JOURNAL of STEM OUTREACH

Vol. 5, Issue 1, January 2022

Improving Parents' and Teachers' Perceptions of Girls' STEM Activities and Interests Before and After an Informal STEM Intervention

Rebecca L. Hite[1] and Jessica L. Spott[2]

[1]*Department of Curriculum and Instruction and* [2]*STEM Center for Outreach, Research & Education, Texas Tech University, Lubbock, TX*

Keywords: Capital, doxa, girls, habitus, informal, kits, parents, STEM, teachers

Publication Date: January 5, 2022

DOI: https://doi.org/10.15695/jstem/v5i1.01

ABSTRACT: This study investigated how a STEM outreach program, focused on promoting adolescent girls' interests in STEM, augmented parents' and teachers' (adults) perceptions of doxa (socialization that enhances or stymies girls' STEM interests) after the event, at home and school, respectively. To this end, we provided participating adults with in-event STEM experiences (e.g., participating in STEM activities and interacting with women STEM professionals) and tools (e.g., an activity-based STEM kit) to enhance STEM capital and habitus. Twenty-five adults participated in a post-event open-ended questionnaire and three-month post-event follow up interview. Data were parsed by race (White) and ethnicity (Hispanic) and then coded inductively and deductively using a framework to examine gendered perceptions for STEM. Findings suggest adults found value in the event to nurture girls' STEM interests and preparing girls for STEM futures; yet only four of the sampled adults chose extended STEM experiences by using the provided kit. The significance of this work suggests that adults, regardless of race or ethnicity, require more generative informal experiences with STEM capital and habitus (e.g., hands-on experiences to model at home, information on varied STEM careers) to shift their perceptions of girls' experiences in STEM (doxa) to actively promote girls' interests in STEM and STEM careers.

INTRODUCTION

Improving girls' access to generative experiences in science, technology, engineering and mathematics (STEM), has been a focus of K-12 outreach programs and research (Gamse et al., 2017; Valla and Williams, 2012). Early adolescence (ages 10 to 14) is considered to be an ideal time to capture middle grade girls' interests in STEM fields; especially given that their interest strongly predicts STEM persistence more than their prior experiences and achievement in STEM (Maltese and Cooper, 2017; Maltese and Tai, 2011). Therefore, targeted interventions may help to spur or accelerate girls' interests in STEM during their youth and throughout their formative teenage years (Christensen et al., 2015). Many institutions of higher education are taking strident steps to address the dearth of experiences for young girls to nurture their STEM interests by offering programmatic opportunities for girls to have hands-on STEM learning and access to professional STEM women. These programs often do increase girls' access to resources (capital) or modify their social situations (habitus) to establish STEM interests in the moment, but how do girls continue to nurture their STEM interests at school and at home? This critical piece may be why outreach programs appear to be ephemeral in supporting long term interest in STEM among participating girls (Darke et al., 2002; Prieto-Rodriguez et al., 2020). Research suggests that the materials families provide to and use with their children and the value they place on STEM (capital and habitus, respectively) dramatically influences children's participation in STEM (Archer et al., 2012b). Eccles (2015) has further clarified the importance of home life vis-à-vis STEM interests in her two longitudinal studies of families in Michigan. She empirically evidenced that parents' gendered socialization practices within the family predicted their child's gendered beliefs and behaviors in STEM, concluding this mechanism may be "how a gendered bias might emerge in STEM fields, despite the fact that girls and boys do equally well in math and science throughout their schooling" (Eccles 2015, p. 116). Gilmartin et al. (2006) suggested that the establishment of a STEM-positive home environment, or one that encourages young women to pursue their STEM interests, can drastically increase women's participation and persistence in the STEM pipeline. School has been long seen as an avenue for improving girls' science interests (Baker and Leary, 1995), yet has been largely unfilled due to gendered curriculum and activities (Calabrese Barton and Brickhouse, 2006) and teachers' gendered perceptions of girls and science (Archer et al., 2012a). Adults, defined as teachers and parents in the present study, play an important role in how girls pursue STEM (Gunderson et al., 2012). Based upon the findings of reviewed literature, it is vital that these adults in a young woman's life equally or concurrently participate in STEM-based outreach to nurture girls' emerging STEM interests so they may participate in STEM in the future (Miller et al., 2018; Riggs et al., 2019; Shapiro and Williams, 2012).

The lack of girls interests in perusing STEM has been of particular concern in Texas. As of 2019, 60% of all Texan K-12 students were classified as economically disadvantaged, lacking resources to explore future career choices and trajectories outside of their classroom exposures (Morath, 2019). This is particularly true in West Texas, which is home to marginalized (American Indian) and underserved (Tejan@) communities within a largely rural setting (Thiede et al., 2018). Current research no longer explores why Hispanic students are not completing a STEM degree but rather why Hispanic students are not choosing a STEM-based future in the first place (Hunt et al., 2014; Wang, 2012). Several scholars have cited 'family influences' as being vitally important to whether or not students, especially rural Hispanic (Aschbacher et al., 2010; Grimes et al., 2019; Hite et al., 2018) and White (Miller and Votruba-Drzal, 2013; Prakash, 2017) females are not choosing STEM futures. Not just restricted to parents, these influences are generally thought to be misunderstandings of (1) what STEM is, (2) the value of STEM experiences, and ultimately (3) what it means to pursue a STEM career (Breiner et al., 2012; Watson et al., 2020). This further suggests that direct family and teacher involvement is needed, as a necessary part of STEM outreach interventions in order to support and sustain efforts to create and cultivate rural girls' interests in STEM.

In an effort to address these needs, Texas Tech University's STEM Center for Outreach, Research, and Education (STEM CORE, 2019) has taken a comprehensive approach towards STEM career awareness and outreach by hosting a yearly event (*Tech Savvy*) that invites young women to participate in generative STEM activities and discussions along with adults (family members and their teachers). This program seeks to bridge the capital and habitus divides by providing additional materials to help nurture and sustain underrepresented and underserved rural adolescent-aged girls and their adults both during and after the event (e.g., engaging them equally in fun STEM activities, having opportunities to speak with women in STEM, explaining the nature and benefits of STEM careers, and a take-away family- or classroom-based STEM kit). These efforts aimed to provide needed and accessible STEM activities (capital) and add to adults' understandings of STEM (habitus) within the participating girls' families and teachers. This paper reports a case-study of the outcomes among 25 parents and teachers who participated in the Tech Savvy event, providing unique insight to their epistemological shifts in STEM, perceived benefits of participation, and conceptions of having their own female child and/or students participate in STEM and STEM careers.

