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This study addresses the association between middle-school students' reported participation in science summer programmes and their reported expectation of a career in science and engineering. Data were collected on 1,580 students from eight middle schools in five states, applying an accelerated longitudinal design. Two consecutive cohorts were sampled over a two-year period time. Logistic regression analysis was used to examine the relationship between students' participation in science summer camps and their career interest in science and engineering while initial career interest and background information were considered. Results indicate that students who participated in science summer camps before or in the first year of the study, compared to students who did not, are significantly more likely to report science and engineering as their future career field in the second year of the study. It appears that students who once participated in science summer camps were more likely to later report a career interest in the science and engineering fields.

Keywords: *Career interest; Summer camp; Science; Engineering; Out-of-school time; Middle-school students*

Introduction

Do middle-school students who report participating in science-focused summer programmes have a greater likelihood of later reporting higher levels of interest in science, technology, engineering, and math (STEM)-related activities and career choices? This question reflects an intense interest among out-of-school time (OST) science

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programme administrators and facilitators as well as policy-makers and researchers. As there are larger variety of formats and contents of science-related activities in summer, people have been more interested in how these various programmes can help students in learning science (National Academy of Sciences, 2007). In fact, US Secretary of Education, Arne Duncan, highlights the importance of summer camps at Columbia University Teachers College (Ozier, 2010). Informal learning (such as summer camps or programmes) has been speculated to be crucial for all levels of students' growth and development.

Informal learning is defined as 'voluntary, self-directed, motivated by personal needs and interests, and often socially mediated; it engenders cognitive, affective, and other non-cognitive outcomes' (U.S. Department of Education, 2007, p. 20). Learning science in informal environments is an effective alternative to K-12 formal education in STEM in order to further develop the range of science education opportunities in the USA. Informal education, together with K-12 education and postsecondary education are three integral essentials for the US education system, since they play an important role in the nation's economic competitiveness and ability of education institutions to improve the STEM workforce in the future (U.S. Department of Education, 2007). According to the National Research Council (NRC, 2009), there are three categories of informal science learning environments: everyday informal environments (such as watching TV, reading books, or searching online), designed environments (such as museums, zoos, or libraries), and OST programmes (such as 4-H programmes, summer programmes, or after-school activities).

Among various informal learning environments, OST activities play an important role in providing large-scale opportunities to learn science. Based on the information from the National Center for Education Statistics (NCES, 2006), 'in 2005, 40 percent of all students in grades K-8 were in at least one weekly non-parental out-of-school-time care arrangement. School-based or centre-based programmes were the most common care arrangement' (NRC, 2009, p. 175). Among the OST activities, the science summer programme has been considered as an essential element to STEM education (National Academy of Sciences, 2007). Summer vacation is a break period between two consecutive academic years, during which students tend to encounter academic losses if they do not fully utilize this period (Bourman & Boulay, 2004; Bracey, 2002). Therefore, science summer camps or programmes are good venues to engage students in science learning during the summer break.

Science summer camp is also a good recruitment tool for the STEM fields. Compared to some tedious science practices, the science summer camp has an aspect of student recreation and social activities (Bachman, Bischoff, Gallagher, Labroo, & Schaumloffel, 2008). As a result, it is imperative that educators and researchers make use of students' prior perception of summer science camps so as to recruit students and to maintain their interest in STEM during or even after camps (Bachman et al., 2008). A study conducted by Robbins and Schoenfisch (2005) shows that science camps are able to motivate middle-school students, making them believe that they have the potential and ability to become scientists. Bachman et al. (2008,

p. 31) state, 'if done right, a summer science camp can be the single most academic and career influencing experience of their lives'.

Science Summer Camps and Middle-School Students

The period of middle childhood and early adolescence, around the middle-school age, is an important transition in a human being's life in terms of physical and psychological development (Erikson, 1982). According to Erikson (1982), children in this time period often do not receive the support they need to transition from early childhood to later adolescent identity formation. Middle childhood is one of the most crucial periods for activities to help young individuals develop, both intellectually and behaviourally, based on their potential and world views in society (Erikson, 1982). A longitudinal study conducted by Simpkins, Davis-Kean, and Eccles (2006) concludes that OST activity participation in middle childhood period predicts youth's subsequent values and self-concepts of abilities. Furthermore, the middle-school period is essential to maintaining students' interest in science (Sheridan, Szczepankiewicz, Mekelburg, & Schwabel, 2011). Therefore, middle-school students' participation in activities plays an important role in their self-development and formation of values.

