

Sustaining Interest: Do STEM Summer Camps Have Lasting Effects on Students?

Dr. Sandeep Langar, The University of Texas at San Antonio

Dr. Sandeep Langar is an Associate Professor in the Department of Construction Science in the Klesse College of Engineering and Integrated Design at The University of Texas at San Antonio, TX.

Dr. Tulio Sulbaran, The University of Texas at San Antonio

He received his Ph.D. in Civil Engineer from Georgia Institute of Technology with concentration in Construction Management with a minor in Computer Engineering and strong statistical background. He has over 8 years of work experience in the A/E/C (Archite

Amani Qasrawi, The University of Texas at San Antonio

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Sandeep Langar¹, Tulio Sulbaran², Amani Qasrawi³,
The University of Texas at San Antonio, San Antonio, Texas

Abstract

Over the past two decades, summer camps across the US have served as a key strategy for cultivating interest in Science, Technology, Engineering, and Mathematics (STEM) careers among high school students, as well as in the disciplines that support these fields. The impact of such interventions is well documented, particularly among participating high school students, with immediate outcomes mostly showing a positive influence on their interest in STEM careers and related disciplines. At the same time, most measurements were conducted immediately after the summer camp. It is unclear whether, after a significant period of the summer camp, the participants still have a positive outlook towards STEM careers and the disciplines that underpin them. Therefore, this research investigated high school students' perceptions six months after the intervention (a summer camp at a large public university in Texas) to determine their perceptions and the intervention's sustained impact. For this study, an online survey was used to collect data and was hosted on Qualtrics. The study population consisted of high school students who had participated in a STEM summer camp within the past six months. The study received responses from 14 high school students. The research findings indicate how participation in summer camps influences high school students' perceptions in the long run.

Keywords:

STEM Summer Camps, High School Students, Sustained Effects

Introduction and Background

The demand for qualified professionals in Science, Technology, Engineering, and Mathematics (STEM) careers is greater than ever as the United States responds to national and global challenges, including artificial intelligence, climate change, global trade, and other emerging threats. This growing demand is underscored by projected increases in employment across STEM professions for the next ten years [1]. Even with these significant needs for STEM professionals, prior research indicates that students may be hesitant or less inclined to pursue STEM careers [2], [3], due to multiple contributing factors, including “*inadequate preparation in science and mathematics coursework, limited financial resources, a lack of role models, and persistent perceptual barriers, and others*” [4]. Adding to these challenges, national data suggest that student performance in the United States has not kept pace with that of students in other countries in science and mathematics for more than a decade [5], which puts the nation at a disadvantage. STEM Summer Camps have historically been used to address identified challenges and to cultivate interest in Science,

Technology, Engineering, and Mathematics (STEM) careers among high school students, as well as in the disciplines that support these fields.

STEM Summer Camps have been utilized by researchers in the last few decades to improve student interests and perceptions for STEM higher education and Careers, including construction [6], [7], [8], [9], [10]. These experiences are deemed critical as the construction industry can be perceived negatively due to “*dangerous working conditions, lack of integrity, lack of knowledge among teachers and counselors, and others*” [7]. With these experiences, it is anticipated that some of the negative perceptions held by high school students and their parents may be reduced after participating in the summer camp. Such shifts in perception can help students make informed decisions about pursuing STEM-related pathways, including the construction field. This can strengthen the high school-to-construction industry pipeline and help address persistent workforce challenges. The need for the workforce is perceived significantly, with the need for skilled professionals possessing the requisite competencies and their shortages that have adversely affected overall industry performance [11]. Therefore, STEM summer camps can be vital if they provide authentic, hands-on experiences that engage participants (high school students). At the same time, systematic assessment of the summer camps conducted plays a vital role, creating a feedback loop to inform continuous improvement of future camps and to guide others seeking to adopt or adapt the developed summer camp framework.