THEORETICAL FRAMEWORK

This research is situated within the Archer et al. (2014) conceptual framework that explores the interplay between gender, science capital, and the doxa of STEM by relevant persons, which influences how students further engage with science and STEM. The Archer et al. (2014) framework is underpinned by Butler's (1999) understandings of socialized gender performance, Bourdieu's (1977, 2010) notions of social reproduction and capital, and Carlone and Johnson's (2007) theorization of how gendered and racialized lived experiences uniquely contribute to science identity. Archer et al. (2014, p. 6) described doxa as a presentation of "the immediate social world as self-evident and undisputed and hides the workings of power by ensuring that particular dominant values, practices and ideals are misrecognized as legitimate and meritocratic." Meaning, these types of perceptions play into how we are socialized, driving our sense of place or belonging, or lack thereof (Bourdieu, 2002). Doxa has a powerful influence in STEM, for example, Piatek-Jimenez et al. (2018) found from surveying women in college that they held stereotypical views of women in society that precluded their participation in STEM careers. Therefore, we found this framework compelling in its ability to model the complexity of students' STEM-based identities, influenced by parents' and teachers' perceptions of their, perhaps even gendered, place in STEM. This includes: what constitutes STEM work; to what degree STEM work is fulfilling or interesting; how that work is done and by whom; the benefits of STEM in school and life; and the sociocultural difficulties in pursing STEM futures and careers. It is this underlying doxa that many student-focused STEM interventions seek to address, however, they solely focus on children by actively engaging them in interesting or exciting STEM activities to build their positive affect towards (rather than just knowledge in) STEM and establish the beginnings of their STEM identity (National Research Council [NRC], 2009, 2010). This is most evident in national calls and initiatives for targeted interventions and programs in STEM to recruit and retain historically underrepresented groups in STEM (National Academies of Sciences, Engineering and Medicine [NASEM], 2011, 2019). Archer et al. (2014, pp. 5–6) noted that such programs are unlikely to shape doxa or the social production of STEM, and rather suggested that:

> *...the nature of science capital and the extent to which it can be possessed or realized will be shaped by the identities of the social actors in question (their habitus, structural location and embodied identity) and…science capital will vary depending on who is possessing/deploying it and in what context (field).*

This suggests that the environment in which capital is gained is important, not only to those garnering the capital, but also to adults that recognize and (potentially) can build on that capital. This is perhaps why research on students' participation in authentic apprenticeships with STEM professionals (Carsten Conner et al., 2018) and orchestrating community STEM outreach (DeWitt and Archer, 2017; Vennix et al., 2018) have significantly augmented students' perceptions, attitudes, and interests in STEM. Further, it may explain common findings of success among targeted out-of-school interventions for improving students' affect toward STEM by gender and/or race and ethnicity (NRC, 2015), in the middle grades (Dabney et al., 2012; Falk et al., 2016), by providing the right space at the right time (Essig et al., 2020) for perceptions of STEM to shift. These successes are attributed to recognizing and reflecting the contributions of gender, race, and/or ethnicity at an impressionable age. This line of thinking may also help to explain why STEM-focused interventions are brief in regard to sustaining students' positive affect towards STEM. After the intervention, when the girls go back home or to their schools where their newly found STEM habitus is not shared or STEM capital is not recognized, girls are likely are to lose the affective benefits of their participation in those programs, thus stunting further development of their STEM interests and subsequent STEM identity.

Given the aforementioned importance of family and community understanding and perceptions towards STEM, few activities that engage students in informal STEM activities include active participation of adults within the experiences to shift their community's perceptions of girls involvement in STEM. Per Archer's theorization and other scholars (Sjaastad, 2012), we must recognize the immense importance of in how students' teachers (Hand et al., 2017; Robinson-Cimpian et al., 2014) and their parents (Archer et al., 2015; Craig et al., 2018; Sáinz and Müller, 2018) perceptions' of STEM are applied to students, both positively and negatively. Yet, there are minimal opportunities for teachers and parents to receive habitus and capital building experiences, so they may also shift their conceptions of STEM and how they formally and informally relate information about STEM to their students and children. There are even fewer opportunities to extend those experiences, beyond the intervention itself, such that adults' perceptions of STEM for girls can be maintained or improved. Therefore, we employ this conceptual framework in a case study format, to explore how perceptions of girls in STEM (doxa) from adults who participated in mirrored STEM activities to build habitus and capital, contributed to possibly gendered perceptions of girls' performances in STEM activities and STEM futures.

Research Questions. In this study, we used data collected from 25 adults (teachers and parents) who attended a girl-only STEM event with their female student and/or child, such to explore the intersection of gendered, social expectations in their participation in STEM during, immediately after and again three months after the intervention. We chose a quarterly follow up time period since it provided enough time to use the kit and have adequate episodic memory of the event (Banducci et al., 2017). The research purpose was to understand how this event, when explicitly designed to bridge information gaps and co-construct new understandings of STEM among adults by increasing their STEM habitus and capital, augment their perceptions that may enhance or hinder girls' present and future engagement in STEM. Further, are there differences in adults' perceptions if they are a teacher, parent, White or Hispanic as prior literature suggests? To that end, we explored the following three research questions:

1. In what ways, if at all, does engaging teachers and parents in Tech Savvy and equipping them with a STEM kit (to take with them for use with their child and/or students) influence STEM capital and habitus well after the event?
2. In what ways, if at all, did augmentation of STEM capital and habitus influence parents' and teachers' perceptions of their child's and/or student's engagement in STEM?
3. Are there variations in perceptions by teacher and parent or by ethnicity of the adults?

METHODOLOGY

This qualitative interpretive case study sought to explore the how adults construct their world and perceive the reality of STEM and STEM for their own children (Rashid et al., 2019). employed a content analysis approach of contextualization, categorization, and compilation (per Bengtsson, 2016) using open-ended responses from a pre- and post-event questionnaire as well as a post-post interview with participating parents and teachers. This inductive and deductive approach was selected to capture the perceptions of the adults to discern what changes, if any, were made to their perceptions of their girls in STEM with an intervention that contained the infusion of STEM information, experiences and tools. To address the nature of the research questions, only parents and teachers were included in the research given the relative dearth of understanding of adults' experiences in and outcomes from STEM outreach program participation. Further, race (White) and ethnicity (Hispanic) was parsed for analysis given that literature suggests these groups differentially participate in STEM (e.g., Hispanic females having lower participation than White females) and culture plays a role in forming gendered perspectives (doxa) of girls in STEM by adults (Aschbacher et al., 2010; Hite et al., 2018; Martínez et al., 2019; NASEM, 2011, 2019).

Background and Context. Tech Savvy was originally hosted in February 2016 from a grant from the American Association of University Women (AAUW), to bring middle school girls to college campuses and introduce "underrepresented girls to STEM and demystify some of the college admissions and funding processes for parents" (para 1). From 2016 to 2018, as part of the AAUW's then funded events, the full-day, in-person annual event served rural parents in giving them information on scholarships, financial aid and how to apply for college. Participating girls engaged in age-appropriate, hands-on workshops all day, taught by Texas Tech faculty and graduate students, in small groups. Each workshop was led by a female faculty member or graduate student with a series of hands-on activities. Examples of workshops subjects included: forensics, medicine, aerosol science, toxicology, chemistry, and renewable energy (wind). Between the morning and afternoon workshops, all participants were provided lunch as a female STEM academic gave a keynote address. These experiential elements reflect best practices in fostering gender equity in STEM (see Hughes et al., 2020).

