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Informal Learning Environments and Impact on Interest in STEM Careers

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Abstract
Little research has been done to examine the impact of informal science, technology, engineering, and mathematics (STEM) learning on middle school students' career aspirations. Participants included 507 incoming fifth through eighth graders from underrepresented populations in STEM fields, which were recruited at three sites. Data collected included semi-structured interviews, session reflection forms, and surveys administered before and at the end of the STEM summer learning experience. Social Cognitive Career Theory was used to examine the extent middle school students' experiences at a STEM summer learning experience influenced their interest in STEM careers. Quantitative data were examined related to self-efficacy. Self-efficacy scores after the STEM learning experience were significantly higher than initial self-efficacy scores and justified further qualitative analyses. A deductive approach was used to analyze the qualitative data. The themes of role models, influence of the STEM summer learning experience, applicability of STEM, and empathy were revealed. Many students reported they were drawn to a specific STEM career because they wanted to help a person for whom they care about, such as a sibling with an illness or a family member battling cancer. This study demonstrates the need to provide all students the access and opportunity to engage in authentic, hands-on learning experiences that connect STEM to their daily lives, increase their interest in STEM, and introduce them to different STEM careers so they make more informed decisions about future STEM career choices and suggests that the role empathy plays in fostering students' interest in STEM be further examined.

Keywords Empathy in STEM · Informal learning · STEM education · Student interest in STEM careers

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With the increasing need for STEM (science, technology, engineering, and mathematics) workers, it is estimated the number of STEM jobs will increase by one million between the years 2012 and 2022 (Bureau of Labor Statistics, 2017). Despite this increased need, the number of students who pursue STEM majors is decreasing (National Science Board, 2016). Students' inaccurate perceptions of and perceived lack of connection to STEM careers negatively impact their interest in STEM careers (Wyss, Heulskamp, & Siebert, 2012).

Choices middle school students make impact their future education and career pursuits (Trusty, Niles, & Carney, 2005). However, they often are not provided ample information about STEM careers to make informed decisions about their futures (Wyss et al., 2012). Researchers (Mohr-Schroeder, Bush & Jackson, 2018) found that when students have authentic STEM experiences, their interest in STEM and pursuing STEM careers increased. Consequently, informal STEM learning experiences are one way to provide students with authentic experiences that can positively impact students' perceptions of STEM and increase their interest in STEM (Mohr-Schroeder et al., 2014; Roberts et al., 2018) and as a result their interest in STEM careers (Kitchen, Sonnert, & Sadler, 2018). This need for access to STEM learning experiences inspired the creation of the See Blue See STEM Model.

Developed in 2010 at University of Kentucky, the See Blue See STEM Model is a 1-week summer learning experience for middle level students. The summer learning experience provides students access to authentic hands-on STEM activities facilitated by STEM professionals (e.g. STEM education, industry) with the goal of increasing students' interest in STEM, which is a primary factor that influences an individual's choice to select a STEM career (Beier & Rittmayer, 2008; Dayton, 2013; Mitchell, 2016; Ray, 2016). The STEM professionals create a community of practice (Kelley & Knowles, 2016) where students participate in engaging, authentic learning that is "representative of an experience found in actual STEM practice" (Kelley & Knowles, 2016, p. 4). The See Blue See STEM Model has significantly expanded at University of Kentucky and has been replicated at Iowa State University and California State University, Long Beach.

While research exists on developing students' interest in STEM through informal learning environments (e.g. Mohr-Schroeder et al., 2014; Roberts et al., 2018), limited research focuses on middle level students' STEM career aspirations. In this study, guided by Social Cognitive Career Theory (SCCT), we address the following research question: *To what extent do middle school students' experiences at a STEM summer learning experience influence their interest in STEM careers?*

Theoretical Framework

According to SCCT, the choices people make and the actions of putting their choices into practice are related to their interests (Lent, Brown, & Hackett, 1994). Numerous studies (Bahar & Adiguzel, 2016; Lloyd, Gore, Holmes, Smith, & Fray, 2018; Miller, Sonnert, & Sadler, 2018; Nugent et al., 2015) identify personal interest as the primary factor that influences one's career choice, particularly in STEM. Some people compromise their interests if they perceive barriers will get in the way of their career choice (e.g. limited opportunities, non-supportive environments, job availability, self-efficacy

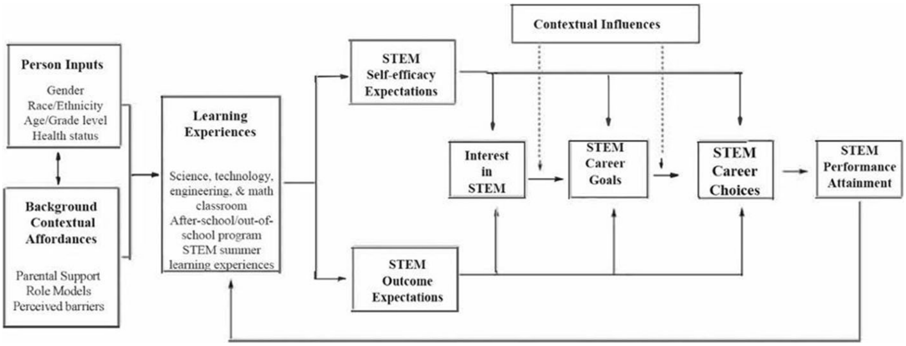

Fig. 1 Adapted SCCT framework as it relates to STEM career choice and informal learning

beliefs) (Bandura, Barbaranelli, Caprara, & Pastorelli, 2001; Brown, 2002). For this study, we adapted Brown's (2002) SCCT model to reflect a STEM context (see Fig. 1).

According to Fig. 1, person inputs and background contextual affordances (environmental factors) interact to influence learning experiences in STEM, which play a critical role in the formation of self-efficacy and outcome expectations, both of which form the basis for developing career interests. Self-efficacy relates to confidence in one's ability to control one's own motivation and behavior (Bandura, 1986, 1997), while outcome expectations pertain to perceived consequences of a behavior (Lent, Brown, & Hackett, 2002). Background contextual affordances influence learning experiences that may either constrict or enhance the development of self-efficacy and outcome expectations—directly impacting career-relevant decisions. For the purpose of this study, we focus solely on middle level students' interest in STEM careers.

Review of Literature

The literature review is based on three prominent components of the SCCT model: (a) influences, which relate to students' person inputs and background contextual affordances; (b) informal STEM learning experiences; and (c) self-efficacy as it pertains to students and their interest in STEM and STEM careers. We then discuss empathy and its role in the SCCT model.

