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Out-of-School Time Science Activities and Their Association with Career Interest in STEM

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Spurred by concerns about an inadequately sized science, technology, engineering, and mathematics (STEM) workforce, there has been a growing interest in out-of-school time (OST) science activities as a means to foster STEM career interest. This study examines the association between OST science activities and STEM career interest in university through a logistic regression model and the calculation of prototypical odds ratios. The analysis addresses two main research questions: What is the correlation among different forms of OST activities? And, controlling for student demographic and background variables, what specific forms of OST activities are associated with STEM career interest in university? The study uses data from the 'Persistence Research in Science and Engineering' survey ($n = 6882$), which employs a nationally representative sample of university students enrolled in introductory English courses. Results indicate that students' participation in OST activities, as well as their middle school interest in science and mathematics and their gender, plays a significant role in university career interest in STEM. Conclusions suggest that making OST clubs and competitions and the inclusion of non-fiction and science fiction within English Language Arts programmes may be beneficial to the development of students in STEM careers. Limitations include the paucity of research examining which students participate in these activities and what specific features or characteristics benefit them.

Keywords: *Career; Interest; Mathematics; Out-of-school time; Science; STEM*

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Recent educational policy has focused on promoting students' interests and involvement in science, technology, engineering, and mathematics (STEM) to address concerns about the inadequate size of the US STEM workforce and about the underrepresentation of females and racial minorities within the field (National Academy of Sciences, 2007). A major part of this focus is the use of out-of-school time (OST) science activities to encourage students to pursue university majors in mathematics and science and to eventually select a career in a STEM-related area.

Both researchers (e.g. Bybee, 2001; Eccles & Barber, 1999; Posner & Vandell, 1999) and national science organizations (e.g. Bell, Lewenstein, Shouse, & Feder, 2009; NSTA, 1998) have advocated the use of OST to supplement and deepen student knowledge learned within the classroom. The majority of research has focused on teacher-led OST activities, such as field trips to science museums (Rennie & McClafferty, 1995). These studies indicate that science-related field trips are only educationally effective when they are closely linked to the current school curriculum. The view of OST underlying such efforts is very narrow and leaves out additional activities, such as hobbies, after-school programmes, summer camps, competitions, and clubs that seek to promote students' interest in furthering their science and mathematics education, their interest in, and eventual career choice of STEM fields.

According to the NARST Ad Hoc Committee's definition, by contrast, OST activities are personal, contextualized, and time consuming (Dierking, Falk, Rennie, Anderson, & Ellenbogen, 2003). This definition is broader, but also makes the systematic study of these activities challenging. The majority of OST experiences that fall within this broader definition occur through students' choices to participate outside of regular school instruction in activities such as science groups/clubs/camps, science and mathematics competitions, personal science hobbies, and reading non-fiction science and science fiction. Overall, little research has been conducted about the self-selection effects governing participation in, let alone the educational effectiveness of, these OST activities (Dierking et al., 2003). Furthermore, there are few studies regarding their long-term association with future STEM interest and occupational choice (Rennie, Fehrer, Dierking, & Falk, 2003).

Literature Review

The National Research Council states that OST science has a uniquely positive impact on the field of education because of its ability to promote interest in science in the real world (Bell et al., 2009). Developing students' interest in science has long been touted as an effective means to motivate STEM career choice and career development (Krapp, Hidi, & Renninger, 1992; Lent, Brown, & Hackett, 1994). Therefore, research on informal science has recently begun to examine the ability of these OST activities to influence both students' STEM interest and STEM career choice. The constructs of OST science, STEM interest, and STEM career choice (examined below) provide the framework for this study.