In 2018, the program was improved by providing additional STEM resources for home and school use (capital) as well as enhanced parent and teacher education sessions on STEM careers and how to cultivate girls' interests in STEM (habitus). Further, the event was reformatted such that the workshop provided students with an individualized, take-away receivable that the student had made during the session. In addition, there were enhanced opportunities for participating girls to interact with female STEM professionals and academics. To that end, each adult participated in unique sessions to engage and educate them in STEM and the affordances of STEM for girls. First, they were given a take-away kit of 8-10 STEM activities, complete with all necessary supplies, to extend STEM learning at home or at school. Second, to promote their use, adults were given explicit directions on how to use the kits (by assuming no prior knowledge of STEM) as well as insight to the concepts and affect the kits are intended to convey and generate, respectively. Third, adults were coached on pedagogical aspects of kit use, such as how to ask questions such to spur their child's or students' interests in STEM. Last, adults attended workshops that provided information on the various types

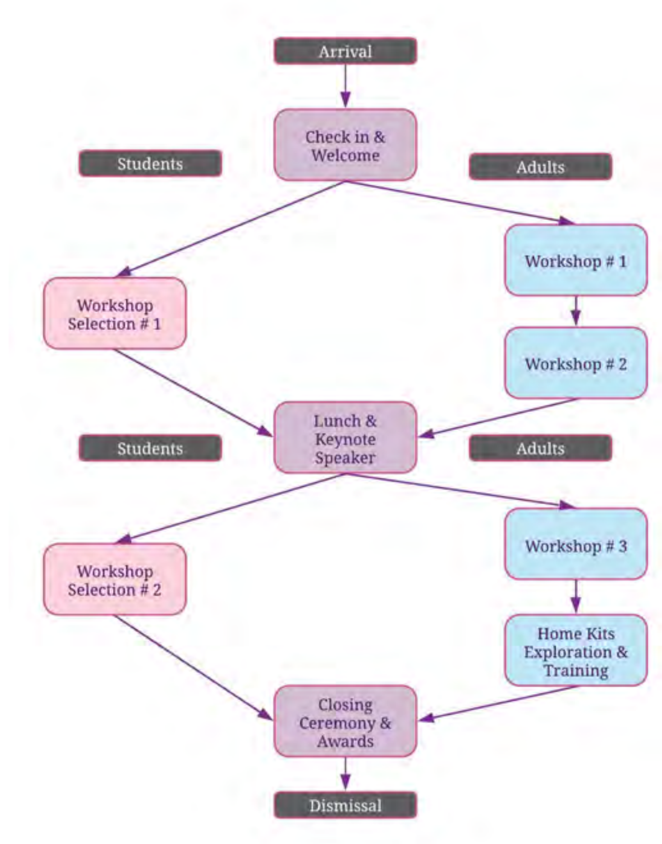

Figure 1. Tech Savvy Activities for Participating Girls and Adults.

and benefits of STEM careers for women and ways to encourage and nurture girls' STEM interests in both the classroom and at home. Figure 1 displays the parallel activities for girls and adults during the event. Appendix A provides all 12 workshop titles and a short description of each.

Data Collection. Participating parents and teachers self-selected to attend the one-day Tech Savvy with their middle school girl(s). The adults' registrations and attendance was not restricted by gender, despite this being an event for middle school girls, although a majority of the adult participants were female. At the beginning of Tech Savvy's adult programming, adults were able to consent to participate in research surveys and/or the follow-up interviews. Among the 50 adults who attended the event, 25 adults (50%) completed the post-event questionnaire and 20 the pre-event questionnaire (40%). Approximately three months after the event, 12 adults (24%) completed a phone interview, with half participating in the questionnaires.

Questionnaires. The questionnaires were given during registration and the conclusion of the event. The pre-questionnaire asking on how they defined STEM sampled adults and post-questionnaire asking if and how that definition changed as well as what they perceived to be the benefits of the event (i.e., the nature of their doxa) for their child(ren). In all, 15 (60%) parents and 10 (40%) teachers completed the questionnaire. Thirteen (52%) respondents identified as Hispanic and 12 (48%) as White. Teachers and parents were equally represented between Hispanic and White groups despite being overwhelming female (n = 21, 83%). The four males sampled were all parents; equally split between White and Hispanic.

Interview. Adults were asked to discuss how their perceptions of STEM had shifted since the event. To discern these changes, questions included 1) how they defined STEM and if their definition had changed post-participation and 2) what they believed to be the benefits of STEM for students now and into the future. The interview sample promised of six (50%) parents, five (42%) teachers and one (8%) individual as both. Eight (67%) identified as White and four (33%) as Hispanic. Teachers and parents were equally represented (approximately half) between the two ethnicities. Seven individuals identified as female and five as male, the latter of whom were all parents, identifying as White (n = 3) and Hispanic (n = 2).

Analysis. The analysis for the case study was twofold, first to explore the nature of the data and second to interpret the perceptions of adult participants. Using both *a priori* (deductive) and *a posteriori* (inductive) coding process afforded greater and more rigorous methodological insight (Fereday and Muir-Cochrane, 2006) to how girls who participated in the event, would be supported in their STEM identity after the event. Therefore, a conventional (inductive) and directed (deductive) content analysis was performed on both data sets of questionnaire and interview transcripts (Bengtsson, 2016). First, data were open-coded to determine the nature of the data set of adults' perceptions of STEM and their perceptions of the STEM event for their students. This inductive process allowed for condensation of data into categories such to allow the data to 'speak for itself' without moderation by a theoretical lens (Thomas, 2003). Then, data underwent a second analysis using a codebook adapted from Archer et al.'s (2014) analysis of children's gendered science aspirations. Table 1 shows the stereotypes and tropes of girls' and women's participation in STEM categorized by six gendered aspects. These gendered aspects represent the extant doxa of girls' participation in STEM, including attributes of both habitus and capital, representing societal expectations of their: prerequisite abilities; purpose or role; place; identity women must possess; preparation needed; and appropriate performances. Responses were coded by gendered responses, parsed by the adult's relationship to the girl (teacher and parents) and by ethnicity (White and Hispanic) to illuminate attributes of STEM perceptions within each respective community. Last, frequency counts were calculated by counting the number of times each inductive and deductive category was represented within the data. These frequency counts were parsed by teachers and/or parents (notably one adult identified as both) and by White or Hispanic to uncover differences in perceptions among participating adults. The a priori and a posteriori frequency counts were assigned percentages to represent the perceptions of each respective group to the whole of sampled adults on what they believe are girls' involvement and interests in STEM; this analysis permits theoretical inference to adults' doxa.

Trustworthiness. Quality qualitative research recognizes and appreciates that the burden of trustworthiness must be

Table 1. *Six Constructs of Gendered Aspects of STEM Operationalized into Stereotypes of Girls/Women in STEM for Coding (Codebook).*

Construct #1: Ability
Must be good at similar, often feminine, topics adjacent to STEM
Must be good at math in order to be good in STEM
Must be in possession of a natural talent or gift for STEM
Must be in possession of an innate curiosity, interest, or desire for challenge in STEM
Construct #2: Purpose (Role in STEM)
Must want to help people and resolve problems people have made
Must want to save the world
Must be able to do mundane, boring, or uninteresting activities
Unknown; girls/women would have an undefined role
Construct #3: Place
Must see evidence of women in STEM (e.g., seeing or hearing women that are in STEM)
Must experience specific activities for women in STEM (in K-12, college, and/or career)
Must not participate in typical male-only or male-specific activities for women in STEM
Cannot be the only one (girl/woman) in a male dominated space; must participate in the safe, "female" spaces in STEM
Construct #4: Identity (per Gee, 2000)
Must be a person that is analytical, introverted, etc. to be in STEM (I-identity)
Must not be a creative person, feminine, extroverted to be in STEM (D-identity)
Must be of the majority culture (white and/or male) to be in STEM (N-identity)
Must have/be around friends, family, classmates who like/do STEM activities (A-Identity)
Construct #5: Preparation
Must have STEM-specific items (equipment, toys, etc.) to be successful in STEM
Must have a family member/mentor in STEM to be successful in STEM
Must become empowered or build confidence to be successful in STEM
Must have early (childhood) experiences in STEM activities to have a STEM future (career)
Construct #6: Performance
Must have competence in STEM (what you need to know or do in STEM-based work)
Must be in STEM for a long duration or a long-term to be considered successful in STEM
Must be a specific profession for women (e.g., related to biology and/or medical fields)
Must be a viable career for women (e.g., women are employable, permits them to rear children and/or care for a family)

met such that the data reported are legitimate, given that this information can be used to inform both policy and practice (Nowell et al., 2017). Trustworthiness in this study adhered to the standards set by Lincoln and Guba (1985) for credibility, transferability, dependability, and confirmability. To that end, the use of transparent protocols and methods, aligned to published conceptual frameworks and empirical literature, established the foundation of trustworthiness. This was followed by intercoding (interrating) the data to ensure consensus on data analysis and interpretation. Interrater reliability was established by having both raters (double) code the data sets, determining areas where coders agreed and disagreed with codes, and reconciling the differences (Miles and Huberman, 1994). A posteriori coding for questionnaire data was 87.5% agreement (based upon 49 instances of agreement and seven disagreements) and for interview data 85.5% (among 118 agreements and 20 disagreements). Disagreements were reconciled by a consensus conference.

