



## **Effective Identity-Safety Cues for Assuaging Social Identity Threat of Young Black Girls in STEM (Work in Progress) (Diversity)**

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## Introduction

Despite efforts to diversify engineering fields, issues with representation persist. In the U.S., women receive only 21% of bachelor's degrees in engineering, and black women account for only 1% of these degrees [1]. Many issues may contribute to the underrepresentation of black women in engineering, but one area that seems particularly fruitful to explore is that of identity. Identity is a person's conception of self, and a positive STEM identity is associated with career aspirations in STEM fields [2]. For women pursuing college STEM degrees, perceived identity compatibility between identifying both as a female and as a STEM student is associated with greater engagement in STEM and lower expectations of leaving the STEM major [3]. Out-of-school contexts are uniquely situated to support students' identity development because they can deconstruct the racialized history and hierarchies that are entrenched in U.S. social systems such as schools [4]. Research findings have shown that out-of-school contexts can support youth in developing new skills and talents, promote self-efficacy, and foster positive identity and belief in the future [5] – [7]. These programs can be a platform for authentic STEM opportunities to support developing STEM identities [8] – [10].

Previous research on social identity threat in STEM suggests that identity-safety cues, including exemplars (i.e., counter-stereotypical examples), role models, and positive contextual factors (i.e., identity-safe environments), assuage social identity threat concerns amongst underrepresented undergraduate students and professional women [11], while identity-safe classrooms promote trust and belonging [12]. However, little is known about the impacts of identity-safety cues on underrepresented girls. This research represents the initial phase of a project that will investigate perceptions of identity safety and the impacts of stereotype threat at multiple points along the STEM education pipeline. This phase of research explores a STEM Academy that integrates educational activities aimed at building intellectual, cultural and emotional assets of learners. The following research questions are investigated:

1. Which identity-safety cues are emphasized within the STEM Academy?
2. How, if at all, does the perceived presence of identity-safety cues differ amongst STEM Academy leaders?
3. What identity-safety cues do parents of STEM Academy participants view as important for supporting student identity (i.e., sense of belonging, safety, and conception of self)?

## Literature Review

**Identity development.** According to Gee [13], identity is a person's conception of self and can be viewed as a result of natural forces, a position given by institutional authorities, a trait recognized in a dialogue with others, or experiences shared in groups. A number of identity theories posit that identity development commonly occurs during adolescence [14], [15], making the middle and high school years a key developmental phase for investigating how students view themselves and their future possibilities. Identities are formed through practice and are impacted by the individual's interests and experiences, but also by social setting, power, privilege, and oppression [9]. Social identity complexity theory holds that individuals have multiple identities that vary depending on context [16]. A student in STEM may therefore simultaneously identify as female, belonging to a specific racial or ethnic group, and possessing an interest in STEM.

Having a positive STEM identity can contribute to career aspirations in STEM fields [2]. Identities are therefore impacted by the opportunities girls have and whether they are able to develop consistent identities across settings, with greater variation in identities leading to feelings of self-doubt or lack of belonging.

**Stereotypes and social identity threat.** Negative stereotypes about skill and suitability of females in mathematics and science continue to be pervasive in U.S. society [17], and girls are well aware of negative stereotypes about females in STEM by age 10 [18]. Social identity threat has been proposed as a key contributor to women's underperformance and low participation in STEM settings [19]. Consequences of stereotype threat include decreased performance in academic and non-academic domains, increased use of self-defeating behaviors, disengagement, and altered professional aspirations [19]. Stereotype threat can result in a fear that individual performance on a task will be judged according to a negative group stereotype [20]. Female college calculus students who ascribed to the stereotype that women have lower mathematics ability than men experienced less sense of belonging, lower grades, and less desire to pursue mathematics in the future [21]. Similar findings were reported among elementary students [22]. With numerous stereotypes about who is successful in STEM, it can be difficult to identify both as girls of color and as individuals who are interested in STEM. However, some level of compatibility between students' personal identities and scientific identities may be a prerequisite to learning [23]. Greater compatibility between multiple identities is linked to a number of positive outcomes for females in STEM, including lower stress, reduced self-doubt, and higher academic performance [3], so it is necessary to look for ways to help girls see STEM identities as compatible with their identities as females of color.