OST Science

OST science may provide students and individuals with interest, motivation, and a better understanding of science (Bell et al., 2009, Zaff & Redd, 2001). The kinds of OST activities that are inspirational to students vary greatly. *Structured* OST can include and is not limited to activities such as museum visits and programmes, science groups/clubs/camps, and science and mathematics competitions (Bell et al., 2009). By contrast, a large number of *unstructured* OST activities occur without any sort of scaffolding other than individual pursuit of activities such as conversations or socializing, tinkering with objects, personal science hobbies, and reading non-fiction science and science fiction (Maltese & Tai, 2010; Nazier, 2010). While there is general agreement that OST activities can benefit students in a variety of ways, the capacious diversity of activities that fall under the umbrella of OST makes it difficult to identify those that are most effective. Furthermore, the OST activities that are structured may inspire different levels of interest than those OST activities that are unstructured.

Research about the implementation of structured informal science programmes, about their effectiveness and their impact on students is more prevalent than research about unstructured activities, which are, by nature, more personal to the student and more likely to occur outside of school grounds. All of these studies impress upon the reader that structured OST has the ability to impact motivation, interest, academic achievement, and career choice (Atwater, Colson, & Simpson, 1999; Falk, 2006; Gibson & Chase, 2002; Simpkins, Davis-Kean, & Eccles, 2006; Stake & Mare, 2005). Unfortunately, it is difficult to tell with the majority of these studies whether interest is a precursor or a result of the OST science programmes that were implemented. In other words, they do not address the role that self-selection may play.

Publications by the National Research Council Committee on Learning Science in Informal Environments report that students do indeed learn science in these OST learning environments, regardless of their structure and connection to the school curriculum (Bell et al., 2009). The challenge lies in knowing how to measure the motivation, interest, knowledge, and intellectual growth that develop through these experiences. Unstructured OST science, or individual students' scientific pursuits in their spare time, can be even harder to measure than structured programmes, owing to the variety and inconsistency of such activities as well as difficulties in consistent and reliable reporting. Therefore, the majority of findings within this area are currently generated through qualitative analysis techniques (Maltese & Tai, 2010; Nazier, 2010). What role, then, do OST science activities play in the development of student interest in STEM-related disciplines?

STEM Interest

A key concept linking OST science activities to STEM career plans is STEM interest. The primary emphasis of STEM interest is not on achievement, but on curiosity and on the enjoyment of learning about a certain topic or field (Krapp et al., 1992).

Furthermore, this curiosity and enjoyment are viewed as leading to an individual's increased focus on a subject like science, followed by an inclination to participating in and seeking out scientific activities in the future (Hidi & Renninger, 2006). Based on Dewey's (1979[1914]) original concept of interest, Krapp et al. (1992) specified two forms of interest: situational and individual.[1] The underlying belief in this model is that interest is inherently dynamic and can be influenced (Hidi & Harackiewicz, 2000). The OST activities that are structured would typically fall under the category of those that inspire situational interest and unstructured OST is more associated with individual interest (Krapp et al., 1992).

Situational interest tends to form quickly and to occur in groups, based on environmental conditions and external factors of support, such as teachers, friends, classrooms, and other forms of instruction. This situational interest is fleeting and does not persist over extended periods of time. Several studies show the ability of students to form situational interest through informal science opportunities (Paris, Yambor, & Packard, 1998; Zoldosova & Prokop, 2006). An examination of informal science learning and interest at the beginning and the end of an experimental OST biology programme indicated that situational interest does form in informal science programmes, but most importantly that this impact is greater with younger age groups (Paris et al., 1998). The spark of interest developed at that age does not guarantee persistence. As children grow and develop, their interests may easily change. Yet, such studies, focusing on situational instead of individual interest, have constituted to the majority of existing research about formal and informal science activities.