Results. The open coding of questionnaire responses, as seen in Table 2, indicated that teachers (*n* = 13) and parents (*n* = 9) felt that the event afforded them access to STEM resources and information through engaging them in STEM activities. Areas of divergence between parents and teachers were preferences in hearing from actual scientists (*n* = 8, 0), doing kit activities (*n* = 4, 0), and doing STEM at home, school (*n* = 3, 1) versus supports to encourage STEM interest (*n* = 1, 3). There were little differences between frequencies between Hispanic and White participants.

Table 3 shows how the seven participants who indicated that their definition of STEM was unchanged, attributed that lack of change to their past personal or professional experiences in STEM. One parent (white male) related, "I think I probably came into it [the event] with a pretty good- working in STEM myself, I probably came into it with a pretty good understanding of what it was." For the five participants who reported they had a changed (broadened) definition of STEM, they reported this shift was due to how they held no prior knowledge of STEM previously, saw new disciplines inclusive to STEM, and/or how STEM could be a viable pathway for students' post-secondary endeavors. Another parent (white male) indicated that he now had a "broader picture of incorporating things like animal sciences, or the earth sciences where as before, it would've been- I would've leaned towards just thinking about maybe the medical sciences or the physical sciences." Notably, only three parents and one teacher at the time of the interview had used the take-away kit with their children at home or in the classroom, although several more planned to but had not yet.

Between parents and teachers, Table 4 compares the most valuable aspects of informal STEM experiences (event and home), finding greatest utility in habitus (improving or maintaining students' interest and curiosity in science and engineering; *n* = 6, 6), followed by having more access to STEM capital (information and technology tools; *n* = 5, 6). One parent (African-American female) noted, "I appreciated how the parents were able to do a hands-on activity" and another (Hispanic female) related that they enjoyed "learning as a parent, [getting] more options, sources, etc. for your child." In regard to perceived outputs for students of informal STEM experiences, parents and teachers found the exposure and exploration valuable in spurring students' STEM interests (*n* = 5, 5), although fewer Hispanic parents reported other affordances compared to White parents.

Using the adapted codebook informed from Archer et al.'s (2014) scholarship on gendered attributes of STEM (see Table 1), Tables 5,6,7, and 8 show attending adults' reports

Table 2. *A Posteriori Coding of 25 Participants' Responses to the Benefits Received from Event.*

Coded Comments (*n* = 63)*	Relationship to Student		Race/Ethnicity	
	Parent (*n* = 15)	Teacher (*n* = 10)	Hispanic (*n* = 13)	White (*n* = 12)
Access to STEM Resources	9	13	9	13
Doing STEM Activities (at Event)	5	7	6	6
Hearing from Actual Scientists (Keynote)	8	0	4	4
Contacts, Programs Available in STEM	3	2	3	2
Doing STEM Activities (from Kit)	4	0	2	2
Discussing and Doing STEM at Home	3	1	2	2
Supports to Encourage STEM Interest	1	3	1	3
How to Encourage STEM Interest	2	0	1	3
Explanation of STEM	2	0	0	2
Totals	**37**	**26**	**28**	**35**

**Participants were able zero to three comments. Mean 2, Median 2, Mode 3*

Table 3. *A Posteriori Coding of 12 Participants' Responses to their Definition of STEM and How it Changed After Event.*

Coded Comments (*n* = 35)*	Relationship to Student			Race/Ethnicity	
	Parent (*n* = 14)	Teacher (*n* = 11)	Both (*n* = 3)	White (*n* = 16)	Hispanic (*n* = 13)
Definition of STEM (*n* = 12)					
Unchanged Definition	2	4	1	5	2
Changed Definition	4	1	0	3	2
Totals	**6**	**5**	**1**	**8**	**4**
Defining STEM (*n* = 23)*					
Subjects in the Acronym	4	3	1	5	3
Fosters pathways to STEM Futures	2	3	0	4	1
Enhances Education	0	3	1	4	0
S-T-E-M working together	2	2	0	3	1
Provides Cognitive Exercises	0	1	1	2	0
Totals	**8**	**12**	**3**	**18**	**5**

**Participants were able to provide more than one reason. Mean 2, Median 2, Mode 1*

Table 4. *A Posteriori Coding of 12 Participants' Responses to the Inputs and Outputs of Informal and Home Experiences in STEM.*

Coded Comments (*n* = 59)*	Relationship to Student			Race/Ethnicity	
	Parent (*n* = 6)	Teacher (*n* = 5)	Both (*n* = 1)	White (*n* = 8)	Hispanic (*n* = 4)
Inputs: Informal and STEM Experiences[a,c] (*n* = 42)					
Improve or Maintain Science and Engineering Interest and Curiosity	6	6	0	8	4
More access to Science Information and/or Technology tools	5	6	0	7	4
Opportunities for Student-Adult Collaboration	4	0	2	5	1
More access to Hands-on and/or Busy Science-Based Activities	0	6	0	5	1
Establishing or Remediating Basic Science Knowledge or Skills	0	2	0	2	0
Generating or Enhancing Advanced Science Knowledge or Skills	2	0	0	0	2
Opportunities for Student-Student Collaboration	2	0	0	1	1
Totals	**19**	**20**	**2**	**28**	**13**
Outputs: for STEM in School and/or Career[b, c] (*n* = 17)					
Exposure and Exploration Generating Further Interest in and Participation in STEM Activities	5	5	1	7	4
Illuminating Relationships between Art and STEM	2	1	0	3	0
Boosts Self-esteem and/or Confidence in STEM	0	3	0	3	0
Totals	7	9	1	13	4

[a]*Responses are sourced from two interview questions (Kit use and Home Experiences).*
[b]*Responses are sourced from one interview question (Perceptions of Career Aspirations).*
[c]*Participants were able to give more than one reason. Mean 2, Median 2, Mode 2*

of gendered ideas that reveal their perceptions of girls in STEM. Table 5 presents the perceived benefits girls received from participation, in which the greatest amount of data was attributed to the preparation construct for both groups, followed by place, identity, and performance. There were no data found that related to ability or purpose. As example, a teacher (white female) remarked that for "especially the girls…exposure I think is everything. So just being exposed to different women leading the presentations I think that just gave them the confidence boost compared to what they see on a daily basis."

Table 6 displays adults' responses to the nature of their changing perceptions of STEM due to the event. Findings suggest that attending adults reported purpose and performance as important to STEM, and to a lesser extent, attributes of place, identity and ability. To evidence this general unknowing of STEM, a parent (Hispanic female) said, "Beforehand, she was more interested in the medical field, but she hadn't thought about engineering because, well, we didn't know much about it."