**Situational context and identity-safety cues.** This research relates to one of the two main threads of identity threat research, which is to develop strategies to remove threat from a local environment [24]. It is believed that by changing the situational cues in an environment, the experiences of identity threat can be reduced [25]. Situational cues, or information about whether a group is accepted and valued in a specific context [24], [26], [27], contribute to experiences of identity threat and ultimately have direct impacts on the formation of STEM identities. According to Murphy and Taylor [27], situational cues are relevant because they elicit identity-related concerns about belonging, institutional fairness, and being marginalized in a setting, particularly among underrepresented groups in academic settings and women in STEM. Just as it is possible to design a space or program with threatening cues, it is equally plausible that a space or program may be designed with identity-affirming or identity-safety cues that suggest to people that their social group is welcomed, respected, and will pose no barrier to advancement [28], [29]. Though situational cues have the potential to trigger and diffuse social identity threat [24], the extent to which individual identity-safety cues (e.g., conveying that diversity is valued, supporting students' sense of belonging, etc.) [30] work to diffuse stereotype threat and promote identity amongst young women is little understood. Understanding the role, impact, and design of these strategies to reduce stereotype threat is one of the primary goals of this project.

## **Methodology**

**Context.** This study focuses on a STEM Academy run by a local chapter of an international not-for-profit organization. The not-for-profit is committed to enriching, sustaining, and ensuring the cultural and economic survival of African Americans and other people of African Ancestry. Led

by a planning team of 12, the local chapter of approximately 60 members in the south-central U.S. has delivered STEM Academy programming for 8 years, with the goals of promoting self-confidence, communication, critical thinking, innovation, and STEM career interest and awareness. In addition to work with girls, the STEM Academy involves parents in discussions of college admissions and financial aid; academic preparation for college; social needs and expectations; and schooling options: 4-year college; community college, predominantly white institutions (PWIs), and historically black colleges and universities (HBCUs).

Over the last eight years, the STEM Academy has had over 400 girls in grades 7-12 participate, enrolling an average of 50-60 middle and high school girls each year. These STEM Academy scholars participate in 10 sessions annually between August and May, including a program orientation, six STEM technical activities, a team building activity, a community service event, and a culmination ceremony at the end of the year. The six technical sessions differ from month to month but generally include hands-on activities that expose girls to new STEM-related careers. Program participants are identified through school counselors, recommendations from family and friends (i.e., former participants), and recruitment efforts undertaken by STEM Academy organizers. Students complete an admissions application and are selected into the program. However, program coordinators make every effort to meet the needs of all students who express interest. The STEM Academy has graduated 16 girls since 2017, each of whom participated in the program for five or more years (i.e., 6<sup>th</sup> through 12<sup>th</sup> grade), and seven more graduates are expected at the end of the 2019-2020 academic year.

**Participants.** This research uses a triangulation approach [31] to collect data from multiple groups. In this first phase of research data was collected from the adults involved with the STEM Academy, including the STEM Academy organizers (i.e., local chapter planning team) and parents of girls currently enrolled in the STEM Academy. In the future, this project will also work directly with the underrepresented middle and high school girls enrolled in the STEM Academy and the graduates of the STEM Academy (i.e., those who matriculated through 12<sup>th</sup> grade and have moved on to post-secondary endeavors).

**Approach.** Because STEM identity is evaluated and documented through both qualitative and quantitative approaches [32], this research utilizes a multi-phase mixed-methods design using surveys, interviews, and focus groups to elucidate identity-safety cues associated with the STEM Academy and girls' engineering identity formation. Interviews with leaders of the STEM Academy planning team were used to collect information about the Academy mission, vision, and programming. Preliminary perceptions about existing programming strategies to support girls' STEM identities were also discussed. A list of empirically validated strategies for reducing stereotype threat [30] was then included in a survey and distributed to the local chapter membership (n = 58) to assess the perceived importance of each strategy, the extent to which the strategy was represented in the STEM Academy, and to highlight areas for programming improvement. Twelve members responded to this survey.

A focus group of 12 parents of currently enrolled STEM Academy participants was then assembled. This step in the analysis sought to uncover parents' perceptions of cues that currently support student sense of belonging and safety. Additionally, parents were asked about cues that would be needed for the continued support of their students as they move into higher education.

Parent responses to semi-structured questions were analyzed to extract key themes. Preliminary results from this initial phase of research are presented below.

### Analysis and Findings

**STEM Academy planning team.** Twelve women involved in planning and implementing STEM Academy programs responded to the initial survey invitation. Using a 1-5 Likert scale (5 = most important/representative), they rated each identity-safety cue in response to two prompts: the general importance of that cue and the level of representation of that cue in the STEM Academy. Mean responses are shown in Table 1.

