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"Science Olympiad Is Why I'm Here": the Influence of an Early STEM Program on College and Major Choice

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Abstract

In the interest of building a larger and more diverse science, technology, engineering, and math (STEM) workforce, many K-12 STEM programs have proliferated in recent years, yet the long-term effects of participation in these programs remain underexplored. This mixed methods study focuses on an established program, Science Olympiad, and uses administrative, survey, and focus group data to investigate characteristics of former Science Olympiad participants at one postsecondary institution and participants' perceived influence of the program on their postsecondary trajectories. Using social cognitive career theory, we identify themes in the ways in which Science Olympiad influenced academic and career decisions among participants, especially focusing on college and major choices. Among former participants who indicated that the program influenced their college decisions, participation in a state tournament hosted by the site institution was especially impactful. Half of the study participants indicated that the program influenced their major choice at this institution, largely through providing opportunities for exposure to and exploration of new subject areas with limited risk. Data suggest that Science Olympiad can influence participants' academic and career interests and trajectories, highlighting implications for K-12 STEM out-of-school programs and opportunities for enhanced partnerships between K-12 and postsecondary STEM educational settings.

Keywords STEM · Students · College · Self-efficacy · Major · Career

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Introduction

In recent decades, the number of science, technology, engineering, and mathematics (STEM) jobs in the USA has increased dramatically, making the preparation of a strong STEM workforce a national imperative (Fayer et al. 2017). As approximately three quarters of STEM occupations require at least a bachelor's degree, achieving a competitive workforce in today's global economy is closely tied to developing a strong STEM education system (Diekman and Benson-Grenwald 2018). Students pursuing bachelor's degrees in STEM commonly report that their interests in science and math began before middle school, often due to frequent positive interactions with STEM-related learning experiences including out-of-school activities such as clubs, camps, and competitions (Krapp and Prenzel 2011; Krishnamurthi et al. 2014).

Out-of-School STEM Experiences

Out-of-school STEM experiences such as clubs, camps, and competitions provide an optimal environment for student learning and self-efficacy development. In out-of-school STEM activities, K-12 students assume an active role in the process of knowledge generation, often producing work that is collaborative and shared with members of their local community, with real-world applications (Sahin 2013). Out-of-school STEM experiences also tend to offer a learning environment devoid of grades, making failure a safer option. As participants learn and practice STEM in such spaces, they come to see themselves as contributors in a science community, leading to the development of scientific identity, confidence, and continued participation in STEM over time (Krishnamurthi et al. 2014; Oliver and Venville 2011; Sahin 2013; Sheldrake 2018).

Out-of-school STEM activities can be particularly important for women and students from racial minorities who are less likely to report positive interactions with STEM-related activities in the classroom (Dabney et al. 2011; Falco and Summers 2017). Because early interest in science is associated with continued STEM participation and degree attainment, out-of-school K-12 programs that provide positive and sustained opportunities for STEM identity and interest development can shape long-term participation in these subjects (Habig et al. 2018; Maltese and Tai 2011; Sahin et al. 2015). The participation of students from groups underrepresented in STEM therefore has the potential to reduce racial, gender, and socioeconomic gaps in STEM from an early age, with implications for broadening participation at collegiate and professional levels (Dabney et al. 2011; DeWitt and Archer 2015; DeWitt et al. 2010; Habig et al. 2018; Sax, Allison, Riggers-Piehl, Sahin, Whang, and Paulson, 2015; Smith and Gayles 2017, 2018).

Postsecondary Influences Out-of-school STEM activities can also help students think about future plans, including college attendance. As out-of-school K-12 STEM activities can expose students to new STEM disciplines and build skills, interest, and positive beliefs about one's abilities, such experiences have been linked to college major selection, even more so than academic achievement (Maltese and Tai 2011; Sahin 2013; Sahin et al. 2015). Students who participate in K-12 out-of-school STEM competitions are more likely to take STEM courses and to major in STEM fields in college, often citing these programs as influential to their major selection (Dabney et al. 2011; Forrester 2010; Miller et al. 2018; Sahin 2013). Further, we might expect that K-12 STEM activities influence students' search for college environments that support their internalized values and habits, or habitus (Perna 2006). Students, especially those underrepresented in higher education, place a high value on the perceived *fit* of an institution with their psychosocial needs and are more likely to choose a college that aligns with their habitus (Cho et al. 2008).