Table 7 provides insight to adults' thinking to the affordances of informal STEM experiences as well as engaging

Table 5. *A Priori Coding of 25 Participants' Responses to the Benefits Received from Event.*

Coded Comments (*n* = 56)*	Relationship to Student		Race/Ethnicity	
	Parent (*n* = 15)	Teacher (*n* = 10)	Hispanic (*n* = 13)	White (*n* = 12)
Preparation	**14 (43%)**	**11 (48%)**	**11 (44%)**	**14 (45%)**
STEM Equipment, Toys and/or Tools	8	9	7	10
Family member or other Mentor	4	1	3	2
Empowered, Building Confidence	2	1	1	2
Early experiences in STEM activities	0	0	0	0
Place	**11 (33%)**	**7 (30%)**	**8 (32%)**	**10 (32%)**
Degree of Belonging in STEM	9	0	4	5
Specific Activities to Perform	2	7	4	5
Excluded Activities of Women	0	0	0	0
Not only one Female in STEM	0	0	0	0
Identity (Must be)	**5 (15%)**	**2 (9%)**	**3 (12%)**	**4 (13%)**
Analytical, introverted: I-identity	0	0	0	0
Uncreative (unfeminine): D-identity	0	0	0	0
Male or Masculine: N-identity	0	0	0	0
With others like/do STEM: A-identity	5	2	3	4
Performance	**3 (9%)**	**3 (13%)**	**3 (12%)**	**3 (10%)**
Perceived as Competent in STEM	2	3	3	2
Expectation of Success in STEM	0	0	0	0
Importance or Values of STEM	1	0	0	1
A Viable Future in STEM	0	0	0	0
Ability (Must have or be)	**0 (0%)**	**0 (0%)**	**0 (0%)**	**0 (0%)**
Adjacent, Similar, or Feminine Areas	0	0	0	0
Good at Math	0	0	0	0
A natural talent or gift for STEM	0	0	0	0
An innate curiosity, interest, challenge	0	0	0	0
Purpose or Role in STEM is to:	**0 (0%)**	**0 (0%)**	**0 (0%)**	**0 (0%)**
Help People and Problems	0	0	0	0
Save the world	0	0	0	0
Boring, Uninteresting Activities	0	0	0	0
Unknown (Role is Undefined)	0	0	0	0
Totals	**33**	**23**	**25**	**31**

Participants were able zero to four comments. Mean 2, Median 2, Mode 3

in STEM activities at home. Results suggest that adults perceived that these experiences were the most critical for girls' preparation in STEM, with additional benefits in developing girls' STEM abilities and determining their purpose in STEM. Adults also reported that informal and home experiences, albeit to a lesser extent, enhanced girls' performance, identity formation, and determining their place in STEM. At home, a parent (white male) related that now he is "continually running into these kinds of activities" to take and use at home, which "has kind of helped nurtured her and show her that it's okay to like space." A teacher (Hispanic female) said such discussions in the classroom "has got them [girls] into I guess thinking about science careers. Maybe they might not

Table 6. *A Priori Coding of 12 Participants' Responses to Changing Perceptions of STEM from the Event.*

Coded Comments (n = 29)*	Relationship to Student			Race/Ethnicity	
	Parent (n = 6)	Teacher (n = 5)	Both (n = 1)	White (n = 8)	Hispanic (n = 4)
Performance	**5 (36%)**	**5 (38%)**	**0**	**8 (35%)**	**2 (33%)**
Perceived as Competent in STEM	1	3	0	4	0
Expectation of Success in STEM	0	1	0	1	0
Importance or Values of STEM	3	0	0	2	1
A Viable Future in STEM	1	1	0	1	1
Purpose or Role in STEM is to:	**5 (36%)**	**5 (38%)**	**0**	**8 (35%)**	**2 (33%)**
Help People and Problems	0	1	0	1	0
Save the world	0	0	0	0	0
Boring, Uninteresting Activities	0	0	0	0	0
Unknown (Role is Undefined)	5	4	0	7	2
Preparation	**1 (7%)**	**2 (16%)**	**1**	**4 (17%)**	**0 (0%)**
STEM Equipment, Toys and/or Tools	0	0	0	0	0
Family member or other Mentor	1	1	0	2	0
Empowered, Building Confidence	0	1	0	1	0
Early experiences in STEM activities	0	0	1	1	0
Place	**3 (21%)**	**0 (0%)**	**0**	**1 (4%)**	**2 (33%)**
Degree of Belonging in STEM	0	0	0	0	0
Specific Activities to Perform	2	0	0	1	1
Excluded Activities of Women	1	0	0	0	1
Not only one Female in STEM	0	0	0	0	0
Identity (Must be)	**0 (0%)**	**1 (8%)**	**0**	**1 (4%)**	**0 (0%)**
Analytical, introverted: I-identity	0	0	0	0	0
Uncreative (unfeminine): D-identity	0	0	0	0	0
Male or Masculine: N-identity	0	0	0	0	0
With others like/do STEM: A-identity	0	1	0	1	0
Ability (Must have or be)	**0 (0%)**	**0 (0%)**	**1**	**1 (4%)**	**0 (0%)**
Adjacent, Similar, or Feminine Areas	0	0	0	0	0
Good at Math	0	0	0	0	0
A natural talent or gift for STEM	0	0	0	0	0
An innate curiosity, interest, challenge	0	0	1	1	0
Totals	**14**	**13**	**2**	**23**	**6**

Participants were able zero to four comments. Mean 1, Median 1, Mode 2

have thought that before but I really like taking them to those kind of things like getting them exposed to especially at this young age and kind of opening those doors for them."

Table 8, conversely to Table 7, shows sampled adults' expectations in regard to outcomes of girls' informal and home experiences in STEM. Similarly, their perceptions in regard to the outcomes of these experiences centrally relate to girls' preparation and performance in STEM, followed by ability and identity development as well as place and purpose. One parent (white male) typified this type of perception by saying that the "key note speakers that they had at the event was like spot on;" for his daughter "somebody that had engineering experience or mathematics experience with a female perspective was very helpful for her."

DISCUSSION

This interpretive case study sought to explore how girl-focused STEM outreach programs, when infused with specific elements to enhance STEM perceptions among adults, may disrupt existing doxa that obstructs or thwarts girls' interests and futures in STEM. We explored this question through a content analysis of open-ended questionnaires and interviews with attending parent and teachers, through both inductive and deductive coding, the latter of which using a framework to explore gendered perceptions of STEM. This research helps to provide a greater understanding to how adults (namely parents and teachers) shift their perceptions of STEM for girls when engaging (not just participating) in targeted STEM outreach for female children and students, respectively.

