“I have this. I’m set.” Expanding Human, Social, and Cultural Capital through Out-of-School STEM Programs

I. Objectives

Between 2016 and 2026, science and engineering occupations are projected to grow by 13% (compared with 7% for other occupations) (National Science Board, 2019). This has led to predictions that in the near future the U.S workforce will struggle to fill millions of jobs in Science, Technology, Engineering and Mathematics (STEM) fields (National Academies of Sciences & Medicine, 2017). At the same time, STEM career interest among young students appears to decline during secondary school (Mau, 2003; Sadler et al., 2012; Saw et al., 2018), a time when adolescents begin to form and decide a potential career path to pursue in adulthood. Declining career interest in STEM among adolescents, alongside a pressing need for a robust STEM workforce, presents a need for action to increase STEM learning, motivation, and participation among students.

Prior studies show that participation in out-of-school time (OST) STEM activities may promote STEM learning and motivation (Kitchen et al., 2018; Knox et al., 2003; Young et al., 2017). However, little is known about which specific elements or mechanisms of OST STEM programs are effective (Dabney et al., 2012; Young et al., 2017). This study addresses this gap in the literature by exploring the specific mechanisms by which OST STEM programs improve both student learning and motivation in STEM. Particularly, this study examines two research questions:

1) How do students who participated in an OST STEM program describe their experiences in shaping their STEM learning (e.g., STEM skills and knowledge)?
2) How do students who participated in an OST STEM program describe their experiences in shaping their STEM motivation (e.g., interest, identity, self-efficacy)?

II. Theoretical Perspective and Relevant Literature

The theories of human, social, and cultural capital offer useful theoretical perspectives for understanding and studying how participating in an OST STEM program encourages student STEM learning and motivation. Two major components of human capital are knowledge and skills, which are traditionally gained through formal education (Becker, 1962; Heckman, 2000). Social capital refers to resources accessed through social interactions, such as shared knowledge, values, and beliefs (Bourdieu, 1986; Coleman, 1988). Cultural capital describes tangible and intangible cultural goods and resources (such as linguistic competencies and cultural knowledge) acquired by individuals from their environments (Bourdieu, 1984; Lareau & Weininger, 2003). Participating in OST

STEM programs that provide enrichment learning opportunities may increase human capital of students by extending their STEM knowledge and training them in specific STEM skills that may not have been learned in traditional schooling. Furthermore, participation in these programs may expand students' social capital through extending their social networks to including STEM-oriented peers and mentors, who may not be present within their immediate family, school, and community. Students who come from underrepresented groups in STEM typically do not have the cultural knowledge needed to navigate STEM education and career pathways. By exposing students to STEM professionals and environments, OST STEM programs can enhance students' cultural capital in STEM, which is traditionally limited to transmissions within the family and school context (Bourdieu, 1984).

Prior research in STEM education suggests participation in OST STEM activities is positively related to students' STEM learning (Knox et al., 2003; Markowitz, 2004) and STEM motivation (Kitchen et al., 2018; Young et al., 2017). For instance, students participating in a short-term science summer program have reported more confidence in their laboratory skills (Knox et al., 2003). Additionally, participation in OST STEM clubs and competitions is associated with an increase in interest of selecting a STEM-related career (Dabney et al., 2012) and of having STEM career aspirations (Kitchen et al., 2018).

While findings from studies point to a positive linkage between OST STEM participation and STEM learning and motivation, it is unclear what it is specifically about participation that increases students' knowledge/skills and interest in STEM. Prior studies tend to focus on main effect findings, yet do not consider the intermediate mechanisms that explain how OST STEM participation can improve STEM learning and motivation. This study extends the literature on STEM education by identifying specific mechanisms that link OST STEM participation and STEM learning and motivation with a diverse sample of adolescents who participated in a STEM summer program.

III. Methods

This study uses a case study methodology to explore the mechanism by which a STEM OST summer program affects students' STEM learning and motivation. Case study methodology is appropriate given that we want to understand how adolescents perceive and describe contextual factors of an OST STEM summer program that shape their STEM learning and motivation (Stake, 1995; Yin, 2017). Case study is also useful for understanding the shared experiences of adolescents who participate in the same program (Yin, 2017).

This study focuses on middle and high school students who participated in a large-scale STEM summer program (hereafter SSP) offered across 25 cities in 7 states across the U.S. We purposefully selected SSP for several reasons. First, SSP is a seven-week summer program with a total of 140 contact hours and students can attend for several summers (up to 4 summers), which may provide more opportunity for STEM exposure and training than other shorter, one-off programs. Second, SSP provides advanced learning opportunities for participants. *Introduction to Engineering* for rising 7th graders and *Introduction to Physics* for rising 8th graders are examples of classes offered in SSP. Participants can also obtain a high school credit after completion of the program. Lastly, SSP provides access to STEM professionals, STEM field trips and informal mentorship, all which may expand students' social networks and cultural exposure and knowledge in STEM.

Participants of this study were recruited from five SSP sites from the southwest U.S. Participant recruitment focused on middle and high school students who are traditionally underrepresented in STEM (i.e., girls, students of color, low-income students) and who have participated in SSP for at least one summer. The final sample consisted of 32 students. Table 1 shows the descriptive characteristics of the participants.