Science Olympiad

There are many K-12 out-of-school STEM programs available for students today (e.g., Dabney et al. 2011; Falco and Summers 2017; Krishnamurthi et al. 2014; Sahin 2013). The present study focuses on Science Olympiad, a STEM competition program available across the USA with participants at elementary, middle, and high school levels. In 2016, Science Olympiad included 230,000 secondary students on 7600 school teams (Science Olympiad 2016). Science Olympiad regional, state, and national competitions often take place on college campuses.

Although Science Olympiad is substantial in its size, we do not know what happens to participants after they are no longer active in the program. Thus, the purpose of this study is to understand the characteristics of former Science Olympiad participants enrolled in postsecondary education to identify the influence of Science Olympiad on former participants' college choice and academic major selection. Given the limited research on this topic, our mixed methods case study explores the experiences of former participants enrolled at a large public institution, addressing the following research questions:

1. What are the characteristics of former Science Olympiad participants as compared to the larger student population at the study institution?
2. How do former participants perceive that Science Olympiad influenced their college choice?
3. How do former participants perceive that Science Olympiad influenced their major choice?

Theoretical Framework

To frame our approach, we use Lent et al.'s (2002) social cognitive career theory (SCCT), a theoretical perspective that centers self-efficacy and outcome expectations in understanding an individual's career development. The theory is inclusive of both academic and career experiences and decisions, acknowledging the frequent interaction and overlap between the two (Lent et al. 2002). SCCT addresses the importance of access and exposure to learning experiences that, in turn, lead to an individual's perceptions of their abilities in these domains (self-efficacy), as well as expectations for future performance in similar tasks. Self-efficacy and positive outcome expectations contribute to the development of career interests, goals, and attainment within the same domain, although this relationship may be moderated by contextual affordances. In short, students with early access to STEM learning experiences explore different topics, build skills, and identify areas of strength and interest within STEM, with long-term implications for career interests and attainment.

Methods

This investigation utilizes an explanatory sequential mixed methods design, a multistage approach that provides opportunity to explore a larger assortment of divergent views to make stronger inferences (Creswell and Plano Clark 2011; Teddlie and Tashakkori 2009). Data collection and analysis were conducted in three stages using institutional administrative data, a survey, and focus groups, all from a one site institution (Fig. 1). The study institution is a large public land-grant institution in the Southeastern US. The study institution has an existing relationship with Science Olympiad, serving as the annual host for the program's state tournament, which typically draws approximately 2200 middle and high school student competitors.

Data Collection and Analysis

After institutional review board approval, we received a dataset from the institution's enrollment services office that contained demographic information and e-mail addresses for all undergraduate students enrolled in Fall 2016 who had used the term "Science Olympiad" on their admissions applications to the institution, a sample comprising approximately 5% of the institution's undergraduate population ($n = 1185$; Appendix Table 2). To address the first research question, we ran descriptive statistics on this dataset, comparing characteristics such as gender and race, state residency, and STEM major to the institution's undergraduate population using public data available through the institutional research office. We used a narrow definition of STEM, that of the Department of Homeland Security (2016). The Department of Homeland Security (DHS) STEM definition uses Classification of Instructional Programs (CIP) codes that include subjects such as agricultural science, biology and life science, chemistry, computer science, engineering, environmental science, geoscience, mathematics, and physics and astronomy, and generally excludes health and social sciences. We then compared DHS CIP codes to those of the academic programs at the study institution to create a dichotomous STEM variable. To identify significant differences between characteristics of former participants and the institution population, we conducted *t* tests.