Direct Influences of Science Summer Camps

Recently, large numbers of researchers are conducting projects to investigate and evaluate the effect of various science summer camps or programmes. Generally speaking, studies pertaining to science summer camps can be categorized into two groups in terms of their main focuses. Some researchers focus on the camps themselves and whether camp participants benefit directly from those camps; while others examine the extent to which the camps influence participants in terms of their interest in STEM fields in the future.

In many studies, researchers are interested in the camp itself and what participants may learn during the camp. Camps may have a positive impact on participants in terms of their personal skills and perspectives related to science. During the preparation, recruitment, retention, and excellence in the physical sciences (PR^2EPS) summer camp, students have positive study experience by improving self-confidence in the sciences (Bischoff, Castendyk, Callagher, Schaumloffel, & Labroo, 2008). Another quantitative study indicates that a two-week engineering-focused summer programme may help directly increase secondary school students' attitudes towards engineering (Elam, Donham, & Solomon, 2012). In qualitative studies of summer camps, students report that the perceived benefits from the camps are personal autonomy and a deeper knowledge of science (Fields, 2009; Sterling, Matkins, Frazier, & Logerwell, 2007; Williams, Ma, Prejean, Ford, & Lai, 2007). In addition, summer camps also have a positive impact on students' creativity, active learning, and understanding of interdisciplinary science (Saxon, Treffinger, Young, & Wittig, 2003; Stevens et al., 2007).

Camp participants gain positive socialization experiences through science summer camps. Many quantitative and qualitative studies conclude that students report to have a positive experience by learning to value collaborative team work in addition to relationships with peers and staff (Bischoff et al., 2008; Fields, 2009; Sterling et al., 2007). A qualitative study on middle-school girls' science camp participation experiences emphasizes the importance of students' various interaction experiences during activities, such as friendship and leadership (Farland-Smith, 2012).

Long-run Effects of Science Summer Camps

The focus of another group of studies is on the long-term impacts of science summer camps. Some researchers maintain that students who participate in science summer camps may have the tendency to choose more science courses in high school than those who do not (Gibson & Chase, 2002; Robbins & Schoenfisch, 2005). A longitudinal study conducted by Gibson and Chase (2002) suggests further effects of an inquiry-based programme—the Summer Science Exploration Programme (SSEP): all the students become less interested in science-related careers as they grow up. However, the interest of students who applied but were not accepted to SSEP decreases much more than SSEP students' interest in science over the time period in the study (Gibson & Chase, 2002). In a study related to an interactive analytical chemistry summer camp, almost all participants indicate that the programme encourages them to take more science classes in the future (Robbins & Schoenfisch, 2005). Some studies, however, do not find statistically significant growth in participants' motivational disposition and attitudes towards careers in science (Bachman et al., 2008; Sterling et al., 2007).

Furthermore, researchers discuss that participation in science summer camps may also have a profounder influence—camp participants may be more likely to choose the STEM-related fields as their majors in college or even future career fields than students who do not have camp participation experiences. The study of PR^2EPS also indicates that the science summer camp may influence what students decide to study in college (Bischoff et al., 2008). Johnson (2011) conducts a study related to the Math–Science–Computer Camp (MSCC) on the campus of St. Cloud State University. Results indicate that the MSCC is able to help participants prepare for undergraduate scientific research experiences and to increase high-school participants' interest in choosing STEM fields as their college majors (Johnson, 2011). Through the evaluation of a one-week science-focused summer camp, researchers find that the number of students who report a career interest in science significantly increased after the science summer camp (Foster & Shiel-Rolle, 2011).

In summary, the above studies indicate that science summer camps can influence both students' learning potential and their course enrollment in the science-related fields in high school or in college. However, all of these studies applied relatively small samples, and were mostly content-oriented—researchers of each study examined a specific content-based summer camp. Furthermore, few studies were longitudinal and few researchers paid attention to the long-term effects of science summer camps in general, not to mention the impact on future career choice.