Influences

Parents influence an individual's decision regarding a STEM career, and their influence on career choice is stronger than any other social group (Ing, 2014). This may be due to the parental influence on students' self-efficacy and educational goal setting. Several studies (e.g. Bahar & Adiguzel, 2016; Sellami et al., 2017) report cases where either or both parents exert influence. Durbin (2013) found the father has a more significant effect on individuals career choices especially for those who opt for a career in engineering, and Harwell (2012) found students with at least one parent in a STEM field chose to major in a STEM discipline at a higher rate than students without parents in STEM. Unfortunately, some parents unconsciously pass onto their children their own gendered-stereotyped notions about STEM careers (Jahn & Myers, 2014; Lloyd et al., 2018). Parents provide guidance and motivation in their child's career choice.

Informal Learning Experiences

Limited research exists on informal STEM learning and its influence on students' interest in pursuing STEM careers. Students who participate in STEM competitions (e.g. robotics, engineering, science fair) and afterschool STEM-related programs are more likely to express interest in a STEM-related field than those who do not participate and participating in more than one competition increases the impact by three times (Miller et al., 2018). An after-school robotics program, organized by FIRST (Melchior, Burack, & Hoover, 2018), influenced students' choice of college majors, first-year courses, and STEM related co-curriculars. Informal STEM experiences also enhance students' self-efficacy in STEM careers (Halim, Rahman, Ramli, & Ellany, 2018). Participation in informal learning experiences during high school increased females' interest in STEM, especially for females who did not have an initial interest (Dabney, Johnson, Sonnert, & Sadler, 2017).

STEM Self-Efficacy

In SCCT (Brown, 2002), self-efficacy leads to an enduring interest in an activity. Self-efficacy is the self-perceived competence of an individual (Bandura, 1977), and it is not particular to distinct conditions or tasks. Instead, self-efficacy is the beliefs individuals have about their abilities to make connections and perform skills across contexts (Bandura, 1977). An individual with high self-efficacy believes they can perform in a way that will produce a desired outcome (Maddux, 2016). Self-efficacy beliefs develop across time, contexts, and experiences. Social and cultural interactions where individuals feel included facilitate the development of self-efficacy while feelings of exclusion hinder the development and deter an individual from gaining interest in that area (Bandura & Wessels, 1997).

The development of self-efficacy empowers individuals to explore and try new things creating an opportunity to develop a sense of agency (Maddux, 2016). When individuals develop agency, they gain a sense that they have influence on their life course and pursuits (Bandura, 1990; Schwartz, Côté, & Arnett, 2005). Moreover, according to Baumeister and Leary (1995), a sense of belonging is the underlying force that drives motivation, interest, and the development of self-efficacy related to career pursuits. For instance, several studies identified self-efficacy (Halim et al., 2018; Patterson, 2011; Tuijl & Molen, 2016) and motivation (Bahar & Adiguzel, 2016; Wang & Degol, 2013) as key factors for individuals choosing a STEM career. Thus, interest, motivation, and sense of belonging are critical components of developing self-efficacy.

Positioning the Role of Empathy in SCCT

Empathy is the abstract notion of being able to mentally identify oneself with, as well as fully understand, another person (Brown, 1996). This definition articulates a clear importance of "feeling with" and not simply "feeling for." The concept of "fully comprehending another person" immediately raises concerns about the validity as well as the possibility of such a difficult idea, especially with all the complexities that define another person (Cooper, 2011). Although empathy remains abstruse, it is far too critical for the growth of students and their ability to understand real-life situations to go unexamined (Cohen, 2001). Empathy is developed over time and is to be fostered through authentic experiences (Rogers, 1975).

We propose empathy may play an important role within STEM education and students' career choice. Positioning empathy within STEM education can make learning more meaningful to students, as they ultimately can see the impact of STEM within their lives and the lives of others (Sun, 2017). Mcgee and Bentley (2017) noted STEM education must evolve to move beyond the simplistic pathways to socioeconomic success to become more equity, altruistic, humanitarian focused, and contend that embracing empathy could portray a larger access to STEM related careers for all students (especially those of marginalized populations). The current force of STEM learners has an immense desire to improve the current disarray of global concerns (e.g. diminishing world-health, economic concerns, quality of life-disparities), and thus, STEM education needs to address these concerns, or students will not feel connected to STEM training or careers (Mcgee & Bentley, 2017). This empathy, as defined, must be built through experiences that emphasize students using STEM education and practices to address real-world issues, so ultimately, students can see how STEM can be used in their everyday lives.

Bush and Cook (2019) examined the role of fostering student empathy through integrated learning experiences, specifically integrated STEAM (STEM with the inclusion of the arts) education. Bush and Cook (2019) stated empathy is a vehicle for inspiring students to engage in solving authentic problems to make the world a better place. In their study, Bush, Cook, Edelen, and Cox (under review) found that not all integrated STEAM inquiries are of equal quality, and the ones that engaged students in empathetic problem solving provided the most transformative learning experiences for students. Further, in a paper focused on the role of empathy, Edelen, Bush, Simpson, Cook, and Abassian (in-press) argued empathy can be key to help students connect with contexts that may otherwise be distant to them and through such opportunities we allow students to "holistically develop as humans" (n.p.).

We position empathy as a potential bridge from students' informal STEM learning experiences to interest in STEM and STEM careers. Empathy changes the way STEM experiences impact students' STEM career interest because a student with empathy can engage with STEM's ability to make a life-changing difference in their and others' lives. However, students who engage in STEM without empathy may only relate to a STEM experience via its "wow" factor or their own natural curiosity.

Methodology

In SCCT theory, interest in STEM and STEM career goals is influenced by self-efficacy (Brown, 2002); therefore, an explanatory mixed methods design was used to explore the relationship between self-efficacy and students' interest in STEM careers. Mixed methods research provides a more comprehensive explanation of a research problem than either a qualitative or quantitative study can do alone (Creswell, 2014). A naturalistic inquiry methodology was also used to explore students' interest in STEM careers while participating in a weeklong STEM summer learning experience. Naturalistic inquiry allowed us to examine the multiple realities students created during students' experiences (Lincoln & Guba, 1985). Meanings are created by students' participation in specific settings and contexts (Crotty, 1998). Using a deductive approach with SCCT as a lens, we explored students' "lived experiences" (Van Manen, 1990) specific to the setting of the STEM summer learning experience. Their participation offered insight into the meaning students gave their experiences and how those experiences influenced their career interests can be investigated (Merriam, 2009).

See Blue See STEM Model

Named a Top 5 model for Broadening Participation at the 2015 EPSCoR National Conference (Mohr-Schroeder, 2015), the See Blue See STEM model is a 1-week summer learning experience that has served more than 1000 students in grades 5–8 and introduces students to a variety of integrated STEM content and practices through high-quality, authentic, hands-on learning experiences from collaborating STEM professionals in the Colleges of Arts and Sciences, Education, Engineering, Medicine, and practitioners in the private sector (e.g. STEM industry experts). The STEM professionals involved change each year and provide students the opportunity to engage in a wide range of STEM disciplines in authentic settings. The science and engineering practices (NGSS Lead States, 2013) and the standards for mathematical practice (CCSSI, 2010) are incorporated in the STEM learning experiences.