Next, we invited members in the administrative dataset to complete an electronic Qualtrics survey about their participation in Science Olympiad. An initial invitation and two reminders were sent out, eliciting 135 respondents, a 16% response rate. Characteristics of survey

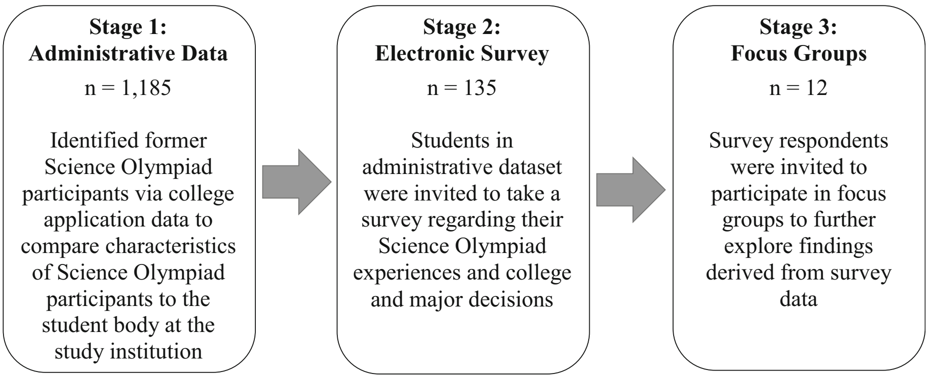

Fig. 1 Stages of data collection and analysis

respondents are available in Appendix Table 3. The survey began by asking about the location, length of time, and education levels in which students had participated in Science Olympiad; why they had gotten involved; and to what extent they believed that participation in Science Olympiad influenced their college and major choice, respectively. Nine survey questions were open-ended, allowing for respondents to share their experiences in their own voices. The survey also contained demographic questions such as parental education level, family income, race and gender, and a description of the urbanicity or rurality of a participant's hometown.

We analyzed survey data by conducting descriptive analysis on closed-ended questions. Next, we coded open-ended responses over multiple cycles, using descriptive coding or assigning labels to data to summarize the topic of the data (Saldaña 2015). Second, we used in vivo coding, or words from participants' own language, replacing descriptive codes where applicable. Third, process codes with gerunds (-ing suffix) were used to highlight action in the data. Fourth, emotion coding was used to explore intrapersonal and interpersonal participant experiences and actions (Saldaña 2015). For example, the action of solving a problem or winning a competition was often described alongside a feeling of relief, triumph, pride, or even surprise, an experience with implications for self-efficacy, especially given the role of affective experiences in building self-efficacy (Bandura 1997). Finally, pattern coding was used to categorize codes into major themes (Saldaña 2015).

In the final stage, we conducted focus groups, giving participants an opportunity to interact with those with complementary experiences, to reveal commonalities and differences in experiences (Liamputtong 2015). Focus groups also allowed us to explore trends identified through the first two stages of administrative and survey data analysis (Creswell and Plano Clark 2011), using the SCCT framework to analyze how specific learning experiences influenced self-efficacy and outcome expectations related to academic and career choices.

At the end of the survey, respondents were invited to share their e-mail address if they were interested in participating in a focus group; 58 (43%) shared this information. In Spring 2018, we invited 35 of these respondents still enrolled at the site institution to participate in focus groups. Twelve students participated and were all assigned pseudonyms (Appendix Table 4). Each group met for 60 min and was led by one member of the research team, with another team member taking notes. Protocol questions were designed to align with the SCCT, focusing on how participants came to join Science Olympiad and what they knew about it before they joined which were especially useful to understanding background characteristics and access points to Science Olympiad as a learning experience. We also asked participants to reflect on how Science Olympiad influenced their thoughts about their skills as a scientist. Additional questions aimed to understand whether, and how, students attributed subsequent postsecondary interests, goals, and behaviors to the program. Focus group data were audio and video recorded, professionally transcribed, and were analyzed with the same coding strategy conducted for open-ended survey comments: descriptive, in vivo, process, emotion, and pattern coding (Saldaña 2015).

