Out of School and into STEM:

Supporting Girls of Color Through Culturally Relevant Enrichment

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Abstract: *Increasing the participation of girls of color in Science, Technology, Engineering, and Mathematics (STEM) is a national concern. Due to the persistence of achievement and opportunity gaps, sustaining positive STEM dispositions in girls of color is critical to diversifying the STEM pipeline. Enrichment activities can serve as a means to address persistent gaps in opportunities to learn. The purpose of this article is to explain how teachers can adapt traditional STEM enrichment activities to support girls of color through culturally relevant instructional practices. The three components of culturally relevant pedagogy are utilized to demonstrate how traditional activities can be adapted to support girls of color in STEM. Presented here are examples to foster (1) academic success, (2) cultural competence, and (3) sociopolitical consciousness in girls of color. Both pre-and in-service teachers who desire to serve as teacher leaders in STEM need greater opportunities for STEM professional development, especially those that help teachers build upon culturally relevant teaching. Implications and suggestions for teacher leaders are given throughout.*

Keywords: Out of School Time, STEM, girls of color, culturally relevant teaching

Increasing the participation of girls of color in Science Technology Engineering and Mathematics (STEM) is a national concern. Projections suggest that the proportion of underrepresented people of color in science and engineering would need to triple to match their proportions in the U.S. population (Schneider, Judy, & Mazuca, 2012). Promoting STEM career interests for a more diverse population of learners is a major goal of U.S. educational policy. Access to, and participation in STEM enrichment is one way to increase STEM career interest. STEM enrichment has two primary benefits for traditionally marginalized populations.

First, participation in authentic applications of STEM through projects promotes interest in science and mathematics careers (Rukavina, Zuvic-Butorac, Ledic, Milotic, & Jurdana-Sepic, 2012). Due to differences in opportunities to learn, educational outcomes vary by educational settings and resource availability (Bell, Bricker, Reeve, Zimmerman, & Tzou, 2013). Hence, enrichment activities can serve as a means to address persistent gaps in opportunities to learn. The purpose of this article is to explain how teachers can adapt traditional STEM enrichment activities to support girls of color through culturally relevant instructional practices.

BACKGROUND

Gender and racial disparities are prevalent in STEM professions. Women hold approximately half of all jobs in the U.S. economy; however, they hold disproportionately fewer STEM degrees than their male counterparts and fill less than 25% of all STEM jobs (e.g., engineering) (Beede et al., 2011). Additionally, women who hold STEM degrees are more likely to work in fields such as education and healthcare (University of Sciences, 2012). Research suggests that gender disparities in STEM interest and achievement among students have narrowed significantly (Choi & Chang, 2011; Shapiro & Williams, 2012). Trends suggest that achievement differences have lessened across course taking, as well as content knowledge.

Girls in high school attempt a similar number of advanced mathematics courses as boys and those in grades two to eleven (i.e., grade levels most commonly tested via large-scale state standardized assessments) exhibit mathematics ability similar to that of boys on observed assessments (Hyde, Lindberg, Linn,

Ellis, & Williams, 2008). Correspondingly, Quinn and Lyons (2011) found no difference in science engagement between boys and girls, while others suggest that the science gender gap is a reflection of perceptions rather than ability (Knezek, Christensen, & Tyler-Wood, 2011). Unfortunately, racial achievement gaps remain, most notably between Black and Hispanic students and their White counterparts (Riegle-Crumb, Moore, & Ramos-Wada, 2011). To redress these inequities, it is important that teachers lead the charge in STEM success for girls of color.