In the See Blue See STEM model, students participate in robotics (e.g. LEGO Mindstorm EV3, Vex) or EDISON for 3 h each day. The robotics provide an inviting and inspiring context for students to actively build, explore, investigate, collaborate, and communicate together to develop problem solving and programming skills. The other 3 h of each day are spent in different content sessions, such as the "Explorations in Biomedical Science: DNA Extraction" offered by University of Kentucky. Students explored DNA with a content professional from the College of Medicine, even extracting and examining their own DNA. This allowed students to engage in the Standards for Mathematical Practice (e.g. attend to precision) and the NGSS Science and Engineering Practices (e.g. planning and carrying out investigations).

Reform-based pedagogical practices are central to the See Blue See STEM model. Students engage in hands-on learning experiences that are authentic to the discipline, that are facilitated by experts in the field, and that actually occur in STEM workplaces. Students collaborate as a community of practice to learn, apply, and refine their ideas by engaging in discipline specific practices. Science and mathematics content is applied through the hands-on explorations students complete. In short, students participate in integrated STEM learning in a community of practice where "learning is authentic and relevant, therefore representative of an experience found in actual STEM practice" (Kelley & Knowles, 2016, p. 4).

Participants and Setting

Students were recruited for the summer learning experience in a variety of ways. An informational flyer and website address were sent out annually on statewide listservs and to middle schools in the three regions where the experience was held. While the experience was open to students of all backgrounds, an emphasis was placed on recruiting underrepresented populations in STEM fields. We define underrepresented populations in STEM fields as female, Black, Hispanic, American Indians or Alaska Natives, Native Hawaiians, or Other Pacific Islanders (National Science Foundation, 2017), students are economically disadvantaged, students with special needs, and potential first-generation students. Additionally, the directors at each site worked with school social workers at high needs schools in their local areas to identify and recruit underrepresented students. These students are guaranteed a place, provided scholarship if needed, and provided transportation to and from the site if needed.

Students were incoming fifth through eighth graders. Based on student self-identified data, the first institution's population between 2012 and 2017 was 39% female, 8% Black, 5% Asian, 1% Hispanic/Latinx, 75% White, and 5% other (e.g. mixed race and 6% no response). Of the total population at the first institution, 43% of the students were from underrepresented populations in STEM. The second institution's population in 2017 was 55% females, 36% Black, 6% Asian, 39% Hispanic/Latin, 15% White, and 3% other (e.g. mixed race). Of the total population at the second institution, 91% of the students were from underrepresented populations in STEM. The third institution's STEM summer learning experience population in 2017 was 59% females, 76% Hispanic, 12% Asian, and 12% other (e.g. mixed race). Of the total population at the third institution, 94% were from underrepresented populations.

Data Collection

Data were collected from students' responses to semi-structured interviews and session reflection forms of their experiences at the STEM summer learning experiences. The interviews and reflection forms were crafted to elicit students' "lived experiences" (Van Manen, 1990, p. 9) relating to the STEM summer learning experience. Interviews were conducted during the last 2 days of the STEM summer learning experience with students for whom we had IRB consent and assent and lasted approximately 5 min each. More than 40% of students who attended the 2015, 2016, and/or 2017 iterations of the STEM summer learning experience were interviewed so we could better understand their perceptions of STEM, what they enjoyed most about STEM, how they plan on using STEM in the future, and how they may use STEM in a career. All interviews were audio recorded and transcribed. The interviewer also took notes and conducted member checks at the end of each interview.

Students also completed reflection forms after each STEM content session to collect students' perceptions of the STEM content session (specifically, what they learned) and to provide feedback to session presenters. The forms were collected from students at all three sites.

The overall qualitative data set for this study consisted of 320 artifacts, 254 of where were unique interview transcripts from students across all three sites, with the majority (85%) coming from the founding site. For the interviews, 78% (197 of 254) of the students were from underrepresented populations in STEM. The remaining 66 artifacts were session reflections from across all three sites, with the majority (85%) coming from the founding site.

Additionally, quantitative data was collected on 507 students across all three sites. The majority (81%) of participants came from the founding site, and a majority (70%)

were from underrepresented populations in STEM. The data consisted of a seven-item measure of STEM self-efficacy which was administered before and after the STEM summer learning experience. For each statement, participants indicated their level of agreement on a four-point agreement scale. Sample items include "I can use STEM skills and knowledge to help solve real world problems" and "I am able to develop a plan to solve a difficult STEM problem." Internal consistency was acceptable both at the pre- ($\alpha = .74$) and post- ($\alpha = .83$) conditions.

Data Analysis

The semi-structured interviews were transcribed verbatim and pseudonyms were assigned to each participant. The session reflection artifacts were created by transcribing session reflections from each student and combining all reflections from a single session into one document. For example, for the DNA extraction session, all session reflections for that content session were combined into one document to create a more detailed, rich artifact to help the authors examine the "lived experience" of the students collectively during that session.

We used a deductive approach to analyze the data, using the theoretical lens of SCCT as a guide "as to what issues are important to examine" (Creswell, 2014, p. 64). One member of the research team developed a list of 25 provisional codes (Miles, Huberman, & Saldaña, 2014; Saldaña, 2016). The entire author team discussed the codes and the codes were revised as necessary. All disagreements were discussed until the group reached consensus. Once consensus was reached, four of the researchers coded the interviews and reflections using Dedoose. The provisional codes were used for first cycle coding (Saldaña, 2016) to better understand students' perceptions of how their participation in STEM summer learning experience influenced their interest in STEM careers. Inter-rater and intra-rater reliability standards were set at 90% agreement. All four researchers exceeded the threshold of 90% agreement on both intra-rater (ranged from 90 to 94%) and inter-rater reliability (94%), which exceeded the minimum threshold needed for reliability analyses (James, Demaree, & Wolf, 1993).

After the initial coding, the subset of four researchers conducted second cycle coding by pattern coding (Saldaña, 2016). Using SCCT as our theoretical lens, the groupings we identified related to concepts within the framework. These patterns helped identify common themes and divergent cases (Delamont, 1992). When the subset of four researchers identified initial themes, the entire research team reviewed the themes and data for clarity and connections to the theory used. During this review process, questions were raised about appropriateness of the theme in connection to the theory and whether each theme was well supported with rich data. All discrepancies were resolved during the final development of overall themes.