Most studies conduct assessments immediately after the summer camp experience and have found that the impacts are positive [10], [12]. However, most assessments of the summer camp have been conducted immediately after it ended. It is unclear if, after a significant time of attending the summer camp, the participants still have a positive outlook towards STEM careers and the disciplines that underpin these fields. Therefore, this research investigated high school students' perceptions six months after the intervention (a summer camp at a university in Texas) to determine their perceptions and the intervention's sustained impact.

Research Question

Immediately after the summer camp, the participating students demonstrated a high level of knowledge and awareness of STEM careers and disciplines, as determined by post-tests; however, the intervention's sustained effects needed further evaluation. Therefore, this research investigates high school students' perceptions six months after the intervention (a summer camp at a public university in Texas) to determine whether they have changed or remained the same. The research also explored whether positive perceptions immediately after the summer camp led to positive actions (such as applying to universities), as well as perceptions about career choices related to the “*construction of agricultural infrastructure.*” The career choice “*construction of agricultural infrastructure*” was purposively selected in the survey as the intervention (summer experience)

focused on that career and is associated with STEM. The intervention (summer experience) for high school students was grounded in the theories of Transformational Leadership and Constructivism. The intervention (summer experience) included hands-on activities and field trips to reinforce STEM and Professional Marketable Skills, as well as Career and Higher Education in STEM. The hands-on activities included simulations of construction safety, construction technology, project management, and software use (commonly used in the Architecture, Engineering, and Construction Industry), as well as games emphasizing teamwork, communication, and consensus-building, among others.

Methodology

This study used an online survey to examine participants' perceptions six months after their participation in a STEM summer camp at a public university in Texas. The STEM summer camp served as an intervention to increase high school students' knowledge and awareness of STEM disciplines and career pathways, "construction of agricultural infrastructure." An online survey approach was selected because it allows perceptions to be measured at a specific point in time [13], is cost-effective, speed, and timeliness [14], and enabled researchers' access to the study population through their instructors and/or school counselors.

The study population consisted of high school students who had participated in the STEM summer camp within the previous six months. This time gap was purposefully selected to assess the sustained impact of the intervention rather than immediate outcomes. The survey instrument was developed and administered using Qualtrics, based on the research team's prior experience with the platform [15], [16] and its established use in STEM education research [17].

The online survey instrument included mostly closed-ended questions (such as dichotomous, multiple-choice, multiple-response, and Likert-scale items) and one open-ended question. The survey was organized into five sections: (1) participant demographic information; (2) STEM applications to universities or community colleges; (3) barriers and facilitators related to the application process; (4) participants' knowledge and perceptions of STEM and professional, marketable skills; and (5) perceived effects of the summer camp intervention. This paper reports findings from selected items within the first three sections.

After the instrument was developed, it was pilot tested by a subject-matter expert and a student to ensure clarity and appropriateness. The finalized survey was then shared with a high school teacher and a counselor from two school districts whose students had participated in the STEM summer camp. Six months after the camp concluded, the teacher and counselor distributed the survey to eligible participants. The survey remained open for three months to allow sufficient time for completion, after which it was closed, and the responses were downloaded for analysis.

In total, fourteen respondents completed the survey in full, while one respondent partially completed it. Only complete responses were included in the descriptive analysis.

Results

Of the fourteen respondents, the majority identified as female (64.3%), with the remainder identifying as male (35.7%). In addition, 79% (11) of the respondents identified as Hispanic, and 21% (3) as White.

Impact of Summer Camp on Student Knowledge and Perception

When asked about changes perceived after attending the summer camp, 64% of respondents (9 students) reported increased interest in STEM subjects, and only one respondent reported “*somewhat less interest*,” as shown in Figure 1. When asked about the reason for the change in interest, 13 of 14 respondents (92.4%) attributed it to participation in the summer camp, and 1 student did not. When asked how they would best describe the change in their perception of their ability to succeed in STEM subjects since attending the Summer Program, the majority (8 respondents) reported having “*Somewhat improved*” (Figure 2). When asked about the reason for the change in their perception of their ability to succeed in STEM subjects since attending the Summer Program, 13 of 14 respondents (92.4%) attributed it to participation in the summer camp, and one student did not.

