



Pre-college STEM camps as developmental context: Mediation relations between gender, career decidedness, socioemotional development, and engagement



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ABSTRACT

One potential mechanism to mitigate the underrepresentation of females within STEM is the use of Out-of-School-Time programs and camps with supportive staff, instructors, and parallel orientation towards socioemotional development. This study examines factors which may mediate the relation between gender and STEM career aspiration within a pre-collegiate week-long STEM camp experience among a sample of 365 adolescent campers. Campers were an average of 15.58 years old, primarily white (69.8%), and male (51.8%). The results of the mediational structural equation model (SEM) suggested socioemotional development did not mediate the relation between gender and career decidedness, and there was no statistical difference between male and female STEM career decidedness. The lack of effect could be a result of the systematic and ongoing emphasis towards the development of STEM skills and aspiration within minority and underrepresented groups, specifically females.

1. Introduction

An aggregate of research examining the career fields of science, technology, engineering, and math (STEM), indicates a longstanding marginalization and absence of women from the field (Hughes, Nzekew, & Molyneaux, 2013; Wang & Degol, 2017). While the causes and consequences of the lack of representation of these groups within STEM are seemingly well documented (Dasgupta & Stout, 2014; Wang & Degol, 2013), exploration to establish strategies to address these deficiencies remain ongoing. Specifically, one potential mechanism is the use of informal science programs and semi-structured STEM courses to encourage the continuous participation of unrepresented groups across STEM career paths, with a specific focus on youth STEM programs to encourage them in their future careers (Beier et al., 2018; Holmes, Redmond, Thomas, & High, 2012). However, the factors within these programs that promote STEM career decidedness are less understood (Beier et al., 2018; Liben & Coyle, 2014). Consequently, the present study examines factors which may enhance STEM career decidedness through the attendance of pre-collegiate STEM programs. Below research exploring the gender gap within STEM careers is explored, literature examining potential contributors to STEM program success are shared, and the current study is presented.

1.1. The gender gap within STEM

The gender gap within some aspects of the STEM career field is potentially declining; in some areas, girls and young women are performing equivalent to or better than their male counterparts in STEM competencies (Klahr, Triona, & Williams, 2007). Indeed, Stoet and Geary (2018) illustrated adolescent females tended to perform as good or better than their male counterparts in science, mathematics, and reading competencies. However, the overall representation of women within actual STEM remains limited compared to men (Eccles, 2011). For instance, about 50% of all science and engineering (S&E) degrees have been awarded to women since the late 1990s, but approximately 64% of scientists or engineers working in the for-profit S&E sector are male (National Science Foundation, 2017). While there are other potential outlets for STEM employment (e.g., education, government), the for-profit sector is the largest STEM employer, “regardless of gender, race, ethnicity, or disability status” (p. 12, National Science Foundation, 2017). The lack of balance between degrees awarded (50% male: 50% female) and those actually employed in their degreed field (64% male: 43% female) represents a challenge within STEM, pointing to a potential issue with pipeline for young women and girls interested in a STEM career (Stoet & Geary, 2018). Put differently, it appears the

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early competencies and requisite skills sets are present in both adolescent females and males, but females tend to engage in STEM careers at lower rates and in many cases forgo participating in a STEM centered college major, representing a potential “exodus of talent among girls and women who could otherwise become the next generation of scientists, engineers, and creators of technology” (Dasgupta & Stout, 2014, p. 22).

1.2. Out-of-school-time programming to enhance STEM career decidedness

The motivation to pursue (or not pursue) a STEM career may begin in adolescence (Lubinski, 2010), where a variety of macro- and micro-level factors can inhibit later gender equity across STEM fields (Sinclair, Nilsson, & Cederskar, 2019; Stoet & Geary, 2018). More specifically, evidence suggests gender disparities within STEM appear early in adolescence, illustrating the need for “intervention” at phases earlier than emerging adulthood (e.g., 18–24 years old) where STEM equity programs are more frequent (Kang, Hense, Scheersoi, & Keinonen, 2019). For instance, out-of-school-time STEM programs that target early to middle adolescents have been associated with the development of STEM competencies and corresponding confidence in one’s “fit” or desire towards a STEM career, in both mixed gender settings and female only settings (Holmes et al., 2012; Hughes et al., 2013). In a review of research examining the gender gap within the STEM field, Wang and Degol (2017) noted career paths and preferences are often established in adolescence, and gender frequently plays a meaningful role in this decision-making process. Programs that cultivate aspiration towards STEM-centered learning in adolescence could lead to meaningful decreases in the gender gap within STEM (Wegemer & Eccles, 2019).

Both within-school and out-of-school-time (OST) STEM programs serving adolescents are generally orientated to enhance engagement and motivation in STEM centered learning (Kong, Dabney, & Tai, 2014). In many cases these programs are designed to foster youth motivations to engage in advanced STEM learning (i.e., college major selection) and careers (Dasgupta & Stout, 2014; Jungert, Hubbart, Dedic, & Rosenfield, 2019), especially for cohorts historically underrepresented in STEM (e.g., some ethnic/racial minorities, persons with disabilities, females) (Eccles & Wang, 2016; Gasiewski, Eagan, Garcia, Hurtado, & Chang, 2012). For example, an emerging body of evidence suggests participation in these STEM centered experiences may enhance female motivation to engage in further STEM education, conceptualized by an improvement or shift in decidedness on a STEM centered career (Mohr-Schroeder et al., 2014; Wang & Degol, 2017). However, research in this area is relatively scant and based primarily upon college student (i.e., 18–24 years old) samples rather than adolescents, illustrating a gap in our understanding of how these programs may decrease gender effects on STEM career decidedness at earlier phases (Kang et al., 2019).