Limitations

Because participation in Science Olympiad is self-reported on college applications, we expect that our sample underestimates the number of students who had participated, especially in early grades. Additionally, all quantitative analyses are correlational and do not account for selection bias. Our data do not allow for the isolation of Science Olympiad as a singular reason why students made certain decisions. Instead, we follow qualitative traditions and rely on participants' positioning of the experience within their own decision processes. Further, given the site institution's focus on STEM and its hosting of the annual Science Olympiad state tournaments, we expect that our participants may be more likely to attribute their college decisions to the program than a larger sample of former Science Olympiad participants who attended a variety of colleges and universities. Finally, while our participants offer diverse experiences by socioeconomic status, hometowns, and school resources and experiences, racial diversity in the sample was especially limited. Eleven of the 12 focus group participants were White, with one Asian participant. Whether this sample reflects the overrepresentation of White students among Science Olympiad participants (Forrester 2010), STEM fields as a whole (National Science Foundation 2017), or is the result of selection bias that limited the participation of racially minoritized students, remain undetermined.

Findings

First, analysis from enrollment data provides important insight into the demographic characteristics of students at the study institution who mentioned former participation in Science Olympiad on their admissions applications (Table 1). In comparison to the larger student body, students who had formerly participated in Science Olympiad were significantly more likely to pursue STEM majors. In considering demographic characteristics, former Science Olympiad participants were significantly less likely to be female, Hispanic, Black, and White in comparison to the campus population students. Former Science Olympiad participants were significantly more likely to be Asian, biracial/multiracial, and to be from within the same state as the study institution.

Table 1 Characteristics of former Science Olympiad participants at the research site in comparison to the institution's full undergraduate population

	Science Olympiad participants Mean	Institution population Mean	*t* value
Female	.39	.45	− 4.44*
Race			
White	.68	.72	− 2.60*
Asian	.16	.06	9.22*
Biracial/multiracial	.08	.04	5.27*
Black	.03	.06	− 4.88*
Non-specified	.03	.03	1.09
Hispanic	.01	.05	− 10.63*
Native American	.00	.00	− 0.94
International	–	.05	–
Pacific Islander	–	.00	–
Residency			
In-state	.95	.87	12.02*
Out of state	.05	.09	− 6.77*
International	–	.05	–
STEM major	.79	.61	16.15*

Data on Pacific Islander students, and those who are international, were unavailable for the Science Olympiad sample

*$p < .001$, significant differences

Among survey respondents, nearly all (97%) had participated in Science Olympiad within the same state as the study institution. Just over half of survey respondents (56%) only participated in Science Olympiad in high school (grades 9–12), while an additional 39% participated in both middle (grades 6–8) and high schools. Fewer than 2% of respondents participated in Science Olympiad before fifth grade. A plurality of respondents participated in Science Olympiad for 3 to 4 years (37%), with nearly 20% participating for over 5 years. Additional characteristics of survey respondents are shown in Appendix Table 3.

Influence on College Choice

Among survey respondents, half (49.4%, $n = 78$) said that Science Olympiad influenced their decision of which college or university to attend, a theme further explored in focus group conversations. Among those who indicated that Science Olympiad influenced their college choice, the most common experience that led to this decision was participation in the state tournament, which was held annually at the study institution. Three subthemes comprise findings related to the influence of Science Olympiad on college choice.

Desire and Comfort: "I fell in love with the university" Many students who indicated that Science Olympiad influenced their college decisions described the study institution using strong positive affective words such as "awe," "desire," and "love." This language was most evident in participants' reflections about attending the state tournament for the first time, with nine survey participants used the terminology "falling in love" with the institution during their initial experiences (e.g., "We went to the state competition at [institution] and I fell in love with the university"; "After competing at the Science Olympiad State tournament at [institution] my 6th grade year, I absolutely fell in love"). In focus group conversations, Kim described, "I didn't get to travel much, so when we made state tournament in my 6th grade year, I was overwhelmed by [the institution's] campus… I just fell in love." For some, this interest was new, sparked by the visit: "I couldn't have seen myself going to [institution] before getting to see campus and learning about the great science programs here," while, for others, the state tournament helped to confirm an existing interest: "cement[ing] that desire" to later apply to and attend the institution.