Unlike situational interest, *individual interest* includes more than just a passing positive affect toward science, but the development of long-term feelings, information, and values that encourage further thinking and taking part in science (Hidi & Renninger, 2006). The primary findings regarding individual interest are currently uncovered through qualitative analysis techniques. Nazier (2010), for example, interviewed 300 science and engineering professors regarding what influenced them to pursue their current career. The professors reported that longstanding mathematics and science hobbies outside of structured programmes, such as playing with chemistry sets, collecting fossils, and making and fixing things, influenced their pursuit of STEM careers (Nazier, 2010). Maltese and Tai (2010) found, through an analysis of interviews of scientists and science graduate students, that students tended to show interest in science prior to middle school. It appeared from this analysis that classroom-based activities tended to spark these interests among females, while males tended to report more self-initiated, unstructured, informal science activities (Maltese & Tai, 2010). These qualitative studies support the idea that individual interest is linked to choosing a career in STEM, but they have been unable to show clear links between specific OST activities, the development of individual interest, and STEM career interest. In particular, the transition from situational to individual interest has remained unclear. Yet, both situational (Paris et al., 1998; Zoldosova & Prokop, 2006) and individual (Nazier, 2010) interest in STEM appears to be significant concepts for advancing science career research as well as critical career theory (Brown & Krane, 2000; Lent, 2000) and deserve further exploration.

STEM Career Choice

Research has shown that students' interest within formal classroom and educational settings correlates with career choice (Tai, Liu, Maltese, & Fan, 2006). The same study also reinforced the connection between early career interest and career choice: it examined, in the NELS data set, how strongly the career expectations of eighth graders predicted their future occupations at the age of thirty. Eighth graders with a self-reported interest in science-related careers were more likely to receive life science, physical science, and engineering bachelor's degrees. According to Maines (1983), a high level of interest in science and mathematics at the secondary level predicts majoring and persisting in these fields.

However, much of the existing research on career choice does not address the impact of informal science instruction on subsequent career choice. In fact, there are very few probes that adequately assess students' knowledge of and interest in STEM careers to begin with. Those that do exist, such as the Programme for International Student Assessment and the longitudinal study done by Fadigan and Hammrich (2004), are generally geared toward high school students. An examination of high school Finnish students found a connection between out-of-school experiences and interests in biology and agriculture (Uitto, Juuti, Lavonen, & Meisalo, 2006). In addition, research has shown the importance of high school motivation (Lavonen et al., 2008), attitude (Prokop, Prokop, & Tunnicliffe, 2007), and career choices within STEM fields. Furthermore, gender-based programs have been shown as influential, when females attending women only undergraduate STEM programs had greater STEM aspirations than co-educational or other traditional programs (Szelenyi & Inkelas, 2011). By this age, the probability of a student choosing a STEM career without previously established interest in STEM is far lower than that for a student who has had an interest since middle school.

Studies connecting situational and individual interest during middle school with career choice are minimal, and there is a need for such longitudinal quantitative studies in order to bolster the future STEM workforce. In an ideal situation, a longitudinal data set that includes students' pathways to specific careers and includes variables such as the ones included in this study would be fruitful in filling the gaps in the current body of research on out-of-school science time. In the absence of such a fruitful data set, this current research offers a thorough retrospective examination of these experiences and a cross-sectional analysis of career outcomes from the perspective of the students participating in this study.

With only a small number of current theoretical and methodological research studies focusing on the relationship between OST education, STEM interest, and STEM career choice, building a more extensive and robust research base is essential. A promising avenue for this research includes conducting large-scale quantitative research to tease out questions in unexamined areas such as: pre-existing interest, the development of both situational and individual interest, the joint impact of unstructured and structured OST science activities, and later STEM university career interest.

Research Questions

The purpose of this study is to explore the connection between OST activities and STEM career interest in universities. This paper addresses the following two research questions: What is the correlation among different forms of OST activities? And, controlling for student demographic and background variables, what specific forms of OST activities are associated with STEM career interest in universities?