Table 1. Importance of Identity-Safety Cues and their Representation in the STEM Academy

Identity-Safety Cue	Importance	Representative of STEM Academy
Strategy 1: Conveys that diversity is valued	4.3	4.0
Strategy 2: Creates a critical mass	4.2	4.2
Strategy 3: Values students' individuality	4.2	3.8
Strategy 4: Improves cross-group interactions	4.0	3.7
Strategy 5: Presents and recruits positive role models from diverse groups	4.4	4.4
Strategy 6: Helps students manage feelings of stress and threat	4.0	3.5
Strategy 7: Supports students' sense of belonging	4.3	3.9
Strategy 8: Conveys high standards and assures students of their ability to meet these standards	4.2	4.4
Strategy 9: Promotes a growth mindset about intelligence	4.0	3.9
Strategy 10: Value-affirmations to reduce stress and threat	4.1	3.8
Strategy 11: Helps students overcome stereotypes about who is successful in STEM	4.5	4.4

In addition to the Likert scale items, the survey also included open-ended prompts for respondents to describe their perceived areas of success in the STEM Academy. Qualitative analysis of these responses revealed successes related to a focus on developing new skills and talents within participants [5] – [7], providing role models [11], in the practice of doing STEM, and in forming a critical mass [11]. Sample quotes from respondents include:

- *“The scholars are involved in activities that call on their planning, organizing, and evaluation skills. The sessions are more than lectures and observation. They are about doing.”*
- *“Providing positive role models for the girls. Introducing the girls to all areas of STEAM careers.”*
- *“Diversity of experiences to include diverse participants who are potential role models.”*
- *“The scholars are involved in activities that call on their planning, organizing, and evaluation skills. The sessions are more than lectures and observation. They are about doing.”*
- *“Getting together.”*

In response to an open-ended prompt related to areas for future improvement for the STEM Academy, respondents revealed a desire for an increased focus on mentoring experiences; greater focus on STEM careers; greater focus on hands on experiences; and opportunities for student reflection [30]. For example, they suggested one-on-one mentoring opportunities and student evaluation of experiences as potential areas for growth.

**STEM Academy parents.** The following themes emerged as most important from the parent-perspective for supporting student sense of belonging, safety, and conception of self (listed in order of importance based on the list of validated strategies presented in Table 1 above):

- Strategy 5: Present and recruit positive role models from diverse groups
  - Expose students to successful role models from their groups who refute negative stereotype.
- Strategy 2: Create a critical mass
  - Increase the visibility and representation of people from minority groups in a field [26], [33], among test-takers [34], and in positions of authority such as teachers [35] – [37].
- Strategy 11: Helps students overcome stereotypes about who is successful in STEM
  - Remind students of similarities among groups [38].
  - Undo stereotypical associations through cognitive retraining [39].
- Strategy 4: Improve cross-group interactions
  - Foster better intergroup relations [40] – [42].
  - Promote cooperative classrooms [43], [44].

Focus group participants also placed an overwhelming emphasis on the need for the following characteristics not easily categorized in terms of the empirically validated list of strategies supporting identity-safety: social supports (e.g., support from friends, family, peers, and church); acceptance, friendliness, kindness; small class sizes; and innate courage to speak to others and approach peers and teachers/professors.

### **Discussion, Next Steps, and Anticipated Contributions**

Preliminary results show shared perceptions around the importance of presenting and recruiting positive role models from diverse groups, creating a critical mass, and helping students overcome stereotypes about who is successful in STEM. Program organizers also emphasized conveying the importance of diversity, while parents emphasized promoting cooperation between individuals of diverse groups. In the next phase of research, the identity-safety cue survey will be administered to STEM Academy alumni ( $n = 16$ ) who have graduated high school. Semi-structured interviews will be conducted with graduates to gain an understanding of their perceptions of the importance of identity-safety cues. Interview transcripts will be analyzed using inductive coding methods.

As an investigation of identity formation, this research expands knowledge needed to support the continued growth and increased diversity of the STEM pipeline. Understanding student views of identity-safe environments will serve to enhance programming for improved STEM persistence. Furthermore, this study will allow us to develop a conceptual model for the development of identity-safety environments and programming that support STEM identity formation and interest amongst underrepresented girls. With a focus on K-12 participants, this research broadens our understanding of the role that informal educational communities and networks play in supporting identity formation. The inclusion of STEM Academy alumni will broaden our understanding of STEM persistence through transitions from high school to college.

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