Participants also described feelings of comfort and familiarity with the site institution as a result of the state tournaments, especially after attending multiple times: "I went to the state competition all four years of my high school experience…when I was applying to [institution], I was already very familiar with the campus and culture." Participants recalled these feelings when it came time to apply to college: "When deciding on which college I wanted to go to, the study institution felt the most comfortable." This sense of comfort also contributed to a larger sense of belonging, especially when state tournament experiences had been positive:

> Science Olympiad state competitions were held at [the study institution]. This allowed me to become familiar with the campus…I was able to envision myself being at the study institution because (although it may seem silly) I had been there before and been a part of something there already. Due to my participation in SO, I felt as if I belonged at [the study institution] because I was told that I could do science and research at a research institution of that caliber.

Academic Opportunity: "It made me aware of the scientific community" Beyond emotional experiences, campus visits via the Science Olympiad state tournament also fostered knowledge about academic opportunities at the study institution. College choice and academic interest areas were closely related for many students, with college choice sometimes a product of academic decisions. In these cases, Science Olympiad led to the development of a STEM interest and a resulting goal of attending the study institution based on related academic programs: "[Science Olympiad] reinforced the idea that I wanted to become a scientist, leading me to choose a school with a strong STEM presence"; "Competing in Science Olympiad solidified my decision to pursue my degree in engineering and [the study institution] has the best program in the state so that is why I decided to attend." Students who noticed an alignment between their habitus and that of the study institution began to see it as a place that could support their academic and career interests. One female respondent, for instance, attributed her college decision to a perception of fit based on identity: "I felt that the school encourages more women in science from my experience through Science Olympiad."

No Impact: "I never went to a Science Olympiad event [at the study institution]" Half of the survey respondents indicated that Science Olympiad did not influence their college choice, a theme that was explored in greater depth in focus group conversations. As a student needed to qualify for the state tournament to compete, many participants had not visited the study institution as part of their Science Olympiad experience. Additionally, because regional competitions were not necessarily held at college campuses, Science Olympiad members may not have gained any exposure to college environments through their participation in the program. In a focus group conversation, Hector described:

> I don't know if it's because I started late, but Science Olympiad didn't have any bearing on where I wanted to go to college because whenever we went it was always at a high school. I never went to a Science Olympiad event that was [at the study institution].

As an alternative experience, Valerie was from the same city as the study institution and reported that attending the state tournament did not influence her decisions because it was "just spending more time in a place I've already been." Thus, if visiting the study institution was not a novel experience, it may not have had the same lasting impression or influence on college ideas and related decisions.

Influence on Major Choice

Application data revealed that students who had participated in Science Olympiad were significantly more likely to major in STEM fields, at 79% ($n = 936$), compared to 61% of students in STEM among the institution's overall student population ($t(1184) = 16.15$, $p < .001$). Yet, just under half of survey respondents (45%, $n = 71$) indicated that Science Olympiad had influenced their major choice. To address the third research question, we analyzed data regarding how participants reported that Science Olympiad influenced their academic major choice, which resulted in three subthemes.

Safe Exploration: "Pushed you past what you'd normally learn" For participants, Science Olympiad complemented science and math classwork, providing an extra opportunity to explore STEM interests and to hone skills place in a context of limited risk:

> It gave me more breadth than some coursework. I realized I really liked math and engineering. I was less of a science person, especially natural science is really not my thing. I got to do that in a "safer to fail" environment than taking an AP course or even starting on the college major that wouldn't necessarily be the right path for me. (Valerie)

Exploring STEM in a "safe" environment allowed students to try out new subjects:

> We didn't have materials science at the regional [competition], and when we went to state, they had that event and my teacher was like, "Somebody has gotta do it." My friends and I were like, "Whatever. We'll try it out" … A couple months into it, I realized I did not like materials science… That helped me figure out where I did want to go. (Victor)

Exposure to subjects of interest not only helped students narrow and eliminate potential majors and subjects within STEM fields but confirm them as well:

> Pretty much from the time I took chemistry I knew that's what I wanted to go to college for… Science Olympiad reinforced that…I was able to go in those events and feel confident… it didn't necessarily change my opinion, but it just reinforced that it was something that I was definitely interested in. (Maggie)

Overall, participation offered a low-stakes and enjoyable environment for participants: "It was fun being able to evolve your design and pick out which parts worked and which parts didn't" (Jackson). Hector described, "I just really enjoyed being able to apply what I learned in a classroom to create something… which is why I'm in engineering and design right now."