Data and Methods

The data used in this study were collected as part of the 'Persistence Research in Science and Engineering' (PRiSE) project, a mixed-method study funded by the National Science Foundation (NSF REC #062444) and conducted at the Science Education Department of the Harvard-Smithsonian Center for Astrophysics. This survey contained 50 questions on multiple topics such as middle school science experiences, high school background information, high school science classes, science-related interests and attitudes, and career plan development. Independent reliability and validity analyses were performed to establish confidence in the robustness of the PRiSE survey from a test–retest design. Test–retest reliability of the survey was established by administering the survey to 96 students twice, in an interval of about two weeks. For continuous variables, the correlation coefficient between the test and retest answers served as a measure of reliability; for dichotomous variables, Cohen's kappa was used. By combining these two analogous measures (for both of which 1 indicates perfect agreement), the overall mean test–retest reliability of the survey was determined to be 0.67. Additionally, the PRiSE survey was pilot tested with 49 students. Furthermore, focus groups were held with undergraduate students and with experts in science education, which indicated that the PRiSE survey could be considered valid.

Project PRiSE collected a national representative sample of university students enrolled in introductory English courses to investigate and identify high school factors that influence the persistence of students, especially females, in STEM. The selection of introductory English courses, a general education requirement for all students, made it possible to compare the experiences of those who had STEM career intentions with those who had no STEM career interests. In total, 7,505 surveys were completed for an overall response rate of 62.5% from 34 randomly selected US universities. For this particular study, the sample size was 6,556 due to the list wise deletion of 949 respondents with missing values for the variables gender or race. Among the studied population 46.9% were male, 53.1% female. Of these respondents, 72.7% identified themselves as Caucasian, 8.7% African-American, 6.0% East Asian, and the remainder identified themselves as members of less populous or other racial groups. On an additional question, 15.0% of the respondents identified themselves as being of Hispanic origin. Within these introductory English courses, of those who responded, 76.5% were first years, 16.4% were second years, 6.7% were other years in university, and 0.3% did not identify their year in university.

Dependent Variable: STEM Career Interest in University

Question #1 of the PRiSE survey, shown in Figure 1, asked respondents about their career interests at various stages of their educational career in the USA (i.e. middle school (ages 11–14), beginning of high school (ages 14–15), end of high school (ages 17–18), and in university (ages 18–22)). This analysis focuses only on STEM career interest in university as the dependent variable. Those who indicated an interest in a STEM area (Biologist, Earth/Environmental Scientist, Astronomer, Chemist, Physicist, Engineer, Computer Scientist, Other Scientist, Mathematician, Science Teacher, Math Teacher, More than One Choice in Science, More than

1. Which of the following BEST describes what you want(ed) to be in middle school, high school (beginning and end), and in college? *Mark only ONE choice per column.*

	Middle School *(Choose one)*	Beginning of High School *(Choose one)*	End of High School *(Choose one)*	In University *(Choose one)*
Medical professional (e.g., doctor, dentist, vet.)	O	O	O	O
Health professional (e.g., nursing, pharmacy)	O	O	O	O
Biologist	O	O	O	O
Earth/Environmental scientist	O	O	O	O
Astronomer	O	O	O	O
Chemist	O	O	O	O
Physicist	O	O	O	O
Engineer	O	O	O	O
Computer Scientist	O	O	O	O
Other scientist	O	O	O	O
Mathematician	O	O	O	O
Science teacher	O	O	O	O
Math teacher	O	O	O	O
Other teacher	O	O	O	O
Social scientist (e.g., psychologist, sociologist)	O	O	O	O
Business person	O	O	O	O
Lawyer	O	O	O	O
English/Language Arts specialist	O	O	O	O
Other non-science related career	O	O	O	O

Figure 1. Question #1 on career interest from the project PRiSE survey

One Choice in Engineering/Computing, More than One Choice in Health/Science, More than One Choice in Health/Engineering/Computing, More than One Choice in Science/Engineering/Computing, and More than One Choice in All Broad Science Fields) while attending a university were labeled as such. Those who indicated an interest in other areas (Medical Professional, Health Professional, Other Teacher, Social Scientist, Business Person, Lawyer, Eng/Language Arts Spec., Other Non Science Career, More than One Choice in a Health Field, More than One Choice that were Not Science Related, and More than One Choice that were Both Not Science and Science Related) were labeled as non-STEM interest.