Analysis of Quantitative Self-Efficacy Data. All quantitative analyses were conducted in SPSS version 25 (IBM, 2017). Prior to conducting and interpreting the analysis, sample statistics review, assumption checking, and dimensionality analysis were conducted. The assumption of equality of covariance matrices was tested using Box's test, and equality of error variances was tested at each time point using Levene's test. Normality of residuals was tested using Shapiro-Wilk tests and visually using Q-Q plots. To test the hypothesis that participation in a summer STEM learning experience improves STEM self-efficacy for all students including underrepresented students, a mixed effects ANOVA was performed. Additionally, due to concerns that different sites may generate different results, the site grouping variable was included as a second between-subject factor.

Results

Social Cognitive Career Theory (SCCT) was used to examine to what extent middle school students' experiences at a STEM summer learning experience influence their interest in STEM careers. In this section, we first present the quantitative results related to self-efficacy to justify further qualitative analyses. Then, qualitative themes are revealed which are organized into the following subsections (a) role models, (b) influence of the STEM summer learning experience, (c) applicability of STEM, and (d) empathy.

Self-Efficacy

According to SCCT theory, high self-efficacy expectations are foundational in the formation of student interest and ultimately their career goals. Before examining the qualitative data, we needed to conclude the STEM summer learning experience increased students' self-efficacy. Box's test of equality of covariance matrices was non-significant, $M = 18.42$, $F(12, 6074.47) = 1.477$, $p = .125$. Additionally, Levene's test of equality of error variance was non-significant at for initial scores ($W(4, 501) = 1.041$, $p = .385$) and for scores after the STEM learning experience ($W(4, 501) = 1.135$, $p = .339$). Using the Shapiro-Wilk test, residuals for initial scores were found to differ from a normal distribution ($W(507) = .986$, $p < .001$), but visual inspection of the Q-Q plot showed only minor deviations from the expected line. Similarly, residuals for scores after the STEM learning experience were found to differ from a normal distribution ($W(507) = .968$, $p < .001$), but visual inspection of the Q-Q plot again showed only minor deviations from the expected line. Residuals were additionally tested for normality at each level of the between-subject factors, with similar results. Overall, the assumptions for mixed effects ANOVA were found to be tenable. None of the interaction effects in the mixed effects ANOVA were found to be significant, so individual effects were tested for significance. Neither the site between-subject factor ($F(2, 501) = .377$, $p = .686$) nor the underrepresented students of color between-subject factor ($F(1, 501) = .576$, $p = .563$) contributed significantly. However, self-efficacy scores after the STEM learning experience were significantly higher than initial self-efficacy scores, $F(1, 501) = 10.998$, $p < .001$, with an effect size of $d = 0.49$. Since both between-subject effects were non-significant, we computed a single effect size for the average change in STEM self-efficacy due to the STEM learning experience across all students measured in units of the standard deviation of pre-scores (Cumming, 2013, p. 290). With an effect size of $d = 0.49$, the quantitative findings provide strong support for a more in-depth analysis of qualitative data. To explore specific components of the SCCT theory influenced by self-efficacy that might have influenced students' interest and ultimately career goals, the researchers discuss the qualitative results.

Role Model Influence on Career Choice

Participants had varied reasons for wanting to pursue a STEM career. Some participants wanted to pursue a STEM career because one of their family members was in that career. For example, Frank commented he wanted to be an engineer, "because my dad is an engineer" (Interview, 2017). Faith mentioned, "my mom's an engineer and I would like to be like her" (Engineering Reflection, 2014). Michalla shared, "I want to be a psychiatrist like my dad…I really want to be a doctor and psychiatrist because my dad, he owns his own business, so it's kind of a win-win" (Interview, 2015). In this case, Michalla's parent was influential in her career choice, as well as her personal interest in becoming a doctor. Consequently, Michalla surmised that she could become both—psychiatrist and doctor—to be like her dad and pursue her immediate interest. In essence, several students wanted to be a doctor, medical scientist, hydrogeologist, anesthesiologist, and FBI agent because their parents were in these STEM fields.

Other students were interested in pursuing a STEM career because of the influence of a non-parent family member. For example, Alyssa commented that she wanted to be a neonatal nurse because "I like working with little kids and my aunt is a neonatal nurse. She has a really cool job… I've seen her work before and she seems to enjoy it, and it sounds like something I would enjoy" (Interview, 2016). Tamara wanted to be a software engineer because "[my] brother got me interested in programming because he started doing it, and then I started programming with the Vex robotics. I program the robotics for our team" (Interview, 2016). Tamara's brother provided an entry point for her to engage in programming, and now, she wanted to pursue a career as a software engineer. Kathy found herself with similar interests as her brother. She was interested in becoming an aerospace engineer because she "had a brother who was like, really into space. And so, space has been like a huge part of my life. So, and I found interest in it myself. So, I've always wanted to do that" (Interview, 2017). Similarly, Jacinda shared she wanted to be an astrophysicist because her grandmother got her interested in astrophysics:

> [She made] me watch cosmos every week, and it was amazing. Dr. Neil Tyson made everything so interesting, and we got to like go back in time and it made me really interested in how you can find the physics in um astronomy and what goes on in like outer space it's just amazing. You get to see planets, and stars, that takes it back to astronomy. (Interview, 2015)

Jason articulated he wanted to be a vet because his "family works with animals. My grandfather works with horses and my Oma works with German shepherds. They sell dogs. And I just love animals" (Interview, 2017). From this experience, Jason surmised he wanted to become a vet.

Influences of STEM Summer Learning Experience

Students' experience during the STEM summer learning experience was an influential factor for many students deciding to pursue a STEM career. The STEM summer learning experiences either reinforced, piqued, or broadened their interest in a STEM career. For example, Jason exclaimed he wanted to be a chemical engineer because "when I experienced it yesterday, I think it was exciting and really fun because I never saw what was coming next" (Interview, 2017). Other students made the connection between their experiences during the summer learning experience and a specific STEM career. Keisha explained she wants to work "in some field in biology" because she "love[s] animals, and [she's] always been interested in learning about animal anatomy" (Interview, 2016). Keisha also noted how her experience in the STEM summer learning experience better prepared her for science classes stating, "it was preparing us a lot for anatomy. We got to actually see a real brain, lung, organs, things like that, which I've never seen before, which was pretty interesting" (Interview, 2016).