This trial and error process also helped students build skills to prepare for college: "Because of my experience with teaching myself complex topics in Science Olympiad, I was not as daunted by this class as many are." In a focus group conversation, Kaylie shared:

> With the [Science Olympiad] lab events…you had to go in there and you just had a problem that you had to figure out, like "What are the steps that I need to take to solve that?" That's exactly what I do on a daily basis in the lab.

Beth, too, reported that Science Olympiad was useful in preparing her for scientific research, especially in regard to the process of trial and error: "Now I'm doing undergraduate research and a lot of it is you spend several months on a project and then you don't get results so you just have to do the exact same thing again…[Science Olympiad] really prepared me for the real aspect of that." Valerie agreed: "The first time you're programming it just doesn't work…it's the same kind of mentality [as Science Olympiad] where you have to accept that it's a process and you just have to know that things aren't going to work out the first time and that's okay."

Exposure to New Subjects: "Introduced me to a different field of study" Science Olympiad also provided some participants their first exposure to new fields and topics they would later pursue in college. As Science Olympiad competition events are selected by committees and communicated to school teams, students have limited autonomy in the selection of topics. Thus, the availability of topics often expanded participants' knowledge of scientific fields and domains, helping many to discover new fields and interests. An event on circuits led one respondent to discover an interest in electrical engineering while an event in water quality inspired another to pursue a major in environmental science. Another student in polymer and color chemistry attributed their major choice to a forensics lab event, which had exposed them to studying fibers, a "different field of study that [they] had not explored before." For one focus group participant, a Science Olympiad event led to a discovery of entomology:

> Science Olympiad is the reason why I got into entomology and that was entirely by accident. When we started, it was our first year having a team… nobody wanted to do the entomology event because bugs are icky and they're gross…. So, I threw myself in. (Eric)

To their great surprise, Eric and his partner won first place at a regional tournament: "It is in that moment that I pretty much dedicated my life to insects." For Eric, success in the regional competition built his self-efficacy, confirming his skills in this area and piquing a new career interest. In an afterthought, Eric mentioned that he and his partner did not perform well at the subsequent state tournament, but this outcome had no impact on his enthusiasm. Eric went on to study entomology and plans to pursue doctoral work in the field.

Participation Not Leading to Major Choice For half the survey respondents, Science Olympiad was not credited to influencing college major choices. We expect that this may be due in part to students' STEM interests preceding their Science Olympiad experiences. Indeed, open-ended survey responses revealed that over half (53.6%) of respondents joined the program due to an existing interest in STEM, with other reasons including encouragement from teachers (25.1%) and friends (24.6%), and/or a general interest in getting involved at school (21.9%). Another reason for this lack of attribution is that 20% of the survey respondents were not STEM majors, thus perhaps deriving interests from other sources. Further, even among those in STEM, Science Olympiad may not have necessarily covered the field participants would later go on to study. Valerie, a computer science major, did not encounter computer science while she competed. Another participant had a similar experience: "[Science Olympiad] didn't push me towards [biochemistry]. There's not really a lot of biochem-based events that I participated in" (Beth). Instead, both women saw Science Olympiad as more broadly supportive of their overall interest and confidence in STEM.

Discussion

Science Olympiad's design offers a unique opportunity to influence any point in an individual's K-12 STEM trajectory. Our results indicate that, for many participants, Science Olympiad provided exposure to new STEM topics and skills, allowing for additional study and exploration of topics in a "safe" environment, often helping participants gain new interests while narrowing and reinforcing existing interests. Our findings are consistent with research suggesting that early interest and involvement in STEM programs can influence later postsecondary decisions (Dabney et al. 2011; Forrester 2010; Maltese and Tai 2011; Sahin 2013; Sahin et al. 2015). Further, this study uniquely contributes to the literature in its exploration of the role of Science Olympiad in participants' developing postsecondary academic and career goals and interests, especially when competitions are hosted by an institution with STEM academic programs and resources.