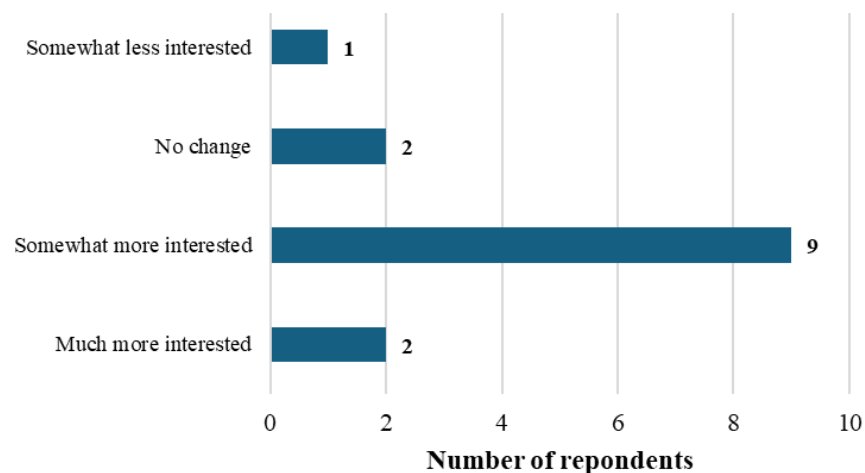


Figure 1: Respondent perceived interest in STEM subjects post-intervention (n=14).

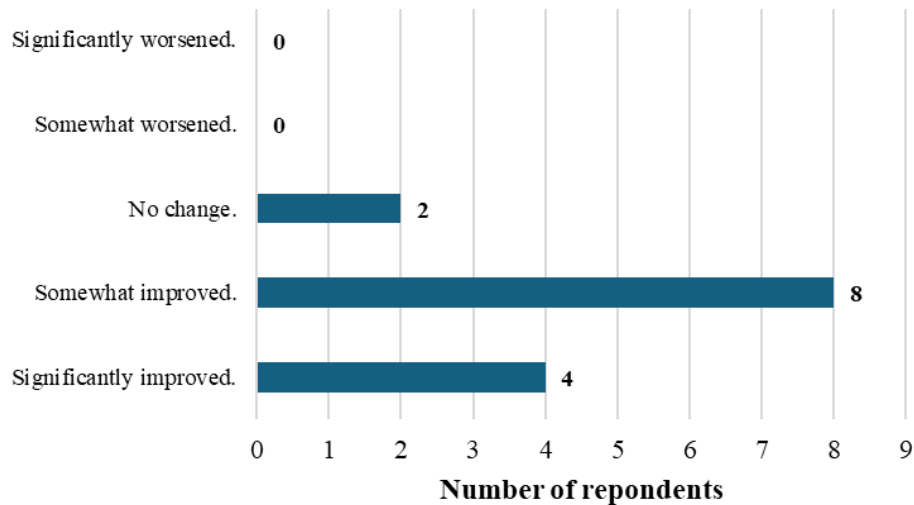


Figure 2: Respondents' ability to succeed in STEM subjects post-intervention(n=14).

When asked about the intervention's impact on their participation in STEM-related extracurricular activities or competitions, most students (8) reported occasional participation (Figure 3). Ten out of fourteen responding students attributed their participation in the summer camp to it, and 4 did not.