According to this categorization, 21.5% of the respondents expressed an interest in a STEM career in university while 78.5% expressed interest in a non-STEM career in university.

Independent Variable: OST Science

Question #29 from the Project PRiSE survey focused on the type and frequency of participation in science activities outside of school (as shown in Figure 2). Of particular interest to this study are the first five parts of the question: participated in science groups/clubs/camps, participated in science/mathematics competitions, engaged in personal science hobbies, read/watched non-fiction science, and read/watched science fiction. OST participation was recoded as a dichotomous variable. Respondents who reported participating at least a few times a year in any of those five activities prior to university attendance were classified as OST participants (coded as '1'). Respondents who reported rarely or never participating in each of the five activities prior to university attendance were classified as non-OST participants (coded as 'Zero').

According to this classification, 6.4% of PRiSE respondents classified as having participated in OST science activities, while 93.6% rarely or never participated in OST science activities.

29. How often did you do the following activities outside of school?

	Never	Rarely	Few times a year	Monthly	Weekly	Daily
Participated in science groups/clubs/camp	O	O	O	O	O	O
Participated in science/math competitions	O	O	O	O	O	O
Engaged in personal science hobbies	O	O	O	O	O	O
Read/Watched non-fiction science	O	O	O	O	O	O
Read/Watched science fiction	O	O	O	O	O	O
Played computer/video games	O	O	O	O	O	O

Figure 2. Question #29 on OST activities from the project PRiSE survey

A series of Pearson correlations were calculated between the five different types of OST science activities as shown in Table 1. This was done to determine the association between the five OST science activities distinguished in this survey and to be aware of any substantial measurement overlap, or collinearity, in the future logistic regression model. A large significant correlation was found between participation in science groups/clubs/camps and participation in science/mathematics competitions (0.57). Due to the overlap in student response to these two OST activities, groups/clubs/camps and competitions were condensed into one variable (OST clubs/competition) that was set to '1' for all students who responded that they had participated in at least one of these activities at least a few times a year, and was otherwise set to 'Zero'. In addition, one other sizeable significant correlation was found between read/watch non-fiction science and read/watch science fiction (0.66). Therefore, non-fiction science and science fiction were condensed into one variable (OST reading/watching) that was set to '1' for all students who responded that they had participated in at least one of these activities at least a few times a year, and was 'Zero' otherwise. Interestingly, these correlations reflected the structured and unstructured dichotomy in OST activities discussed in the previous research literature (Bell et al., 2009; Maltese & Tai, 2010; Nazier, 2010). Hobbies were not separately examined within this analysis because they were found to correlate with all of the other four OST science activities, perhaps indicating that survey respondents tended to consider all of these OST activities' hobbies.

Table 1. Pearson correlations of OST activities from Question #29 from the project PRiSE survey

	Pearson correlations				
	Groups/Clubs/ Camps	Competitions	Non-fiction Sci	Sci fiction	Hobbies
Groups/Clubs/ Camps	–	0.566**	0.277**	0.220**	0.463**
Competitions		–	0.247**	0.204**	0.410*
Non-fiction Sci			–	0.662**	0.501**
Sci Fiction				–	0.391*
Hobbies					–

$^{*}p < 0.05$, $^{**}p < 0.01$.