Research Question

The purpose of this study is to examine the association between middle-school students' reported participation in science summer camps and their later career interest in science and engineering fields while controlling for prior science career interest and demographic information. Specifically, we will examine the hypothesis that middle-school students' previous participation in various science summer programmes will positively predict their future career choice in the science and engineering fields. Therefore, our research question is:

> Comparing middle-school students who reported participating in science summer camps and programmes in the first year of the study to those who did not, are camp participants more likely to choose science and engineering as a future career in the second year of the study than non-participants?

Data and Methods

Originally, the longitudinal data were collected from eight middle schools that are reflective of a diverse array of demographic and geographic factors (e.g., gender, ethnicity, location, etc.) of middle schools in the USA. The source of our data was a survey titled 'Student Survey on Interest and Ideas about Science'. Among the limited accesses to large-scale student data regarding STEM interest and summer camps, surveys are a preferable instrument in order to collect information from students across the USA. Surveys are also appropriate to gather large-scale data repeatedly, to compare differences over time, and to gauge changes in student responses.

Our survey contains 24 questions (39 sub-questions) with topics ranging from science programme participation to students' attitudes about science, from their current levels of interest in science to their future plans. Some of the items in the survey are adapted from an existing reliable and valid attitudinal measure: modified Aattitudes towards Science Inventory (Weinburgh & Steele, 2000). In this study, we are mainly interested in two questions in the survey—students' science summer camp or programme participation experiences and their future career plans, both of which are factual questions. As a result, there is no need to evaluate the reliability of the survey for this study.

Participants

Participants were middle-school students from the eight schools that consented to participate in this study. Specifically, two consecutive grade cohorts were sampled over a two-year period time, with four waves of data (surveys in the fall and spring semesters of each year) collected from each cohort. To be more specific, our participants were sixth-grade and seventh-grade students in the first year of the study, and then they were in seventh grade and eighth grade, respectively, in the second year of the study.

Since this study is a longitudinal design that follows students across two academic years, students who completed the survey in both years were selected as the participants for this study. In total, there are 1,580 participants, with 639 in the sixth–seventh grade cohort, while 941 are in the seventh–eighth grade cohort.

Outcome Variable: Science and engineering career interest

This analysis examines students' reported future career interest in the second year of the survey data as the outcome variable. The survey question regarding participants' future career aspirations contains the following science-related options: 'agriculture and natural resources', 'science and engineering', and 'medicine' (Figure 1). However, in terms of a career expectation that generates new scientific knowledge, only 'science and engineering' applies and therefore is the focus of this study. Consequently, a dummy variable is created based on whether students chose 'science and engineering' in either the fall or spring wave of the second year of the survey.

Predictor Variable: Participation in summer camps or programmes

The predictor variable is whether students participated in the science-focused summer camps or programmes prior to or in the first year of the survey. The survey question examined is: 'Did you ever attend a summer camp or summer programme that was

17. What kind of job do you expect to be doing when you grow up?
(Please check the <u>ONE</u> job category that comes closest to what you EXPECT to be doing.)
___**Agriculture and Natural Resources** (like park rangers, farmers, gardeners)
___**Architecture and Construction** (like builders, planners, architects)
___**Arts, Communications, and Tourism** (like chefs, artists, fashion designers, newscasters, travel agents)
___**Business and Marketing** (like accountants, file clerks, office managers, and receptionists)
___**Education and Counseling** (like coaches, teachers, librarians, psychologists)
___**Entertainment** (like musician, singer, actor/actress)
___**Finance** (like bank tellers, economists, financial managers, insurance agents)
___**Government, Law, Security (**like lawyers, police, inspectors, politicians, postal clerks)
___**Medicine** (like nurses, doctors, physical therapists, dentists)
___**Manufacturing and Repair** (like forklift operators, tailors, welders)
___**Science and Engineering** (like scientists, engineers, computer programmers)
___**Sports** (like professional athlete, coach)
___**Transportation** (like pilot, truck driver, auto mechanic)
___**Not Working**
___**Don't Know**
___**If it's not on this list, please write your answer here:** ____________________

Figure 1. Reproduction of the *future career question* from the survey

mostly or all about science?' Students could choose either 'Yes' or 'No' in response to this question. As a result, another dummy variable is generated according to whether students reported having participated in science summer camps or programmes prior to or in the first-year survey (either in the fall or spring wave).