In seeming parallel with the developing research exploring contributors to the gender gap within STEM, there is an escalation in research regarding the role of OST STEM programs on addressing this gap. More specifically, research examining OST STEM programs has shifted focus from solely on STEM program attendance and outcomes, to an additional focus towards understanding the qualities of STEM programs which best promote continuous STEM-centered learning and career development (Kong et al., 2014; Wang & Degol, 2013). This shift towards a more complete story of the “how and what” of OST STEM programs and camps has increased understanding of mechanisms which may magnify desirable program effects. For example, when a responsive and supportive instructor is present within a STEM course, students tend to become more motivated and perform at higher effort levels in proceeding STEM contexts and courses (Kramer et al., 2018; Leon, Nunez, & Liew, 2015). Similarly, in the context of summer STEM experiences, camp counselors can play a unique role in the improvement of aspirations towards a STEM career (i.e., career decidedness). This focus towards motivations was demonstrated by Fields (2009) who indicated caring and supportive counselors enhanced STEM learning,

and career decidedness among adolescent campers. In a broader study of OST programs, Tiffany, Exner-Cortens, and Eckenrode (2012) illustrated similar findings, where the presence of caring and supportive staff tended to enhance programmatic quality. Explicating on the unique contexts within STEM programs, some research also suggests the intentional exposure of youth to active scientists, may narrow the gender gap within STEM, where female participants become more likely to shift to a STEM career path after their participation in these programs, due in part to role modelling behaviors demonstrated by STEM instructors and scientists (Kang et al., 2019; Mohr-Schroeder et al., 2014; Mostache, Matloff-Nieves, Kekelis, & Lawner, 2013).

Importantly, simple attendance of a STEM program alone is likely insufficient to improve an adolescents STEM career decidedness levels, rather *quality* of participation and *engagement* with a particular program or setting tend to also represent necessary conditions for outcome achievement (Roth, Malone, & Brooks-Gunn, 2010; Simpkins, Little, & Weiss, 2004). Further, there is a breadth of literature linking caring and supportive staff behaviors with greater rates of participant engagement and corresponding achievement of desirable program outcomes in the broader sphere of adolescent program research (Simpkins, 2015; Tiffany, Exner-Cortens, & Eckenrode, 2013) and to a lesser degree within STEM centered programs (Beier et al., 2018; Kramer et al., 2016; Leon et al., 2015). The links between supportive staff behaviors, camper engagement, and camper outcomes illustrate how quality STEM summer programs (e.g., science camps) can lead to greater engagement with STEM coursework, greater aspirations towards STEM college majors, career interests, and improved self-confidence among males and females (Dieker, Grillo, & Ramlakhan, 2012; Fields, 2009; Kong et al., 2014).

1.3. Socioemotional skill development within OST STEM programs

Although underexamined within the context of STEM program research, the development of socioemotional skills and self-determinate behaviors (e.g., autonomy, relatedness, competence) in parallel with STEM career decidedness represents an additional conduit to understand how to best serve and cultivate the next generation of STEM professionals (Beier et al., 2018; Jungert et al., 2019; Kramer et al., 2016; Wilson et al., 2015). Indeed, some research suggests programs that also target and foster socioemotional skills are more likely to enhance STEM career decidedness and motivations to engage in current and future STEM education (Falk et al., 2016; Guay, Senecal, Gauthier, & Fernet, 2003; Leon et al., 2015). For instance, programs emphasizing the development and/or enhancement of friendship skills, self-esteem, and communication abilities can facilitate a sense of belonging to a community interested in STEM and thus enhance motivation to more readily involve oneself in later STEM-centric opportunities (Eccles, 2011; Sinclair et al., 2019). This engagement and satisfaction with course materials and activities has been associated with greater rates of aspiration towards STEM and academic performance (Vedder-Weiss & Fortus, 2011; Wilson et al., 2015). For instance, in an examination of the relationship between gender and motivation within STEM, Solanki and Xu (2018) demonstrated when female undergraduate students develop greater levels of motivation, they are generally more engaged with their STEM course work.

Pre-collegiate STEM summer camps may offer one potential context to develop these socioemotional and motivational skills in parallel with STEM career aspirations and career decidedness (Bevan, Petric, & Wilkinson, 2014; Kang et al., 2019). Indeed, research examining career path development programs among adolescents suggests levels of career decidedness are often intertwined with positive youth development and wellbeing (Hirschi, 2009; Lubinski and Persson-Benbow, 2006). At a broader level, research examining camp as a context for positive youth development suggests engaged participation can improve youth communication skills, attitude, self-regulation, exploration and curiosity, cooperation skills, and personal responsibility (Garst & Gagnon,

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