Students often noted the engaging nature of their summer learning experiences in how they related to a STEM career, as opposed to how they have experienced subjects related to STEM careers in the past. For example, Rayanna explained that she wanted to be a veterinarian when she grows up because she "like[s] helping animals when they're hurt" (Interview, 2016). Reflecting on how the STEM summer learning experience was preparing her for school, she added: "Well it like teaches me how the science classes don't always have to be boring, and they can be really fun if you really think through. School can be really fun if you actually like involve yourself in everything" (Interview, 2016). Rayanna emphasizes the importance of being engaged in the process of learning, to use her words, "think[ing] through" topics can be fun. However, as she implies, how it is presented matters. Raul made a similar connection between career goals and the STEM summer learning experience activities:

> I would like to be an engineer [when I grow up] because I like to make new things. I like to make paper airplanes, go to science museums, it's pretty great. [At the STEM summer learning experience] my favorite part is learning how to build stuff, learning how the solar system works, learning how the world works and everything in it. (Interview, 2017)

The STEM summer learning experience provided an outlet for Raul's curiosity. He got to build, explore, and make things, which reinforced his thoughts about what he thinks engineers do.

While some students' experiences at the STEM summer learning experience reinforced their career choice, other students' career interests were broadened. For example, Laura explained she wants to be a civil engineer "because [she] think[s] robotics and everything… it's all.. in just STEM camp basically. Cause it's uh been enjoying" (Interview, 2017). Anne also made those connections. Torn between engineering and biomedical science, Anne explained she wants to be an engineer because she "like[s] to build stuff. And also, I've always been fascinated with cars and like how the things that you buy everyday is just engineers" (Interview, 2017). Anne stated she wants go into biomedical science "because I took a class here. I really liked learning about the human DNA. And so, and also medicine is really important in everyday life" (Interview, 2017). Anne's experiences in the DNA extraction activity in the biomedical science lab piqued her interest in biomedical sciences as a future career.

Whether students' interests in STEM careers were reinforced, piqued, or broadened, their emphasis on how their STEM learning experiences related to careers was consistently clear. Raul described his desire to be an engineer because he liked making things and connected that to the engaging activities, he participated in that required not only making things but also knowing how they worked. Some students even described their learning experiences as similar to a job. For example, Marianna said,

> Robotics has been fun and that sort of thing. I get to understand a bit [sic] more about learning in … about a work environment as well because one of the things I've found is that, um, while I was doing robotics, [it] was at a job than normal stuff. Because I would usually see robotics as fun but it's taking longer…So, I had a feeling that's how it feels being at a job. (Interview, 2017)

This extended exploration in one topic was not seen as tedious, repetitive, or boring. Instead, Marianna described it as fun.

After participating in the STEM summer learning experience, 73% students identified they were interested in pursuing STEM-related careers. An additional 3% focused on non-STEM careers but included a STEM focus. For example, Karena wanted to be an FBI agent and articulated that she is going to "need math to figure out how to get into buildings, like, how much time, how much time it takes to get from place to place. Like, what engines you need to use to get inside a building" (Interview, 2017). Karena did not specifically identify a STEM career; she saw the importance of STEM in her career choice.

Applicability of STEM

Students shared that they wanted to pursue STEM careers because they would have the power to improve or redesign existing processes or products. After engaging in the STEM summer learning experience, students realized "scientists can use the materials to make better modified items to change and solve problems" (Interview, 2015). Tonja realized she could apply her newfound interest in robotics and, instead of just using robots, "[she wanted] to design them" (Interview, 2017) to improve healthcare and hospital practices: "Like I see those robots at the hospital carrying, uhm, things that humans would be carrying… that would make the world a better place" (Interview, 2017).

Students were able to connect the STEM knowledge and skills they were applying in the hands-on experiences to issues their own lives. For example, Darius "learned about spherification" (Interview, 2017), which is the process of encapsulating liquids using chemical engineering. Darius stated, "I have a lot of little cousins who hate having to drink stuff 'cause once their parents tell them to drink it it's healthy they don't want to drink it. So, if I just made the juice balls it would be a much more fun experience for them to just pop it in their mouth" (Interview, 2017). After interacting with chemical engineers, Darius stated he could improve "my real life one day if I do end up becoming one [a chemical engineer]" (Interview, 2017). After a different hands-on experience, James decided that improving his family's diet was both a short- and long-term goal. "Yesterday where we touch organs, we also got to see what sugar and fat and sodium was in the food. So, it will help by alerting my family and friends not to eat those types of foods" (Interview, 2017).

Other students made connections between different experiences at the STEM summer learning experience and were able to come up with novel solutions to existing problems. For example, Jazmine learned about solar panels with mechanical engineers at a local energy center and also enjoyed working on cars. Jazmine decided she could reduce gas usage and improve energy efficiency by adding “solar panels which are on top of the roof and there is a bottom fan on the car that spins” (Interview, 2017). Michael went into detail adding, “If I have a chance, I could probably make some kind of combination of a car that can use hydropower, but at the same time use solar energy to use a new source of fuel, instead of gasoline” (Interview, 2017). Students at the STEM summer learning experience were able to make real and feasible improvements to everyday technologies and processes by understanding how they work.

Students also made connections between their content sessions at the STEM summer learning experience and STEM in general. After the fruit flies lab, both Nate and Josh saw how that small case study related to biology as a whole. Nate realized, “it is important to learn about fruit flies because that could be the clue to learning more about us” (Biology Reflection, 2013). And Josh explained:

> I want to be a lot of things when I grow up, but I want to work, right now that is, in some field in biology cuz I love animals, and I’ve always been interested in learning about animal anatomy and how some especially evolution how one thing that was tiny became this big huge thing. I just want to know how did that little tiny thing become that. (Josh, Interview, 2016)

Students understood that seemingly insignificant topics could lead to significant findings.

Some of the most powerful connections that students made were between careers that they had not associated with STEM and the importance of STEM in pursuing those careers. Cindie remarked she “always enjoyed the creativity that you can have using make-up” (Interview, 2017) and determined she wanted to be “a special effects cosmetologist… doing makeup for like haunted houses or maybe something that’s not really an everyday makeup thing” (Interview, 2017). Cindie connected her passion for make-up to STEM noting even “if you’re going for like a career [that’s] not even really a STEM thing, like, for example if you’re going to be like a makeup artist you still have to have science and math to know all the different body parts” (Interview, 2017). Cory enjoyed playing video games and connected his passion for video games and design and drawing to determine that he “want[ed] to be… a technology engineer” (Interview, 2017). Similarly, Bre took one interest from her daily life, animals, and connected it to something that interested her from the STEM summer learning experience, robots. She decided she could make “therapy cat robots. So [patients] wouldn’t have to actually buy a cat. They’d just have to buy a therapy cat robot” (Interview, 2017). She surmised a therapy cat robot would be easier to take care of and provide the same therapeutic benefits. Grace wanted to be a “History Museum Curator” because she is fascinated by artifacts. She was able to apply STEM to her future career goal knowing one could use “science to determine how old an artifact is” (Interview, 2017).