Control Variables: Demographic and background variables

Students' career interest in science and engineering may be influenced by demographic and background factors beyond science camp and programme participation. Therefore, the following control variables are included in this study: gender, ethnicity, school membership, and initial career interest in science and engineering in the first year of the study. Previous studies have discussed difference in levels of interest in science and engineering fields between female and male students, as well as among students from different ethnic groups (Kulturel-Konak, D'Allegro, & Dickinson, 2011; Lewis, Menzies, Najera, & Page, 2009; Whalen & Shelley, 2010). Meanwhile, the school difference should also be examined in terms of influencing our analysis. By including students' initial career interest, we may control for the situation where participants were already interested in the science and engineering fields prior to participating in summer programmes. At the same time, however, we may also control for the cases where students became interested in science-related careers after attending summer camps but before completing our survey. Consequently, the extent to which summer camp participation is related to career interest in science and engineering may be underestimated.

Modelling

In the study, the quantitative method was applied to analyse the data. A logistic regression model was constructed applying the predictor, control and outcome variables discussed above. Prior to the analysis, assumptions are checked for the logistic regression model including an examination of missing data and a test for multicollinearity. This logistic regression model investigates how much of students' career aspirations can be accounted for by their camp participation after controlling for demographic and background characteristics. To be more specific, we are interested in whether students' participation either in science summer camps or programmes in the first year of the survey or prior helps explain the probability of reporting to choose science and engineering as a future career field in the second year of the survey after controlling students' initial career interest and demographic information.

Results and Discussion

Descriptive Results

In order to better understand the participants, it is important to have a basic idea of students' demographic characteristics and other information concerned in this study.

Table 1. Frequencies and percentages of participant characteristics

Demographic information, camp participation and initial career interest	Subsample	Percentage of sample ($N = 1{,}580$)
Gender		
Female	798	50.5
Male	781	49.4
Ethnicity		
Caucasian	992	62.8
African-American	310	19.6
Asian	66	4.2
Hispanic	379	20.4
Native American	24	1.5
Participated before or in the first year		
Yes	137	8.7
No	1,442	91.3
Initial career interest		
Science and engineering	147	9.3
Others	1,417	89.7
Career interest in the second year		
Science and engineering	169	10.7
Others	1,324	83.8

Table 1 shows a summary of proportions of various characteristics of the participants. Female students account for 50.5% and males account for 49.4% of the sample. As for the ethnicity, Caucasian students are the majority of all the participants and represent 62.8% of the sample. African-American and Hispanic students account for 19.6% and 20.4% of the sample respectively. Finally, Asian and other ethnic groups represent less than 5% of the sample respectively. The sum of the students from different ethnic groups exceeds the total number of the participants because some students chose more than one ethnic group and all of these groups were controlled for. Each ethnic group except for the Caucasian group (considered as the reference group) is coded as a dummy variable in the logistic regression model.

In addition to the demographic information, Table 1 provides information related to students' camp participation and their future career choices. In the first year of the study, 137 students (8.7%) reported that they had participated either in science summer camps or programmes. Meanwhile, 147 students (9.3%) reported a career interest in the science and engineering fields in this first year. In the second year of the study, 169 students (10.7%) reported the expectation of working in the science and engineering fields in the future.

Regression Model Results

The model summary of the logistic regression analysis shows that the χ^2 (df $= 15$) is 256.268 ($p < 0.001$), and that pseudo R^2 (Nagelkerke) is 0.315. It indicates that camp participation, initial career interest, and demographic information together account for 31.5% of the variance in whether students chose science and engineering as their future career fields in the second year of the study. Meanwhile, our regression model is significant at the α-level of 0.05 compared to a model with no predictors.

From the analysis shown in Table 2, it appears that camp participators have 2.1 times greater odds in reporting a career interest in science and engineering than non-participators, while differences in participants' initial science career interest and demographic characteristics were controlled for. That is to say, students who reported having once participated in science summer camps are significantly more likely to show an interest in choosing science and engineering as their future career fields after their initial career interest and demographic information are taken into account. As mentioned before, by using this regression model, we may underestimate the significance of the relationship between students' camp participation in the first year of the study and their science career interest in the second year of the study. Therefore, camp participators may have even greater odds (greater than 2.1) in reporting a career interest in science and engineering than non-participators.