Table 7. *A Priori Coding of 12 Participants' Responses to the Inputs of Informal and Home Experiences in STEM.*

Coded Comments (n = 66)*	Relationship to Student			Race/Ethnicity	
	Parent (n = 6)	Teacher (n = 5)	Both (n = 1)	White (n = 8)	Hispanic (n = 4)
Preparation	**11 (35%)**	**10 (32%)**	**0**	**16 (35%)**	**5 (25%)**
STEM Equipment, Toys and/or Tools	6	4	0	8	2
Family member or other Mentor	3	3	0	5	1
Empowered, Building Confidence	1	0	0	1	0
Early experiences in STEM activities	1	3	0	2	2
Ability (Must have or be)	**3 (10%)**	**6 (19%)**	**2**	**9 (19%)**	**2 (10%)**
Adjacent, Similar, or Feminine Areas	0	1	0	0	1
Good at Math	0	1	1	2	0
A natural talent or gift for STEM	0	0	1	1	0
An innate curiosity, interest, challenge	3	4	0	6	1
Purpose or Role in STEM is to:	**5 (16%)**	**5 (16%)**	**0**	**5 (11%)**	**5 (25%)**
Help People and Problems	1	0	0	0	1
Save the world	0	0	0	0	0
Boring, Uninteresting Activities	1	2	0	3	0
Unknown (Role is Undefined)	3	3	0	2	4
Performance	**6 (19%)**	**3 (10%)**	**0**	**3 (7%)**	**6 (30%)**
Perceived as Competent in STEM	4	2	0	2	4
Expectation of Success in STEM	0	0	0	0	0
Importance or Values of STEM	2	0	0	1	1
A Viable Future in STEM	0	1	0	0	1
Identity (Must be)	**3 (10%)**	**3 (10%)**	**2**	**6 (13%)**	**2 (10%)**
Analytical, introverted: I-identity	0	0	0	0	0
Uncreative (unfeminine): D-identity	0	0	0	0	0
Male or Masculine: N-identity	0	0	0	0	0
With others like/do STEM: A-identity	3	3	2	6	2
Place	**3 (10%)**	**4 (13%)**	**0**	**7 (15%)**	**0 (0%)**
Degree of Belonging in STEM	1	0	0	1	0
Specific Activities to Perform	1	3	0	4	0
Excluded Activities of Women	0	0	0	0	0
Not only one Female in STEM	1	1	0	2	0
Totals	**31**	**31**	**4**	**46**	**20**

Participants were able zero to four comments. Mean 3, Median 3, Mode 4

A posteriori coding from Table 1 suggests that parents interpreted more benefits (n = 37) than teachers (n = 26), and White parents (n = 35) reported more benefits than Hispanic parents (n = 28). Sampled adults liked having access to resources and participating in the STEM activities themselves. Interestingly, parents overwhelmingly liked interacting with women scientists (n = 8), with no differences found between demographic groups. This may help to explain why parents reported a broadening in their understanding of STEM more than their teacher counterparts (Table 3). McClain and Zimmerman (2019) found similar affordances in their studies of scientists conducting workshops with families; they suggest that these interactions supported science-based sensemaking between children and parents. This finding is extended in Table 4, in which adults recognized the importance of informal and home experiences to improve or maintain girls' interests (n = 12). This is contradicted by the fact that only four adults utilized the take-away kit. It is unclear why they would choose to not utilize the kit given to them after specific training in its use. Adults may recognize the importance of STEM experiences yet choose to delegate this responsibility to others perhaps more equipped in STEM. Allen et al. (2020) utilized 'STEM guides,' community members charged with brokering STEM resources to rural youth "instead of relying on parents or teachers to provide such connections opportunistically and only for their own youth" (p. 17). It may seem that adults view sustaining or enhancing girls' STEM interests as important yet perceive that as the responsibilities of others. It also could be that additional adults might have used the take-away kits if they had been given more time before the follow-up interviews. Further exploration of this should be explored.

A priori coding using the Archer et al. (2014) framework suggested that perceived benefits of engaging in this type of event enhanced girls' preparation for STEM, revolving around elements of STEM capital and habitus (Table 5). Changing perceptions of STEM (from Table 6) was related to gendered performance in STEM followed closely by girls' purpose or roles in STEM. Notably, despite explicit instruction and take-away information on STEM careers, parents and teachers alike were unable to define the purpose or role of their girls in STEM (see the unknown subcategory). Inputs of participating in STEM outreach (in Table 7) suggest that preparation was important (as it was at home), however, ability was attributed to success in STEM in this space, especially in the subcategory of girls' possessing an innate curiosity and interest. This departure indicates these attributes are 'fixed' at home and more pliable during STEM events. The outputs (Table 8) largely mirrored the inputs (Table 7), with preparation being the biggest outcome of informal and home STEM experiences. These gendered elements reflect what Lloyd et al. (2018, p. 308) found in their studies of families in New South Wales that, "even when parents created a supportive environment, there was little evidence indicating that girls were encouraged to pursue STEM." Despite this finding, there is little indicating that participation in the event reinforced gendered elements of girls needing to have gendered identities or abilities in order to participate in or

Table 8. *A Priori Coding of 12 Participants' Responses to the Outputs of Informal and Home Experiences in STEM.*

Coded Comments (n = 31)*	Relationship to Student			Race/Ethnicity	
	Parent (n = 6)	Teacher (n = 5)	Both (n = 1)	White (n = 8)	Hispanic (n = 4)
Preparation	**4 (25%)**	**6 (46%)**	**0**	**6 (30%)**	**5 (45%)**
STEM Equipment, Toys and/or Tools	0	1	0	1	0
Family member or other Mentor	2	1	0	1	2
Empowered, Building Confidence	1	3	0	3	1
Early experiences in STEM activities	1	1	0	1	1
Performance	**4 (25%)**	**3 (23%)**	**2**	**5 (25%)**	**4 (37%)**
Perceived as Competent in STEM	0	2	1	2	1
Expectation of Success in STEM	0	0	0	0	0
Importance or Values of STEM	3	1	1	3	2
A Viable Future in STEM	1	0	0	0	1
Ability (Must have or be)	**4 (25%)**	**3 (23%)**	**0**	**6 (30%)**	**1 (0%)**
Adjacent, Similar, or Feminine Areas	1	1	0	2	0
Good at Math	0	1	0	1	0
A natural talent or gift for STEM	1	0	0	0	0
An innate curiosity, interest, challenge	2	1	0	3	1
Identity (Must be)	**3 (19%)**	**0 (0%)**	**0**	**2 (10%)**	**1 (9%)**
Analytical, introverted: I-identity	1	0	0	1	0
Uncreative (unfeminine): D-identity	1	0	0	1	0
Male or Masculine: N-identity	0	0	0	0	0
With others like/do STEM: A-identity	1	0	0	0	1
Purpose or Role in STEM is to:	**1 (6%)**	**0 (0%)**	**0**	**0 (0%)**	**1 (9%)**
Help People and Problems	1	0	0	0	1
Save the world	0	0	0	0	0
Boring, Uninteresting Activities	0	0	0	0	0
Unknown (Role is Undefined)	0	0	0	0	0
Place	**0 (0%)**	**1 (8%)**	**0**	**1 (5%)**	**0 (0%)**
Degree of Belonging in STEM	0	1	0	1	0
Specific Activities to Perform	0	0	0	0	0
Excluded Activities of Women	0	0	0	0	0
Not only one Female in STEM	0	0	0	0	0
Totals	**16**	**13**	**2**	**20**	**11**

Participants were able zero to four comments. Mean 3, Median 3, Mode 3

enjoy STEM. However, this does suggest further research is warranted to understand why adults were reluctant to implement the STEM kit activities at home with their children or in school with their students.