DEVELOPING TEACHERS AS LEADERS IN STEM SUCCESS

STEM success for all begins in the classroom. According to Beier and Rittmayer (2008), teachers must recognize and reward achievement in STEM in order to foster positive STEM dispositions. Students who are STEM proficient and active in advanced courses are more likely to pursue STEM degrees (Sahin, Erdogan, Morgan, Capraro, & Capraro, 2013; Wang, 2012). Classroom experiences can foster these positive experiences (Aschbacher, Li, & Roth, 2010; Scantlebury, 2014). Teachers must provide instruction that supports knowledge building in K-12 and postsecondary classrooms (Lichtenberger & George-Jackson, 2013). These more general strategies provide support to all learners, but due to the persistence of dual marginalization based on race and gender, girls of color require additional classroom considerations.

Although research for, and support of, STEM teaching has increased and has far greater potential to benefit students, particularly girls of color, challenges still exist in recruiting and retaining high-quality teaching staff, maintaining funding, and making connections to formal learning standards (Dyer, 2004). High-quality teachers need adequate background knowledge, confidence, and efficacy for teaching STEM in order to be effective (Nadelson et al., 2013). In order to become more confident and effective teacher leaders in STEM, many teachers, especially at the elementary level, would benefit from opportunities to expand their content knowledge and engage in ongoing professional development training (NRC, 2011). Teachers who have strong STEM content knowledge and effective pedagogical skills are better prepared to be teacher leaders in STEM. Thus, teachers should receive STEM-specific instruction and mentoring that is relevant to their instructional practices and individual needs in STEM professional development training (NRC, 2011; Smith & Neale, 1991).

For example, Nadelson et al. (2013) examined the impact of attending a three-day summer institute designed to increase teachers' confidence, efficacy, content knowledge, and awareness of STEM professionals and careers. They found that the institute had a significant positive influence on teacher participants' efficacy for teaching STEM, confidence for teaching STEM, and attitudes toward engineering (Nadelson et al., 2013). Lotter, Smiley, Thompson, and Dickenson (2016) also found that middle school teachers who attended professional development over a three-year period (summer and school year) that focused on inquiry pedagogy and science content had statistically significant increases in the quality of their instruction, as well as in their self-efficacy for teaching through inquiry.

To help girls of color understand practices, concepts, and core ideas, teachers need to not only have the prerequisite content knowledge, but also be able to recognize students' diverse backgrounds and utilize instructional strategies to facilitate learning (Rivet & Krajcik, 2008). Focused preparation and ongoing professional training can help teachers develop the necessary content knowledge that contributes to self-efficacy (Schoon & Boone, 1998). The section that follows provides a discussion of how STEM enrichment can redress student negative experiences and low teacher self-efficacy.

TEACHER LED CULTURALLY RELEVANT STEM ENRICHMENT

Teacher led culturally relevant Out of School Time (OST) STEM activities have practical as well as educative merit. Opportunities to pursue STEM interests are not available in all schools, thus OST helps to address the opportunity gap (Woolley et al., 2010). STEM-related interests and aspirations

for girls of color emerge early (Watt & Eccles, 2008) and, as Young points out (Young, 2017), culturally relevant, gender specific STEM promotes and sustains positive STEM dispositions in girls of color. Hence, exposure to high-quality culturally relevant STEM instruction through OST activities is pivotal to developing and sustaining positive STEM dispositions amongst girls of color. The three components of culturally relevant pedagogy are present in the examples that follow:

1) Academic success;
2) Cultural competence; and
3) Sociopolitical consciousness.

Additionally, these examples are tailored to meet the unique learning needs of girls of color.

ACADEMIC SUCCESS

Success begets success, thus culturally relevant OST activities should promote academic achievement through productive struggle and opportunities to succeed. When appropriately executed, STEM OST engages youth in rigorous high-quality activities (Gupta, Adams, & Dierking, 2011; Vandell, Simzar, O'Cadiz, & Hall, 2016; Young, Ortiz, & Young, 2017). To support the learning needs of girls of color, teachers should create activities that support the "productive struggle". The "productive struggle" is an academic process that yields deeper conceptual understanding when a student's prior knowledge is insufficient to understand or address the given problem, or the student is unable to assimilate new information and thus struggles to complete the task.

