip stakeholders to address inequity and disengagement*

Many equity-centered design initiatives explore innovative ways of engaging stakeholders (eg: Stanford's d.school, Creative Reaction Lab, Civic Creatives). Educators and mentors should be equipped to (a) recognize stereotypical behavior among youth; e.g. assumptions in the use of everyday language, and (b) identify and deal with disengaged youth [22]. Some efforts explore training mentors and facilitators to observe how learners engage, and conduct debriefs after programs [31]. Research has found that girls who learned about gender discrimination and famous female scientists who faced discrimination demonstrated increased confidence [23]. Mentors, usually young women learning science, act as role models [24,25]. Mentors can dispel girls' negative stereotypes about science by showing that they have interesting lives outside their work environments [25]. A study has shown success with facilitators using stories and narratives from personal contexts and relating them to science learning [24].

B. *Towards continued science learning in the home*

Research has highlighted the importance of engagement in STEM across settings to sustain interest [5]. Programs could equip parents and caring adults to engage youth in everyday science learning by suggesting activities at home related to their learning [22]. Programs can also equip parents with resources to facilitate science conversations at home. One study reports different ways in which parents communicated with youth; ones with formal education in science engaged youth in knowledge acquisition and concepts, while others used story-telling and personal narratives in conversations about STEM [26]. Providing a set of tools and resources to youth, and adults, easily accessible at home contexts, may help increase level of engagement for those who may not have access to technology at home [31].

C. *Making STEM learning relevant to community's priorities*

While career readiness is a worthy goal, it is also important to address measures grounded in community perspectives [31]. Cultural norms and practices of families from non-dominant groups may vary [29]. Informal learning opportunities can leverage knowledge about their communities' interests (e.g. addressing health disparities, climate change) to help direct communities' and learners' interest in science learning [26].

D. *Facilitating learning in ways that may not be as formal as school contexts*

OST program GET (Green Energy Technology) city explored building agency by having girls play the role of science experts in their community [27]. Collaborative learning can be facilitated by encouraging peer to peer interaction through team projects [28]. Learning experiences should highlight forms of participation in science that are familiar to non-scientist learners, such as asking questions and drawing analogies [22]. In order to garner youth interest, facilitators need to maintain a balance between what is "cool/fun" and what is "scientific" in discourse [24]. Exploring facilitation of concepts through currently relevant topics (e.g. recycling) has been reported to increase interest [24]. Research shows that prescriptive and informal feedback encourages learning and interest [32].

IV. Conclusion

OST initiatives and research-practice partnerships [30] are in a unique position to engage girls of color in current and future STEM opportunities. Research points to the need for exploring revised metrics of program success in the out-of-school space [2], focusing the efforts towards increasing minority engagement. This review is aimed at a call for action for further research to use OST programs' context in the learning ecosystem to build resources, tools, and practices towards more equitable outcomes.

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