CONCLUSION

The qualitative nature of this work inherently places limitations on the generalizability of this research; however, we believe that the use of different data sources (questionnaires and interviews) as well as applicable and vetted theoretical perspectives (habitus and capital) provides a valuable insight to ongoing challenges of recruiting underrepresented ethnic and gender minorities to STEM. Given the desire to engage adults in supporting and cultivating the interests of girls in STEM, our study explored changes in the perceptions of adults when provided specific STEM experiences and tools to better understand what they perceive as girls' involvement in STEM and/or supporting the growing interests of their girls in STEM. By studying Tech Savvy, we analyzed data that suggests adults found great value in nurturing interest and preparing girls for STEM futures, projecting onto girls the value of the STEM they received at the event. However, they were reticent to take up the responsibility of continuing those valued experiences at home (parents) or at school (teachers) during the three months after the event. It could be possible adults used the kit after our three-month check-in. In lieu of not knowing their doxa prior to the event, our research suggests that gendered elements remained despite direct instruction, with a notable example of not understanding the careers available to women in STEM despite receiving explicit information on STEM careers and interacting with women working in a variety of STEM fields. Despite this finding, we did determine that the event itself did not contribute to fixed, gendered perceptions of girls in STEM related to identity and ability. The significance of this work suggests that adults, regardless of race or ethnicity, require more generative experiences in STEM to shift their perceptions to promote girls' interests in STEM. Per the findings of the present study, recommendations for generative experiences in informal STEM events should include, but not be limited to, more hands-on experiences for adults to model for their student at home or in the classroom as well have greater access to information on the variety of STEM careers available that recognize and reflect the growing interests of their female student.

ASSOCIATED CONTENT

Supplemental material mentioned in this manuscript can be found uploaded to the same webpage as this the manuscript.

AUTHOR INFORMATION

Corresponding Author

Dr. Rebecca L. Hite, Assistant Professor of Science Education, Department of Curriculum and Instruction, College of Education, Texas Tech University. 3002 18th Street, Lubbock, TX, 79409. 806-834-6370. Rebecca.hite@ttu.edu

Author Contributions

The manuscript was written through contributions of both authors, who have given approval to the final version of the manuscript.

FUNDING SOURCES

The authors would like to acknowledge the support of the STEM Center for Outreach, Research & Education (STEM CORE) at Texas Tech University.

ABBREVIATIONS

AAUW: American Association of University Women; NASEM: National Academies of Sciences, Engineering and Medicine; NRC: National Research Council; STEM: Science, Technology, Engineering, and Mathematics; STEM CORE: STEM Center for Outreach, Research, and Education

REFERENCES

Allen, S., Kastelein, K., Mokros, J., Atkinson, J., and Byrd, S. (2020). STEM Guides: Professional brokers in rural STEM ecosystems. International Journal of Science Education, Part B, 10(1), 17-35.

Archer, L., Dewitt, J., and Osborne, J. (2015). Is Science for us? Black students' and parents' views of science and science careers. Science Education, 99(2), 199–237.

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., and Wong, B. (2012a). "Balancing acts'': Elementary school girls' negotiations of femininity, achievement, and science. Science Education, 96(6), 967-989.

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., and Wong, B. (2012b). Science aspirations, capital, and family habitus: How families shape children's engagement and identification with science. American Educational Research Journal, 49(5), 881-908.

Archer, L., DeWitt, J., and Willis, B. (2014). Adolescent boys' science aspirations: Masculinity, capital, and power. Journal of Research in Science Teaching, 51(1), 1–30.

Aschbacher, P. R., Li, E., and Roth, E. J. (2010). Is science me? High school students' identities, participation and aspirations in science, engineering, and medicine. Journal of Research in Science Teaching, 47(5), 564-582.

Baker, D., and Leary, R. (1995). Letting girls speak out about science. Journal of Research in Science Teaching, 32(1), 3-27.

Banducci, S. E., Daugherty, A. M., Biggan, J. R., Cooke, G. E., Voss, M., Noice, T., Noice, H., and Kramer, A. F. (2017). Active experiencing training improves episodic memory recall in older adults. Frontiers in aging neuroscience, 9, 133. https://doi.org/10.3389/fnagi.2017.00133

Bengtsson, M. (2016). How to plan and perform a qualitative study using content analysis. NursingPlus Open, 2, 8-14.

Bourdieu, P. (1977). Outline of a Theory of Practice. Cambridge, UK: Cambridge University Press.

Bourdieu, P. (2002). Distinction: A social critique of the judgement of taste. Reprint Edition. Cambridge, MA: Harvard University Press.

Bourdieu, P. (2010). Sociology is a martial art. New York, NY: New Press.

Breiner, J. M., Harkness, S. S., Johnson, C. C., and Koehler, C. M. (2012). What is STEM? A discussion about conceptions of STEM in education and partnerships. School Science and Mathematics, 112(1), 3-11.

Butler, J. (1999). Feminism and the Subversion of Identity. New York, NY: Routledge.

Calabrese Barton, A., and Brickhouse, N. W. (2006). Engaging girls in science. In C. Skelton, B. Francis, and L. Smulyan (Eds.), Handbook of gender and education (pp. 221–235). Sage.

Carlone, H. B., and Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. Journal of Research in Science Teaching, 44(8), 1187–1218.

Carsten Conner, L. D., Perin, S. M., and Pettit, E. (2018). Tacit knowledge and girls' notions about a field science community of practice. International Journal of Science Education, Part B, 8(2), 164–177.

Christensen, R., Knezek, G., and Tyler-Wood, T. (2015). Alignment of hands-on STEM engagement activities with positive STEM dispositions in secondary school students. Journal of Science Education and Technology, 24(6), 898–909.

Craig, C., Verma, R., Stokes, D., Evans, P., and Abrol, B. (2018). The influence of parents on undergraduate and graduate students' entering the STEM disciplines and STEM careers. International Journal of Science Education, 40(6), 621-643.

Dabney, K. P., Tai, R. H., Almarode, J. T., Miller-Friedmann, J. L., Sonnert, G., Sadler, P. M., and Hazari, Z. (2012). Out-of-school time science activities and their association with career interest in STEM. International Journal of Science Education, Part B, 2(1), 63–79.

Darke, K., Clewell, B. C., and Sevo, R. (2002). Meeting the challenge: The impact of the National Science Foundation's program for women and girls. Journal of Women and Minorities in Science and Engineering, 8(3-4), p. 285-303.

DeWitt, J., and Archer, L. (2017). Participation in informal science learning experiences: The rich get richer? International Journal of Science Education, Part B, 7(4), 356–373.

Eccles, J. S. (2015). Gendered socialization of STEM interests in the family. International Journal of Gender, Science and Technology, 7(2), 116-132.

Essig, R. R., Elahi, B., Hunter, J. L., Mohammadpour, A., and O'Connor, K. W. (2020). Future Girls of STEM Summer Campus Pilot: Teaching girls about engineering and leadership through hands-on activities and mentorship. Journal of STEM Outreach, 3(1), 1-9. DOI: 10.15695/jstem/v3i1.09

Falk, J. H., Staus, N., Dierking, L. D., Penuel, W., Wyld, J., and Bailey, D. (2016). Understanding youth STEM interest pathways within a single community: The Synergies project. International Journal of Science Education, Part B, 6(4), 369–384.

Fereday, J., and Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. International Journal of Qualitative Methods, 5(1), 80-92.

Gamse, B. C., Martinez, A., and Bozzi, L. (2017). Calling STEM experts: How can experts contribute to students' increased STEM engagement?. International Journal of Science Education, Part B, 7(1), 31-59.

Gilmartin, S. K., Li, E., and Aschbacher, P. (2006). The relationship between interest in physical science/engineering, science class experiences, and family contexts: Variations by gender and race/ethnicity among secondary students. Journal of Women and Minorities in Science and Engineering, 12(2–3), 179-207.