Semi-structured interviews and focus groups were designed to understand SSP experiences from the participant perspective. Interviews and focus groups with students ranged from approximately 45 to 60 minutes and were conducted in person by four different researchers. Participants received $35 cash for their participation. Interviews were recorded and later transcribed.

We conducted a thematic data analysis of the interview data to identify key themes of human, social, and cultural capital that are present in the SSP. An initial code book was created based on previous literature and interaction with the data (Elo & Kyngäs, 2008). Two coders analyzed the interview and focus group data and two independent cycles of coding were conducted to reach an inter-rater reliability of 0.86. The remaining data was coded and collapsed into themes.

IV. Results

Preliminary results revealed three overarching themes from the data: (a) advanced learning, (b) community of shared interests, and (c) real-world STEM knowledge. The first theme, *advanced learning*, discusses participants extending their knowledge to include advanced STEM topics. For instance, when asked how SSP has helped her STEM learning, Jasmine (Black female) stated:

> *“What we would do in SSP would prepare me for the next year. I would be like, ‘Oh, I did that.’ I remember doing proofs this year [in school], but we did proofs in SSP and I was like, "Oh, I have this. I'm set. I'm good." So I was given let's say triangle RT X or whatever [which] was like a right triangle. I'll be like, "Okay, I know what a postulate is” So it really helped me.”*

Jasmine increased her human capital by having the opportunity to learn advanced STEM curriculum during the summer. This, in turn, allowed her to be better prepared once she returned to school.

The second theme, *community of shared interests,* explores the expanding of students’ social networks to include a broader array of individuals with whom they shared similar interests. During a focus group session, the students began to share who they met at SSP. Sofia (Hispanic female) shared:

> *“I've met some friends from other districts …I've met several people that at first I'm like ‘okay these people are weird’ but at the same I get along with them because I'm equally as weird as them. But also I get to become friends with my mentors even though they're supposed to be directing us. But they direct us and they also have fun with us.”*

Sofia communicates with us that by participating in SSP she built her social network to include peers from outside of her usual school environment. By acknowledging that she is “equally as weird” as her new friends, she pointed to feeling included within her social and academic environment at SSP. Many students at SSP emphasized that they enjoyed being with people they could relate to and shared that they valued the new friendships created with others who also enjoy STEM. Sofia also points to her network expanding to include “mentors”, who are college students and are available to help the students throughout the day.

The third theme, *real-world STEM knowledge*, refers to experiences that allowed students to learn about STEM pathways and careers directly from STEM professionals. For instance, Stephanie (Hispanic female) said:

> *“They bring in different people from the area. It can be parents of people at SSP or someone that has a STEM profession, and they spend like 30-40 minutes just talking about what they do and how they got there. And some of them even went to SSP. So it was really cool to see like, oh, that could be me in 10 years.”*

Many participants, such as Stephanie, mentioned weekly guest speakers that provided them insights into becoming a STEM professional and allowed them to develop a stronger STEM identity and imagine themselves as STEM professionals. This theme also refers to experiences that were enjoyable for the students while expanding their understanding of the real-world application of STEM. During a focus group the following conversation arose regarding group projects. Claribel (Hispanic female) said:

> *"Last summer we built Lego robots in one of the courses. I think that was the most fun part because I feel that with normal school, they teach you things but it's for the sake of teaching you just because that's in the curriculum. But in SSP, it gives you the chance to actually apply what you're learning. That was the most fun part, doing things hands-on"*

Justin (Black male) agreed with Claribel, and even joked at the end as he added:

> *"Yeah, the hands-on things are cool. This summer, we were building boats and I learned a lot about buoyancy and I actually drowned ... Well, no. I almost drowned. I fell in"*

It is evident that through the enjoyable hands-on learning, students participating in SSP are enhancing their teamwork skills while conducting projects they could be doing as a STEM professional (e.g. building a robot, building a boat). Students are then expanding their human capital, not only by meeting STEM professionals, but through experiencing the real-world application of STEM.

V. Significance of Study

This study contributes to the literature on student STEM learning and motivation in several ways. First, this study brings together the well-established theories of human, social and cultural capital to analyze an OST STEM programs' impact by centering the experiences of the students. In doing so we understand how OST STEM programs can work to increase various forms of capital among students from diverse backgrounds, which can enhance their STEM learning and motivation. Second, while most prior OST STEM studies tended to interview participants from one-off programs during an exit survey, our participant recruitment focused on students who have participated in SSP for multiple years. As such, we can understand the benefits of student participation in an OST STEM program over a span of time. Furthermore, while previous studies have established that OST STEM activities do promote STEM learning and interest, this study goes beyond main effect findings by identifying, through the participants themselves, specific components and mechanisms of OST STEM programs that engage and enhance the learning and motivation of students.

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Table 1. Demographic characteristics of study sample (N=32)

	Percentage
Gender	
Female	40.6
Male	56.3
No response	3.1
Race/Ethnicity	
Hispanic	65.6
White, non-Hispanic	6.3
Black, non-Hispanic	12.5
Asian, non-Hispanic	6.3
Multi-racial, non-Hispanic	9.4
Grade	
7th	9.4
8th	34.4
9th	34.4
10th	21.9
Parental Education	
No high school degree	3.1
High school degree	9.4
Associate degree	12.5
Bachelor's degree	25
Graduate degree	37.5
Unsure	12.5