Control Variables: Demographic and Background Educational and Middle School Factors

A student's STEM career interest in university depends on numerous factors, in addition to the potential influence of OST science participation. We therefore include a number of control variables in our statistical models. These control variables included gender, combined parental highest education, socioeconomic status based on annual per capita income by zip code in 1999, race and ethnicity (i.e. East

6. In middle school, how interested were you in

	Not Interested at All					Extremely Interested
Science	1	2	3	4	5	6
Mathematics	1	2	3	4	5	6

Figure 3. Question #6 on Middle School Science and Mathematics Interest from the project PRiSE survey

Asian, Caucasian, and African-American), middle school interest in science, middle school interest in mathematics, average middle school grade in math, and average middle school grade in science. Specifically, Question #6 from the Project PRiSE survey focused on middle school interest in science and mathematics (as shown in Figure 3).[2] Respondents who reported being moderately to extremely interested, a four to six on the survey scale, in middle school science or mathematics respectively were coded as '1'. Whereas respondents who indicated that they were not interested at all to moderately interested, a one to three on the survey scale, in middle school science or mathematics, respectively, were coded as 'Zero'.

Decisions about which control variables to include in our statistical models were based on the bodies of literature surrounding the association of these variables with STEM career interest (Tai et al., 2006).

Results

OST Science Activities and Career Interest in STEM

A logistic regression model was constructed using career interest in university (STEM versus non-STEM) as the outcome variable (coding from question 1). The predictor variable for the model was participation in OST clubs/competitions and OST reading/watching science. Demographic variables such as gender, race, ethnicity, gender, parental education, and socioeconomic status and background variables such as middle school interest in mathematics, middle school interest in science, middle school science grade, and middle school mathematics grade were controlled for in all cases. The results are summarized in Table 2.

The results indicate that those respondents who reported participating in OST clubs/competitions and reading/watching science activities at least a few times a year were more likely to report a career interest in a STEM discipline in university than those respondents who did not participate in these OST science activities at least a few times a year. As indicated by the odds ratio, respondents had 1.5 times higher odds to report a career interest in a STEM discipline in university if they had participated in a science-focused OST club/competition activity at least a few times a year. In addition, respondents who participated in science-focused OST reading/watching at least a few times a year had 1.3 times higher odds to report a

Table 2. Logistic regression model summary with odds ratio

	B	Sig.	SE	Odds ratio
Intercept	−4.943	***	0.281	0.007
Gender	1.514	***	0.080	4.544
Parental education	0.004	0.819	0.019	1.004
Socioeconomic status	0.000	**	0.000	1.000
Race/Ethnicity				
East Asian	−0.203	0.247	0.175	0.817
Caucasian	−0.007	0.949	0.110	0.993
African-American	−0.006	0.969	0.163	0.994
MS interest				
Science	0.592	***	0.090	1.808
Math	0.664	***	0.093	1.904
MS grade				
Science	0.013	0.875	0.083	1.013
Math	0.399	***	0.079	1.490
OST clubs/Competitions	0.409	***	0.086	1.506
OST reading/Watching	0.287	**	0.084	1.332

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

career interest in a STEM discipline in university. Thus, the logistic regression shows that the contribution of OST science participation is significant after controlling for the demographic and background variables.

Some of these demographic and background control variables also showed a connection to reported career interest in STEM careers in university. Males were 4.5 times more likely than females to report STEM career interest among university students. Students who reported a middle school interest in science had 1.8 times higher odds, and students who reported a middle school interest in mathematics had 1.9 times higher odds to report STEM career interest while in a university. In addition, students who reported higher middle school mathematics grades had 1.5 times higher odds per grade to report a STEM career interest in university. Finally, students with higher socioeconomic status, as indicated by annual per capita income by zip code, were more likely to report STEM-related career interests among university students.

Interactions were modeled by crossing individual factors (e.g. gender, middle school mathematics grade, and socioeconomic status) with OST clubs/competitions and OST reading/watching science variables. These interaction variables were incorporated into the logistic regression model. The first interaction model estimated included the interactions of gender and OST clubs/competitions and gender and OST reading/watching science. None of these interactions were significant. Additional interaction models included the interactions of middle school mathematics grade and OST clubs/competitions and middle school mathematics grade and OST reading/watching science, but again no interactions were found significant. A final set of interaction models included the interactions of socioeconomic status and OST clubs/competitions and socioeconomic status and OST reading/watching science, and only the socioeconomic status and OST clubs/competitions interaction were found significant ($p < 0.01$). Conceptually, this interaction implies that students from a higher socioeconomic background are more likely to participate in OST clubs/competitions. This may tie into research indicating that parental level of education, parental support, and shared OST experiences influence student attitudes toward science (George & Kaplan, 1998).