Grimes, L. E., Arrastía-Chisholm, M. A., and Bright, S. B. (2019). How can they know what they don't know? The beliefs and experiences of rural school counselors about STEM career advising. Theory and Practice in Rural Education, 9(1), 74-90.

Gunderson, E. A., Ramirez, G., Levine, S. C., and Beilock, S. L. (2012). The role of parents and teachers in the development of gender-related math attitudes. Sex roles, 66(3), 153-166.

Hand, S., Rice, L., and Greenlee, E. (2017). Exploring teachers' and students' gender role bias and students' confidence in STEM fields. Social Psychology of Education, 20(4), 929–945.

Hite, R., Midobuche, E., Benavides, A. H., & Dwyer, J. (2018). Third Space Theory: A Theoretical Model for Designing Informal STEM Experiences for Rural Latina Youth. In T. T. Yuen, E. Bonner, & M. G. Arreguin-Anderson (Eds.), (Under)Represented Latin@s in STEM: Increasing Participation Throughout Education and the Workplace (pp. 189-202). Peter Lang Publishing.

Hughes, R., Schellinger, J., Billington, B., Britsch, B., and Santiago, A. (2020). A summary of effective gender equitable teaching practices in informal STEM education spaces. Journal of STEM Outreach, 3(1), 1-9. DOI: 0.15695/jstem/v3i1.16

Hunt, A. S., Lockwood, P. R., and Hunt, E. M. (2014, June 15-18). Exploring and Developing Hispanic STEM Education in West Texas. [Paper presentation]. ASEE Annual Conference and Exposition, Indianapolis, IN. https://peer.asee.org/20468.pdf

Lincoln, Y., and Guba, E. G. (1985). Naturalistic Inquiry. Thousand Oaks, CA: Sage.

Lloyd, A., Gore, J., Holmes, K., Smith, M., and 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.

Maltese, A. V., and Cooper, C. S. (2017). STEM pathways: Do men and women differ in why they enter and exit? American Educational Research Association: Open, 3(3), 1–16.

Maltese, A. V., and Tai, R. H. (2011). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among U.S. students. Science Education, 95(5), 877–907.

Martínez, A. J. G., Pitts, W., de Robles, S. L. R., Brkich, K. L. M., Bustos, B. F., and Claeys, L. (2019). Discerning contextual complexities in STEM career pathways: Insights from successful Latinas. Cultural Studies of Science Education, 14(4), 1079-1103.

McClain, L. R., and Zimmerman, H. T. (2019). Family connections to local science issues: How scientists use questions to engage families in personally-relevant learning during science-themed workshops. International Journal of Science Education, Part B, 9(2), 154-170.

Miles, M. B., and Huberman, A. M. (1994). Qualitative data analysis: An expanded sourcebook (2nd ed). Thousand Oaks, CA: Sage.

Miller, K., Sonnert, G., and 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.

Miller, P., and Votruba-Drzal, E. (2013). Early academic skills and childhood experiences across the urban–rural continuum. Early childhood research Quarterly, 28(2), 234-248.

Morath, M. (2019). 2018-19 Texas Public School Statistics (p. 2). Texas Education Agency.

National Academies of Sciences, Engineering and Medicine. (2019). Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce. Washington, DC: National Academies Press.

National Academy of Sciences, Engineering and Medicine. (2011). Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads. Washington, DC: National Academies Press.

National Research Council. (2009). Learning Science in Informal Environments: People, Places, and Pursuits. Washington, DC: National Academies Press.

National Research Council. (2010). Surrounded by Science: Learning Science in Informal Environments. Washington, DC: National Academies Press.

National Research Council. (2015). Identifying and Supporting Productive STEM Programs in Out-of-School Settings. Washington, DC: National Academies Press.

Nowell, L. S., Norris, J. M., White, D. E., and Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. International Journal of Qualitative Methods, 16(1), 1–13.

Piatek-Jimenez, K., Cribbs, J., and Gill, N. (2018). College students' perceptions of gender stereotypes: Making connections to the underrepresentation of women in STEM fields. International Journal of Science Education, 40(12), 1432–1454.

Prakash, N. (2017, June 25-28). Engagement in Practice: Unlocking STEM as a Career Choice for Middle School Females in a Rural School District. [Paper presentation]. ASEE Annual Conference and Exposition, Columbus, OH. https://peer.asee.org/28241.pdf

Prieto-Rodriguez, E., Sincock, K., and Blackmore, K. (2020). STEM initiatives matter: Results from a systematic review of secondary school interventions for girls. International Journal of Science Education, 42(7), 1144-1161.

Rashid, Y., Rashid, A., Warraich, M. A., Sabir, S. S., and Waseem, A. (2019). Case study method: A step-by-step guide for business researchers. International Journal of Qualitative Methods, 18, 1-13. DOI: 1609406919862424.

Riggs, R. A., White, C. J., Kuenzi, T., Sifuentes, M., Garner, S. R., Gleason, R. A., Lee, J., Ziese, C. C., Berry, J., Garza, M. A., Vann, D., Fordtran, C. W., Grimes, K. K., Gray, J., and Evans, T. M. (2019). Engaging the community through science nights: An elementary school case study. Journal of STEM Outreach, 2, 1-10. DOI: 10.15695/jstem/v2i1.06

Robinson-Cimpian, J. P., Lubienski, S. T., Ganley, C. M., and Copur-Gencturk, Y. (2014). Teachers' perceptions of students' mathematics proficiency may exacerbate early gender gaps in achievement. International Journal of Science Education, 34(10), 1615–1636.

Sáinz, M., and Müller, J. (2018). Gender and family influences on Spanish students' aspirations and values in STEM fields. International Journal of Science Education, 40(2), 188-203.

Shapiro, J. R., and Williams, A. M. (2012). The role of stereotype threats in undermining girls' and women's performance and interest in STEM fields. Sex roles, 66(3-4), 175-183.

Sjaastad, J. (2012). Sources of inspiration: The role of significant persons in young people's choice of science in higher education. International Journal of Science Education, 34(10), 1615–1636.

STEM Center for Outreach, Research & Education. (2019). Tech Savvy. https://www.depts.ttu.edu/stem/techsavvy/index.php

Thiede, B., Kim, H., and Valasik, M. (2018). The spatial concentration of America's rural poor population: A postrecession update. Rural Sociology, 83(1), 109-144.

Thomas, D. R. (2003, August). A general inductive approach for qualitative data analysis. Paper presented at School of Population Health, University of Auckland, New Zealand.

Valla, J. M., and Williams, W. M. (2012). Increasing achievement and higher education representation of under-represented groups in science, technology, engineering and mathematics fields: A review of current K-12 intervention programs. Journal of Women and Minorities in Science and Engineering, 18(1), 21–53.

Vennix, J., den Brok, P., and Taconis, R. (2018). Do outreach activities in secondary STEM education motivate students and improve their attitudes towards STEM? International Journal of Science Education, 40(11), 1263–1283.

Wang, X. (2012). Modeling student choice of STEM fields of study: Testing a conceptual framework of motivation, high school learning, and postsecondary context of support. (ED529700). ERIC. https://files.eric.ed.gov/fulltext/ED529700.pdf

Watson, S., Williams-Duncan, O. M., and Peters, M. L. (2020). School administrators' awareness of parental STEM knowledge, strategies to promote STEM knowledge, and student STEM preparation. Research in Science and Technological Education, 1-20. DOI: 10.1080/02635143.2020.1774747