Our analysis of administrative data of former Science Olympiad participants at the study institution revealed that the male and Asian students were significantly overrepresented, with White students also outnumbering those of other racial identities, a dynamic consistent with existing research (Forrester 2010) and also representative of current STEM fields in the USA (National Science Foundation 2017). While the role of these identities in Science Olympiad was not a focal point of our analysis, SCCT acknowledges that demographic characteristics, socioeconomic status, and other background inputs can influence the types of experiences a person accesses, thus enabling or limiting career development opportunities. An example is evident in students' experiences with the Science Olympiad state tournament. Students who qualified to attend, especially multiple times, became familiar and often comfortable with the study institution even prior to applying, increasing self-efficacy and shaping postsecondary outcome expectations, with important implications for college choice (Perna 2006). Exposure to the college environment provided opportunities for students to assess fit and also to see the study institution as a STEM-friendly environment. For some students, visiting the study institution was a novel experience that evoked strong emotions and that left a lasting impact.

However, for participants who did not have the experience of competing in the state tournament, this sequence of self-efficacy and interest development towards attending the study institution did not occur via Science Olympiad. Differential access to state tournament may be moderated by contextual affordances that highlight discrepancies between schools, teams, and individuals. Although Science Olympiad is designed to be structurally consistent across settings, our data revealed that students' experiences varied substantially by the quality and availability of school and team resources. While some teams qualified perennially for the state competition, the opportunity was out of reach for others. Access compounded success: better-resourced teams had greater access to more practice resources, often performing better in competitions and, as a result, qualifying for additional opportunities to hone STEM interests and visit postsecondary settings. As SCCT suggests that performance contributes to self-efficacy, students who were well-positioned to succeed may have reaped extra academic and career-related benefits as a result of their participation in the program.

Although the benefits offered by the state tournament are evident, our emotion coding also revealed that students tended to describe practices just as positively as competitions. Thus, indicators of performance were not always connected to events and competitions, but rather to a variety of positive affective experiences across environments that led to increased self-efficacy in these domains. Participants saw success in competitions as rewarding, validating, and, at times, surprising. At the same time, the collaborative success encountered during practices also led to confidence and enthusiasm for STEM topics and skills.

While our data do not show that Science Olympiad created newfound interests in STEM topics for all participants, especially as half of the survey sample indicated that the program did not influence their major choice, qualitative data suggest that the program helped some participants learn about new topics and refine interests in ways that informed their postsecondary decisions (Miller et al. 2018). Consistently, Science Olympiad allowed students hands-on opportunities to explore scientific topics, including those outside school curricula, without negative academic repercussions in the case of poor performance (Sahin 2013). Though the outcomes participants derived from Science Olympiad varied according to unique intersections of access and motivation, our results suggest that the program can shape college-going interests and goals, especially when competitions are hosted by an institution with STEM resources, enriching the experiences of its participants and shaping short- and long-term academic and career pursuits in STEM.

Implications for Practice

STEM interests and goals begin with access and participation. If students are unable to participate in programs like Science Olympiad, they will not have the types of experiences our participants richly describe. Thus, directing resources to support K-12 STEM programs like Science Olympiad promotes the availability of these opportunities, an important step in fostering positive STEM outcomes like those seen in the present study for more students. For many participants who joined Science Olympiad in high school, interests within STEM had already been identified. Offering STEM programs for elementary and middle school students may therefore be especially beneficial in providing opportunities for early interest development, especially among a more diverse body of student participants.

Findings from this study illuminate the mutual benefit of partnerships between STEM programs and postsecondary institutions, and we encourage colleges and universities to continue to build and provide these opportunities. By hosting state tournaments, the study institution was identified as a STEM-friendly campus by an academically engaged population of secondary students, aiding recruitment. Other institutions may similarly benefit from such partnerships. The experience of attending a competition at the study institution was especially impactful for students with limited exposure to postsecondary settings, especially middle school students and those from rural areas. Small regional institutions and community colleges may help address these gaps by conducting outreach to local K-12 STEM programs such as Science Olympiad, perhaps hosting similar events or otherwise sharing resources. These institutions could serve as a vital link between K-12 and postsecondary STEM education, especially in rural and other underresourced areas. Additionally, institutions of all types may consider hosting events and competitions open to all students, providing greater access without requiring students to qualify.