One notable change that occurred during the STEM summer learning experience was the specificity of STEM careers students indicated they were interested in pursuing. Prior to engaging in STEM experiences and interacting with STEM professionals, students provided generic STEM careers such as an engineer or scientist. Bella knew she wanted to be "an engineer 'cause I like making stuff and programming" (Interview, 2017). However, after working with a variety of engineers in their professional settings, she was able to identify specific types of engineers and how their work related to her interests. "I'm thinking electrical engineer or mechanical engineer because I like to program …Wait that was the wrong one, I meant software engineer. I meant, because I like making stuff and I like programming stuff" (Bella, Interview, 2017). Bella was able to connect her love for programming to a specific career interest—software engineer. Daniel began the summer learning experience wanting to study space but was unsure what career he was interested in pursuing. At the end, Daniel remarked, "[I] want to be an astronaut because it is like it has so many mysteries and mysteries interest me" (Interview, 2017). After the STEM summer learning experiences, several students were able to narrow their STEM career interest. "When I was little, I thought a scientist was when you get to work with chemicals. But now I realize being a chemical engineer is when you make up detergents and all that and that really interests me" (Tyra, Interview, 2017). Students made connections between the STEM professionals and learning experiences to their STEM career interests.

The Role of Empathy

While several students shared that they would like to enter a STEM field because their parents or relative had a career in STEM, others wanted to pursue a STEM career to help a close family member who was ill and they were interested in "sav[ing] lives and help[ing] people" (Taylor, Interview, 2016). For example, Kylie remarked, "I would probably want to be an epileptic doctor because my brother has epilepsy and I've seen how the people can be really sad. I want to help the people who have epilepsy and like heal the problem and everything" (Interview, 2015). Amy voiced she wanted "to be like a pediatric hematologist and oncologist [because] I really like kids. I like working with kids. They're just so cute. And then my grandfather had cancer. But he's okay. But I just like to, you know, find the cure and help people with cancer" (Interview, 2016).

Many students were interested in pursuing STEM careers because they wanted to help animals, people, and/or make the world a better place. For example, Thomas wanted to become a veterinarian because they "liked animals and wanted to help them" (Interview, 2015). Other students expressed their empathy toward animals and shared how they will use what they learned from the summer learning experience to help animals. For example, Shalea said,

> I really do want to create prosthetics and false limbs for dogs or other animals when I grow up. Because when a person walks a dog down the street and the dog doesn't have a leg …and I don't want it to be like oh your dog has a robotic leg. Oh, what happened to it? Because that might be uncomfortable for the owner to talk about. (Interview, 2017)

Shalea further described how she would make the prosthetic limbs, "So, I want to [create] prosthetics and false limbs for animals that look real and [are] energy efficient like solar panels. So, it is safe and easy to use for the dog" (Interview, 2017). Although

Shalea came to the summer learning experience already empathetic toward animals and their owners, the STEM summer learning experience provided a way for her to realize how she could help animals and their owners through STEM. Similarly, Dolly shared,

> I know how some dogs or cats, or pets could be really hurt and can lose a limb because it has to be amputated and they might have to get a robotic leg like some humans. But most owners will probably get a bit uncomfortable when people ask them "hey what's with your dog's robotic leg" or something like that. So, when I grow up, I want to be able to make prosthetic legs for dogs and animals that look like the real thing and are energy efficient, so it doesn't make the world filled with CO2 and stuff like that. (Interview, 2016)

For Dolly, the robotics activities inspired her to use robotics to build prosthetic limbs that look more realistic and were better for the environment.

Not only were students empathizing with animals, they extended their empathy to helping humans. Raquan explained "when I grow up, I want to be someone who develops robotic limbs for people who have lost them …in like the war or something like that" (Interview, 2016). Other students stated they could use the robotics they learned to become an engineer so he "could help people" (Rod, Interview, 2017) and "build stuff to help people out. Like for example um an artificial arm that you can actually feel stuff with or something like that" (Sakina, Interview, 2017). Jimmy went on to say that the robots could help people in "an earthquake, and people were stuck, [he] could use a robot to lift any dangerous stuff, of cement or anything" (Interview, 2017). For Jimmy, the robotics activities inspired him to become an engineer so that he could design robots to help during natural disasters. After participating in robotics, the students were inspired to pursue careers in robotics so they could improve the lives of others.

In addition, several students reported they wanted to become engineers so they could help people. Taylor said she wanted, "to be a biomedical engineer to save lives and help people" (Interview, 2016). Similarly, Denise said she wanted to build "instruments that can help with surgeries to help people heal faster or go through less pain during their surgery" (Interview, 2017). For these students, STEM was way to help people by creating instruments that could possibly save them. Other students voiced they wanted to make the world a better place by becoming a scientist, particularly a chemist. Simone wanted to become a chemist because

> Partially out of what I've learned about chemists here and the last year because I came last year, so I think it's pretty cool that… how they can try to make new substances and materials. Also, they use those materials to try to help a lot of people. (Interview, 2016)

Some students wanted to become doctors so they could improve the lives of people in their community. Julia said she wanted to be a doctor because "it's part of [being] human. You're able to help others with their health" (Interview, 2017). Timmy said he wanted to become a pediatrician because "I love kids and I really like helping people and so that's why I want to be a pediatrician cuz I can help kids and I can do what I can help others too" (Interview, 2016). Thersa said she wanted to be a doctor because she could "make a lot of medicine so they can help doctors use the medicine, so they can help other people" (Interview, 2017). Beverly articulated she could do "research and many things that could benefit the world like finding new medicines or just coming up with a cure" (Interview, 2015). It was clear participants' empathy for the community and people around them influenced their career choices.

Discussion and Implications

As suggested by SCCT, background contextual affordances such as families, particularly parents, have strong influences on students' career choices (Ing, 2014). In this study, we also found parents and family members influential. Oftentimes, students explained they wanted to pursue a STEM career because they wanted to be like a parent or family member with that career. Similar to the results of Jacobs, Ahmad, and Sax (2017), the findings in this study reveal that when students see adults, they know in STEM careers, it resonated with them and increased their interest. A key implication of this finding is the need to better inform and provide strategies for parents and families who do not have STEM careers. This could include providing them with at home activities as well as free community activities to do with their children that relate to STEM careers. This might also include talking with parents about not negatively influencing their children by making comments such as "science is too hard" or "I was never a math person."

In SCCT, learning experiences influence both STEM self-efficacy and STEM outcome expectations. Wyss et al. (2012) found students' interest in STEM careers increased when students were provided information about different STEM careers. In this study, the activities during the summer learning experience either expanded or broadened students' interests in STEM careers. The students interacted with STEM professionals in authentic ways, which also heightened and piqued (i.e. students were more curious) their interest in STEM and STEM-related careers. Specifically, students described specific desires to pursue STEM careers. As described above, Bella wanted to become an engineer because of her experience designing and programming. Similarly, Tyra's experiences broadened her conceptions of STEM careers as she articulated her interest in becoming a chemical engineer.