Deeper learning occurs because the student is forced to reexamine, restructure what is already known in order to solve an unfamiliar problem (Hiebert & Grouws, 2007). This process helps students to correct and reconstruct prior knowledge, and construct new knowledge (Granberg, 2016). The productive struggle is the measured amount of academic frustration and rigor necessary to build resilience without destroying student self-efficacy. Thus, activities should be assessed using rubrics that incorporate multiple criteria for academic success.

CULTURAL COMPETENCE

OST programs provide valuable experiences that foster interest and help students realize how STEM connects to everyday experiences (Thomasian, 2011). OST provides exposure to learning experiences that can be impractical in many traditional school settings. For example, STEM enrichment affords students opportunities to reinforce practical connections by visiting museums and STEM-related businesses (Morana, Bombardier, Ippolito, & Wyndrum, 2012).

These visits however must be purposeful in order to bring STEM to life. Girls of color should be encouraged to identify the unique contributions of women of color to the exhibits and products presented during these interactions. For example, until their recent depiction in the movie "Hidden Figures" the contributions of Mary Jackson, Katherine Johnson, and Dorothy Vaughan have been absent from the mainstream history of NASA. Girls should be required to conduct research before visiting museums or businesses to uncover similar contributions from women of color. Uncovering and reporting the absence of these stories empowers girls of color by providing STEM related ethnically and gender matched aspirational role models.

Girls should be exposed to experiences that explicitly and tangentially reflect their cultural funds of knowledge. This can be accomplished by soliciting female engineers of color as guest speakers or mentors. According to Weber (2011), female university students, faculty, and alumni can serve as role models for girls in elementary and secondary schools by engaging in OST activities such as visits, guest lectures, after-school and summer programs, etc. Interactions with positive female role models in the scientific community can encourage girls to pursue their interest in STEM at the university level (Austin & Sax, 2006; National Research Council (NRC), 2006). This is important because girls of color are especially underrepresented in science.

SOCIOPOLITICAL CONSCIOUSNESS

Often women of color avoid STEM careers because of the lack of explicit opportunities to

serve their community; they tend to not be exclusively driven by the financial gains of the profession (Ellington & Frederick, 2010). However, by promoting social consciousness through culturally relevant pedagogy, girls of color may reconsider STEM careers. Thus, culturally relevant STEM activities should have a community focus (Young, Young, & Hamilton, 2013). For example, activities like designing a new playground for the local neighborhood would allow older girls to give back to their community schools. Alternatively, girls could research a social or health crisis that is prevalent in their community and then create a public awareness campaign. They could also investigate the science behind childhood obesity, diabetes, or other issues affecting their community and work toward solutions.

CONCLUSION

Women of color represent a proportion of diverse learners that remain underrepresented in STEM professions. The absence of women of color in STEM fields is a national concern (Hill, Corbett, & St. Rose, 2010). Women are represented in 50% of the U.S. jobs but hold less than 25% of STEM jobs (Bean et al., 2014). When categorizing data by race and gender, it becomes apparent that women of color are grossly underrepresented (Larke, Webb-Hasan, & Young, 2017).

Specifically, women of color represent only 10% of the professional STEM workforce (Feller, 2012). This suggests that women have experienced advances in STEM access; however, women of color remain particularly underrepresented in STEM professions. In conclusion, we propose that teachers begin to consider the effect of culturally relevant STEM to support girls of color in OST activities.

Teachers as leaders have a participatory obligation to support all learners, and in the essence of equity, it is important that teachers are attentive to the traditionally marginalized. It is our hope that teachers currently leading afterschool clubs and competitions will consider making these spaces more culturally relevant to support the access and achievement of girls of color. Strong teacher leaders can advance this cause by mentoring their peers and facilitating professional development trainings that are applicable to STEM OST activities. Greater opportunities for STEM professional development, especially those that help teachers build upon culturally relevant teaching, are needed for both pre- and in-service teachers who desire to serve as teacher leaders in STEM.

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