What is more, we also find some statistically significant results as for the associations between the outcome variable (students' career interest in the second year of the study) and control variables (gender and students' initial career interest). Results show that male students are significantly more likely to choose science and engineering as their future career fields than female students in middle school. In addition, students who expected to work in the science and engineering field in the first year of the study have much greater odds in selecting this field again in the second year of the study than those who did not choose this field. This is reasonable as it is assumed that many students stick to their career interest after a year in middle schools. Meanwhile, it also reflects that middle-school students' career aspirations are very stable within two years.

In an effort to provide a more complete description of the associations, two potential interactions were examined: the interaction between camp participation and gender, and the interaction between camp participation and initial career interest. We incorporate two interaction variables in the logistic regression model by crossing

Table 2. Logistic regression model summary with odds ratio

	B (SE)	Sig.	Exp (*B*)	95% CI
Participation in summer camps	0.7 (0.3)	0.013*	2.1	[1.2, 3.6]
Gender		Included		
Ethnicity		Included		
School		Included		
Career interest in the first year		Included		
Intercept		Included		
Career interest in the second year		Outcome variable		

$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

camp participation with gender and initial career interest respectively. Results show that neither of these interactions is statistically significant at the α-level of 0.05 in terms of being associated with students' science career interest in the second year. Results indicate that camp participation and gender do not appear to interact with each other, neither do camp participation and initial career interest in terms of predicting students' future career selection in science and engineering. Therefore, science camp participation is an independent factor that is significantly associated with whether students choose science and engineering as their future career fields, without being influenced by other background factors.

Conclusions

This study is mainly to investigate the association between science-focused summer camp participation before or in the first year of the study and students' career interest in science and engineering in the second year of the study. The logistic regression model was used to analyse the longitudinal data. We assigned whether students participated either in science summer camps or programmes before or in the first year of the study as the predictor, and whether students expected to work in science and engineering in the second year of the study as the outcome variable. In the analyses, several characteristic factors were also included as control variables: gender, ethnic group, school membership, and whether students chose STEM as their future career fields in the first year of the study. The results of our analyses suggest several findings that may contribute to the research concerning the science-focused OST programmes and students' career interest in STEM-related fields.

Based on these analyses, it appears that students who reported participating in science-focused summer camps were more likely to choose science and engineering as their career fields than students who did not. This result underscores the findings of some previous studies (Bhattacharyya & Mead, 2011; Eijck & Roth, 2009; Junge, Quinones, Kakietek, Teodorescu, & Marsteller, 2010). Furthermore, students' initial career interest was considered as a control variable in the analyses. That is to say, we already control for the cases where students were already interested in science and engineering career fields before their participation in summer programmes. Meanwhile, we also control for some of the cases where students became interested in these fields after they participated in science-focused summer activities, which is in the interest of this study. Consequently, there should be an even stronger relationship between camp participation and career interest in science and engineering than our results present. In other words, students who reported having participated in science-focused summer activities have even greater odds of indicating a career interest in science and engineering than students who did not.

Another finding is the significant association between gender and career interest. It appears that in middle schools, boys are more likely to show their career interest in STEM than girls, which is consistent with some previous studies (Desy, Peterson, & Brockman, 2011; Kjaernsli & Lie, 2011). However, we do not find significant interaction between gender and science camp participation when these two factors account for the variance of whether students' career interest is in science and engineering. In addition, Pearson's r shows that the correlation between gender and camp participation is not significant at an α-level of 0.05. Therefore, it may be implied that male and female students had equal possibility to participate in science camps before or in the first year in this study. It might not be the focus of this particular study. But as gender difference is still a big contributor in career interest, we suggest science camp staff continue to develop the camps in order to stimulate career interest in science for both male and female students.

In summary, this study indicates that students' camp participation in science before or in the first year of the study is significantly associated with their future career interest in science and engineering in the second year of the study. Additionally, gender and initial career interest also significantly contribute to the difference in students' science career interest. It appears that science-focused summer camps serve students who later on have greater odds of reporting plans for future careers related to science and engineering, and therefore have the contact with these students during a highly influential period of adolescence. Since science-focused summer activities play an important role in middle-school students' long-term career interest, more research is needed to develop and improve various science summer programmes in the future.

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