Similar to Kitchen et al. (2018) research, which found hands-on, engaging activities showing the applicability of STEM increased high school students' interest in STEM careers, in this study, middle school students were engaged in authentic hands-on activities and saw how STEM applies to their lives, which increased their interest in STEM careers. Many students were influenced by their desire to help others and make the world a better place. Some students recognized how their STEM learning experiences could be applied to improve the world. This study solidified and piqued many students' interest in STEM careers. Many students were drawn to a specific STEM career because they wanted to help a person for whom they care about, such as a sibling with an illness. This testament speaks to the power empathy can have getting students interested in STEM careers. Empathy can be particularly powerful when students truly connect to the person(s) (or animals) in need (Edelen, Bush, Simpson, Cook, & Abassian, in-press).

Although empathy is not included in the SCCT theory, the findings of this study warrant further examination the role empathy plays in fostering students' interest in

STEM. Imagine systematic and systemic change where students are engaged consistently and long-term in STEM learning experiences which begin with fostering empathy for the person(s) or animals in need (examples provided in Bush, & Cook 2019). For example, students might design a prosthetic for a student in their community in need (as in Bush, Cox, & Cook, 2016; Cook, Bush, & Cox, 2015), or they might examine a solution for homelessness using the technology of 3D-printed tiny homes (as in Edelen, Simpson, & Bush, 2020). Could implementing a common practice such as this have implications for attracting more students to STEM careers and specifically students from underrepresented populations in STEM? This should be studied further at different grade bands, large-scale, and longitudinally.

All students need access and opportunity to engage in authentic, hands-on learning experiences that connect STEM to their daily lives, increase their interest in STEM, and introduce them to different STEM careers in order to make informed decisions about their future STEM career choices (Jahn & Myers, 2014; Kitchen et al., 2018). Generally, students do not pursue STEM careers because they are not aware of the different STEM career options (Jahn & Myer, 2014). Students do not know what they do not know; it is our job to help them see multiple possibilities and make the connections as to how STEM can be applied to the world around them. When students see how solving authentic problems through STEM can make their lives and the world a better place, they are more interested in pursuing STEM careers.

References

Bahar, A. K., & Adiguzel, T. (2016). Analysis of factors influencing interest in STEM career: Comparison between American and Turkish students with high ability. *Journal of STEM Education, 17*(3), 64–69.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191–215.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Upper Saddle River: Prentice Hall.

Bandura, A. (1990). Perceived self-efficacy in the exercise of personal agency. *Journal of Applied Sport Psychology, 2*(2), 128–163.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. Freeman.

Bandura, A., & Wessels, S. (1997). *Self-efficacy* (pp. 4–6). New York: W.H. Freeman & Company.

Bandura, A., Barbaranelli, C., Caprara, G. V., & Pastorelli, C. (2001). Self-efficacy beliefs as shapers of children's aspirations and career trajectories. *Child Development, 72*(1), 187–206.

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin, 117*(3), 497–529.

Beier, M. E., & Rittmayer, A. D. (2008). Literature overview: Motivational factors in STEM: Interest and self-concept. https://www.engr.psu.edu/awe/misc/ARPs/ARP_SelfConcept_Overview_122208.pdf.

Brown, G. (1996). *Quality of life: Changing youth culture and values*. Values for Tomorrow's Society Conference: Aston University.

Brown, D. (2002). *Career choice and development*. John Wiley & Sons.

Bureau of Labor Statistics, U.S. Department of Labor. (2017, July). 8.8 Million science, technology engineering, and mathematics (STEM) jobs in May 2016. *TED: The Economics Daily*. https://www.bls.gov/opub/ted/2017/8-point-8-million-science-technology-engineering-and-mathematics-stem-jobs-in-may-2016.htm

Bush, S. B., Cox, R., & Cook, K. L. (2016). Building a prosthetic hand: Math matters. *Teaching Children Mathematics, 23*(2), 110–114.

Bush, S. B., & Cook, K. L. (2019). Step into STEAM: Your standards-based action plan for deepening mathematics and science learning. Thousand Oaks, CA: Corwin and Reston, VA: NCTM

Bush, S. B., Cook, K. L., Edelen, D., & Cox, R. (under review). Elementary Students' STEAM Perceptions: Extending Frames of Reference Through Transformative Learning Experiences
Cohen, J. (2001). *Caring classrooms/ intelligent schools: The social emotional education of young children*. Teachers College Press.
Cook, K., Bush, S. B., & Cox, R. (2015). Engineering encounters: Creating a prosthetic hand. *Science and Children, 53*(4), 65–71.
Cooper, B. (2011). *Empathy in education: Engagement, values, and achievement*. Continuum International Publishing Group.
Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Sage Publications.
Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. Sage.
Cumming, G. (2013). *Understanding the new statistics: Effect sizes, confidence intervals, and meta-analysis*. Routledge.
Dabney, K. P., Johnson, T. N., Sonnert, G., & Sadler, P. M. (2017). STEM career interest in women and informal science. *Journal of Women and Minorities in Science and Engineering, 23*(3).
Dayton, E. (2013). Factors that influence females' pursuit of STEM fields: A literature review emphasizing psychological influences. http://sierraschoolworks.com/section/wp-content/uploads/2013/11/FACTORS-THAT-INFLUENCE-FEMALES'-PURSUIT-OF-STEM-FIELDS-E.-Dayton-for-Sierra-College-STEM.pdf.
Delamont, S. (1992). *Fieldwork in educational settings: Methods, pitfalls and perspectives*. Falmer.
Durbin, S. (2013). It's a boy's thing really, isn't it? *The factors affecting career choices amongst male and female engineers*. http://www2.uwe.ac.uk/faculties/BBS/BUS/Research/CESR/Jan_2013_Durbin.pdf.
Edelen, D., Simpson, H., & Bush, S. B. (2020). A STEAM exploration of tiny homes. *Mathematics Teacher: Learning and Teaching PK-12, 113*(1), 25–32.
Edelen, D., Bush, S. B., Simpson, H., Cook, K. L., Abassian, A. (in-press). Moving towards shared realities through empathy in mathematical modeling: An ecological systems theory approach. School Science and Mathematics.
Halim, L., Rahman, N. A., Ramli, N. A., & Ellany, L. (2018). Influence of students' STEM self-efficacy in STEM and physics career choice. *AIP Conference Proceedings*. https://doi.org/10.1063/1.5019490.
Harwell, E. (2012). An analysis of parent occupation and student choices in STEM major. *Project STEP-UP.* http://stepup.education.illinois.edu/sites/default/files/EH%20Parent%20Occ%20Brief.pdf.
IBM Corp. (2017). *IBM SPSS Statistics for Windows*, version 25.0. IBM Corp.
Ing, M. (2014). Can parents influence children's mathematics achievement and persistence in STEM careers? *Journal of Career Development, 41*(2), 87–103.
Jacobs, J. A., Ahmad, S., & Sax, L. J. (2017). Planning a career in engineering: Parental effects on sons and daughters. *Social Sciences, 6*(2), 2–25.
Jahn, J. L., & Myers, K. K. (2014). Vocational anticipatory socialization of adolescents: Messages, sources, and frameworks that influence interest in STEM careers. *Journal of Applied Communication Research, 42*(1), 85–106.
James, L., Demaree, R., & Wolf, G. (1993). Rwg: An assessment of within-group interrater agreement. *Journal of Applied Psychology, 78*, 306–309.
Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education, 3*(1), 1–11.
Kitchen, J. A., Sonnert, G., & Sadler, P. M. (2018). The impact of college- and university-run high school summer program on students' end of high school STEM career aspirations. *Science Education, 102*(3), 529–547.
Lead States, N. G. S. S. (2013). *Next generation science standards: For states, by states*. The National Academies Press.
Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance [monograph]. *Journal of Vocational Behavior, 45*(1), 79–122.
Lent, R. W., Brown, S. D., & Hackett, G. (2002). Social cognitive career theory. In D. Brown (Ed.), *Career choice and development (4th ed.*, *pp. 255–3 11)*. Wiley.
Lincoln, E., & Guba, I. (1985). *Naturalistic inquiry*. Sage.
Lloyd, A., Gore, J., Holmes, K., Smith, M., & Fray, L. (2018). Parental influences on those seeking a career in STEM: The primacy of gender. *International Journal of Gender, Science and Technology, 10*(2), 308–328.
Maddux, J. E. (2016). *Self-efficacy. In Interpersonal and Intrapersonal Expectancies* (pp. 55–60). Routledge.
Mcgee, E., & and Bentley, L. (2017). The equity ethic: Black and latinx college students reengineering their stem careers toward justice. American Journal of Education, 124, 1–36.