OST Science Activities, Demographics/Background, and Career Interest in STEM

Finally, we examined the odds ratios of three prototypes of students to show how the significant variables, OST science activities and middle school interest in mathematics and science, connected with reported STEM career interest in university. The odds ratios reported by these variables in isolation in Table 2 are relatively small, and it may be instructive to examine how the odds ratios compound for prototypical students. Student prototypes can be formed by multiplying the relevant odds ratios. The prototypes included: a student with neither middle school mathematics and science interest who had not participated in any OST activities (Student A), a student with both middle school mathematics and science interest who had not participated in any OST activities (Student B), and a student with both middle school mathematics and science interests who had participated in both OST activities (Student C). The prototypical odds ratios, as calculated by multiplication of the relevant odds ratios from Table 2 are shown in Table 3.

The compounded odds ratios reveal an interesting picture between reported middle school interests in mathematics and science and OST science activities. Individuals reporting a middle school interest in both science and mathematics have a 3.5 times greater odds of also reporting a STEM career interest in university. By comparison, individuals who report participation in both kinds of OST activities have 2 times greater odds. Though weaker, the result is still eye-catching. If we compare two extreme student types (one who had neither middle school interests in science or mathematics nor participated in any OST science activities and the other who displayed the completely opposite pattern), we see a relatively large difference in their odds of having a STEM career plan in university: The odds for the second type are more than 7.0 times greater.

Table 3. Prototypical odds ratio

	Odds ratio
Student B/Student A	3.511
Student C/Student B	2.006
Student C/Student A	7.043

Conclusions and Implications

The overall focus of this study was to examine the association between participation in OST activities and STEM career interest in universities. Using logistic regression models, survey respondents career interest in university operated as the outcome variable while participation in OST clubs/competitions and OST reading/watching science were used as predictor variables. Above and beyond the control variables (i.e. demographic, background, and middle school factors), the results of logistic regression models provide several findings that we believe contribute to the body of research on the association of OST science activities and career interest in STEM-related fields.

First, students' participation in OST activities was associated with a greater likelihood of indicating career interest in STEM while in university. Specifically, those respondents who reported participating in OST science clubs/competitions at least a few times a year had odds of selecting a STEM-related career in the university 1.5 times higher than those respondents not participating in such activities. With regard to those respondents who participated in OST science-related reading/watching at least a few times a year, they had odds of selecting a STEM-related career in the university 1.3 times higher than those respondents not participating in such activities.

The strong association between participating in clubs and competitions and choosing a STEM career may be related to many issues of interest to the educational community, such as the students' self-efficacy, academic confidence, and social acceptance (Brown, Lent, & Larkin, 1989; Fouad & Smith, 1996; Hackett, Betz, Cases, & Rocha-Singh, 1992; Lent, Brown, & Larkin, 1984, 1986). These activities may be voluntary or mandatory, depending on the school environment and requirements. Because the PRiSE survey did not reveal whether students participated of their own volition, we can only conclude that participation in science clubs and competitions increases the probability that a student will later choose a STEM career.

An additional and clearly voluntary and individual-directed OST activity is reading/watching non-fiction science and science-fiction. Here, we also found a predictive association with STEM career intentions, which is also an informative result for the educational community. Offering opportunities for this kind of reading into a more organizational setting (that is, transforming an OST science activity into a more of a school time activity) for instance by adding more science fiction to literature assigned to students in English Language Arts class may serve to increase the probability that a greater number of students will choose STEM careers.