Future Research

Given the growth of K-12 STEM programs in recent years, understanding the long-term effects of these initiatives is an area with great opportunity for future research, especially in identifying the most critical and effective aspects of these programs. For instance, does holding regional and state tournaments at different types of institutions hold the same impact? How do competitive and non-competitive events uniquely influence self-efficacy? What is the differential influence of K-12 STEM programs by education level? Are events hosted by campuses more influential for those whose exposure to college environments is more limited? How can we better understand how these programs support students with identities underrepresented in STEM? Future research should continue to incorporate interviews, focus groups, and other qualitative and mixed methods approaches to explore these ideas, paying close attention to the influence of identity, intersectionality, and the ways in which K-12 programs can enhance wider participation and success in STEM.

Appendix 1

Table 2 Characteristics of former Science Olympiad participants at research site institution

	Percent	*N*
Gender		
Female	38.90	461
Male	61.10	724
Race		
White	68.02	806
Asian	15.61	185
Biracial/multiracial	7.93	94
Black	3.46	41
Non-specified	3.46	41
Hispanic	1.27	15
Native American	0.25	3
Residency		
In-state	94.60	1121
Out of state	5.40	64
Highest parental education level		
Less than HS	1.74	19
High school or equivalent	12.10	132
Associate's	6.23	68
Bachelor's	40.70	444
Master's	25.85	282
Doctoral/professional degree	13.38	146
Major		
Non-STEM Major	21.10	250
Biology and Life Science	14.01	166
Engineering	49.54	587
Computer Science	1.27	15
Agricultural Science	3.71	44
Mathematics	2.62	31
Chemistry	3.12	37
Environmental Science	1.69	20
Geosciences	0.25	3
Physics and Astronomy	2.70	32
Total	100.00	1185
1.99 and under	13.00	154
2.00 to 2.49	12.74	151
2.5 to 2.99	25.99	308
3.00 to 3.49	31.98	379
3.5 to 4.00	16.29	193

Appendix 2

Table 3 Characteristics of survey respondents

	% Respondents	*N*
Current student	73.8	152
Gender		
Female	50.9	86
Male	46.8	79
Other	2.4	4
Race		
Asian	15.7	26
Black/African American	3.6	6
Hispanic/Latino	2.4	4
Native American/Alaskan Native	0.6	1
Pacific Islander	0.6	1
White	77.1	128
Participated in SO in the same state as site institution	96.6	199
Length of time involved in SO		
Less than 1 year	4.4	9
1–2 years	29.6	61
3–4 years	37.4	77
4–5 years	9.2	19
More than 5 years	19.4	40
Grades involved in SO*		
Elementary and middle school	0.5	1
Elementary, middle school, and high school	1.0	2
Middle school only	2.9	6
Middle school and high school	38.8	80
High school only	56.8	117

SO Science Olympiad

Appendix 3

Table 4 Characteristics of focus group participants

Pseudonym	Bachelor's degree program	Class year	Gender	School level in Science Olympiad	Length of time in Science Olympiad
Valerie	Economics and Computer Science	Sophomore	Female	Middle school and high school	More than 5 years
Jackson	Mechanical Engineering	Sophomore	Male	Middle school and high school	3–4 years
Alexis	Psychology	Sophomore	Female	Middle school and high school	4–5 years
Victor	Biology	Junior	Male	Middle school and high school	4–5 years
Maggie	Chemistry	Junior	Female	High school	1–2 years
Hector	Technology, Engineering, and Design Education	Junior	Male	High school	1–2 years
Beth	Biochemistry	Senior	Female	Middle school and high school	4–5 years
Eric	Ecology, Evolution, and Conservation Biology	Senior	Male	High school	1–2 years
Nathan	Electrical and Computer Engineering	Senior	Male	Middle school and high school	4–5 years
Kiley	Mechanical Engineering	Senior	Male	Middle school and high school	3–4 years
Isaiah	Microbiology and Chemistry	Senior	Male	Middle school and high school	3–4 years
Kim	Environmental Science, MS in Forest Biomaterials	Master's student	Female	Middle school and high school	More than 5 years

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