Melchior, A., Burack, C., & Hoover, M. (2018). The impact of after-school robotics programs on STEM interests. https://conference.iste.org/uploads/ISTE2018/HANDOUTS/KEY_110836005/ISTE_RP.ImpactsofAfterSchoolRoboticsProgramsonSTEMInterests.5_30_18.pdf.
Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation (revised and expanded from qualitative research and case study application in education)*. Jossey-Bass.
Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). Sage.
Miller, K., Sonnert, G., & Sadler, P. (2018). The influence of students' participation in STEM competitions on their interest in STEM careers. *International Journal of Science Education, Part B, 8*(2), 95–114.
Mitchell, P. T. (2016). Undergraduate motivations for choosing a science, technology, engineering, or mathematics (STEM) major (Senior thesis). https://trace.tennessee.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=2939&context=utk_chanhonoproj.
Mohr-Schroeder, M. J., Jackson, C., Miller, M., Walcott, B., Little, D. L., Speler, L., Schooler, W., & Schroeder, D. C. (2014). Developing middle school students' interests in STEM via summer learning experiences: see Blue STEM camp. School Science and Mathematics, 114(6), 291–301.
Mohr-Schroeder, M. (2015). Track 3 panel session: national models for broadening participation. Invited panelist speaker at the 24th National EPSCor National Conference, Portsmouth, NH.
Mohr-Schroeder, M., Bush, S. B., & Jackson, C. (2018). K12 STEM education: Why does it matter and where are we now? Teachers College Record. ID Number: 22288.
National Governors Association Center for Best Practices, Council of chief State School Officers. (2010). *Common core state standards for mathematics.*
National Science Board. (2016). Science and engineering indicators 2016 (Report No.NSB- 2016-1). National Science Foundation.
National Science Foundation. (2017). Women, minorities, and persons with disabilities in science and engineering. https://www.nsf.gov/statistics/2017/nsf17310/static/downloads/nsf17310-digest.pdf
Nugent, G., Barker, B., Welch, G., Grandgenett, N., Wu, C., & Nelson, C. (2015). A model of factors contributing to STEM learning and career orientation. *International Journal of Science Education, 37*(7), 1067–1088.
Patterson, D. G. (2011). Student awareness and career motivation in the STEM fields. Northwest Association for Biomedical Research. http://www.cssia.org/pdf/20000096-StudentAwarenessandCareerMotivationintheSTEMFields.pdf
Ray, T. M. (2016). *A preliminary study investigating the factors influencing STEM major selection by African American females* (Doctoral dissertation). https://digitalcommons.odu.edu/cgi/viewcontent.cgi?article=1024&context=efl_etds
Roberts, T., Jackson, C., Mohr-Schroeder, M., Bush, S., Maiorca, C., Cavalcanti, M., Schroeder, C., Delaney, A., Putnam, L., & Cremeans, C. (2018). Students' perceptions of STEM learning after participating in a summer informal learning experience. International Journal of STEM Education.
Rogers, C. R. (1975). Empathetic: An underappreciated way of being. *The Counselling Phycologist, 5*(2), 2–9.
Saldaña, J. (2016). *The coding manual for qualitative researchers* (3rd ed.). Sage Publications.
Schwartz, S. J., Côté, J. E., & Arnett, J. J. (2005). Identity and agency in emerging adulthood: Two developmental routes in the individualization process. *Youth & Society, 37*(2), 201–229.
Sellami, A., Kimmel, L., Hunscher, B., Cotter, A., Wittrock, J., Al-Emadi, A., & Al-Emadi, D. (2017). Factors shaping Qatari students' interest in STEM, business or public sector careers. *Journal of Mathematics Science and Technology Education, 13*(10), 6491–6505.
Sun, K. (2017). The importance of cultivating empathy in STEM education. *Science Scope, 40*(8), 6–8.
Trusty, J., Niles, S. G., & Carney, J. V. (2005). Education-career planning and middle school counselors. *Professional School Counseling, 9*(2).
Tuijl, C. V., & Molen, W. V. (2016). Study choice and career development in STEM fields: An overview and integration of the research. *International Journal of Technology and Design Education, 26*(2), 159–183.
Van Manen, M. (1990). *Researching lived experiences*. State University of New York Press.
Wang, M. T., & Degol, J. (2013). Motivational pathways to STEM career choices: Using expectancy-value perspective to understand individual and gender differences in STEM fields. *Developmental Review, 33*(4), 1–48.
Wyss, V. L., Heulskamp, D., & Siebert, C. J. (2012). Increasing middle school student interest in STEM careers with videos of scientists. *International Journal of Environmental and Science Education, 7*(4), 501–522.

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