Looking at the control variables included in the models, interest in science and mathematics during middle school was also found to be associated with a higher probability of choosing a STEM career. This result underscores the findings of previous work showing the importance of early interest for STEM career choice (Maltese & Tai, 2010; Tai et al., 2006). Gender is also a major contributing factor: male students are more likely than females to be interested in STEM careers in a university setting. However, males and females appear to experience similar boosts in their STEM career interest from OST science.

As our results indicate that OST science activities appear to substantially increase students' STEM career plans, the question then is: which students participate in these activities? An initial look at the Pearson correlations between gender and participation in OST activities indicated that a significant difference between males and females with regard to OST reading/watching science ($p < 0.001$). This statistical difference did not appear to exist for OST clubs/competitions. The underlying cause of this relationship is above and beyond the focus of this particular study. However, this gender relationship is congruent with prior work on the difference in male and female participation in structured versus unstructured OST activities (Maltese & Tai, 2010; Nazier, 2010). These results of this analysis are particularly relevant to those involved in the development, coordination, and implementation of more structured OST science activities (e.g. camps, clubs, or activities). Given the goals of such programmes, this study highlights the possible benefits of making these activities more readily available and attractive both male and female students who may not explicitly express an interest in science or mathematics. This would give students an opportunity to explore, develop, and foster such an interest.

Researchers have argued that novel and relevant situations that encourage interest can be critical in learning and lead to long-term interest even when students do not have previous exposure or individual interest in a subject (Ainley, Hidi, & Berndorff, 2002; Ames, 1992; Hulleman & Harackiewicz, 2009; Krapp et al., 1992). Students may not develop a strong interest in science and mathematics simply because they have not been exposed to these disciplines in such a manner that engages and encourages their interest. This also suggests that more research is needed in the area of OST science programmes. What specific features or characteristics benefit student participants in terms of what outcomes? For example, recent research (George & Kaplan, 1998) has shown that parental support can make a difference in OST activities and resulting student attitudes toward science. Taking the results of this study into account, researchers should pursue further studies into how community and home-based OST science activities might encourage student advancement and career interest in STEM.

These results, although very encouraging for the OST community, should be interpreted with caution. One possible reaction to the results of this study is the immediate increase in OST opportunities for students. This would be a reasonable interpretation in light of the association between OST science clubs/competitions, OST science reading/writing, and STEM career interest. However, the results from the demographic, background, and middle school variables suggest that the number of OST programs may not be as significant of an issue as the access to these programs for certain groups of students. For example, the gender and socioeconomic status gap suggests that greater access to OST activities is important for females and low SES students who may have the proclivity for activities that may lead to the choice of STEM-related careers, but have not had the exposure to such programs to foster this interest. In this instance, the barriers to participation may come in the form of a lack of communication of the existence of these programs to the audience most in need of their potential benefits. As a result, strengthening the connection between

OST programs and schools through targeted recruitment activities may prove to be the best solution to the problem of access among children in underserved communities.

In summary, this research suggests that participation in OST science activities has a strong positive association with the selection of a STEM-related career once in university. The results also found associations involving gender, socioeconomic status, and prior interest, suggesting that OST programs may increase their benefit to the STEM career pathway by targeting populations that may not have access to such programs. As we move to face the persistent challenges to access in STEM education, it is becoming increasingly clear that OST science education plays a powerful role in myriad of science education experiences of youth and that these experiences appear to have an association with long range outcomes. It seems that the strengths of informal science education may help to overcome the weaknesses of formal science education, and vice versa. Therefore, collaboration between school time and OST learning environments, each scaffolding the other, may indeed be a path with great promise for the future of STEM education.

Notes

1. These two forms of interest have been further subdivided, and interest is said to develop through four phases including: preliminary situational interest, sustained situational interest, developing individual interest, and finally a maintained individual interest (Hidi & Renninger, 2006).
2. Middle and high school career aspirations were not specifically included as variables in the final model because of their overlap in variance with the Middle School Interest variable already included in the model. The additional explained variance would not offset the loss of parsimony had these two additional variables been included in the final model.

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