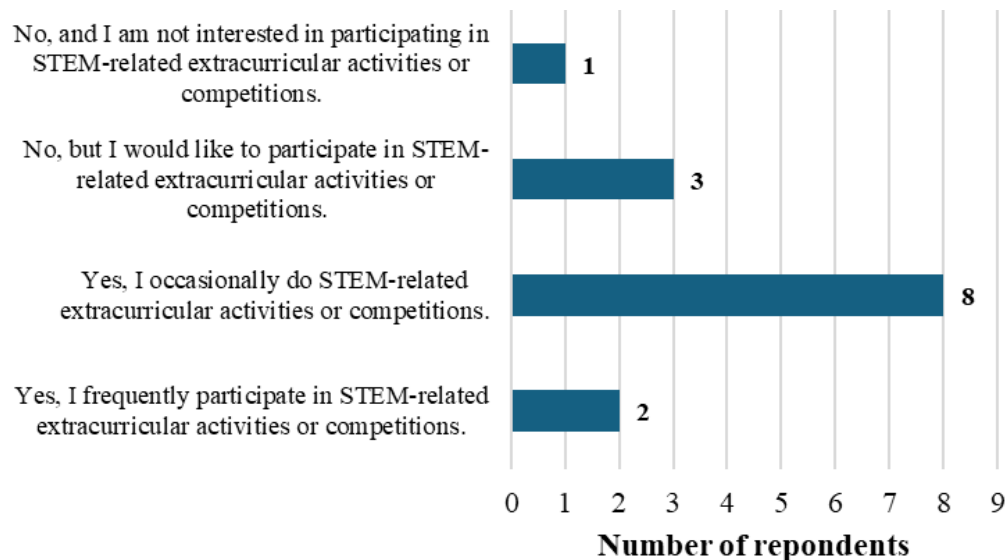


Figure 3: Respondent participation in any STEM-related extracurricular activities or competitions post-intervention (n = 14).

An overwhelming majority of students (13 out of 14) attributed their attendance at the summer camp to their career aspirations in STEM fields. In addition, 6 months after the intervention, 10 students rated their knowledge of STEM subjects as “Average,” while the remaining 4 rated it as “Above Average,” indicating the intervention's sustained impact on participants. Similar trends were observed in participants' perceptions of the importance of STEM subjects to them at this time,

with a significant majority (12 students) identifying STEM subjects as “*Very Important*” (Figure 4).

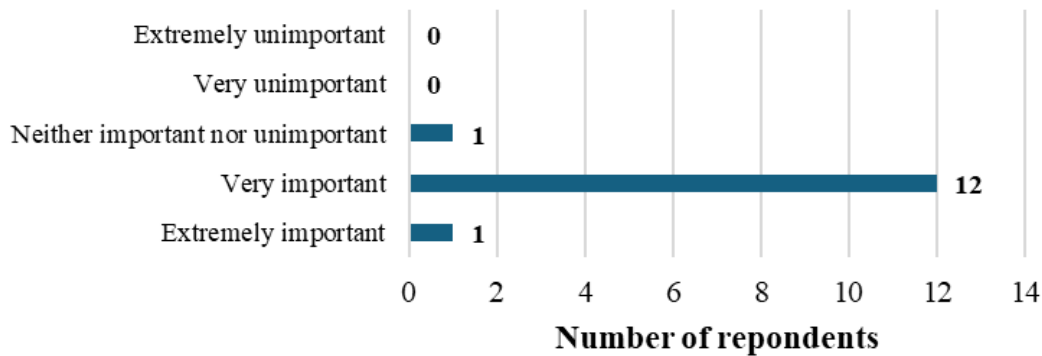


Figure 4: Respondent perception of the importance of STEM subjects (n=14).

Impact of Summer Camp on Student Awareness of Career Choices

The research team also aimed to determine whether positive perceptions of STEM translated into greater awareness and a higher likelihood of selecting career paths related to the “construction of agricultural infrastructure.” When asked to rate their awareness of career choices available in the construction of agricultural infrastructure, 6 students selected “*Moderately aware*,” closely followed by 5 who selected “*A lot aware*” (Figure 5). It is worth noting that none of the respondents reported being “*Not at all aware*” regarding career choices available in the construction of agricultural infrastructure, indicating that impacts were sustained. At the same time, the degree of impact varied, as depicted in Figure 5, with some students reporting “*Extreme awareness*” (2 students) and others reporting little awareness (1 student).

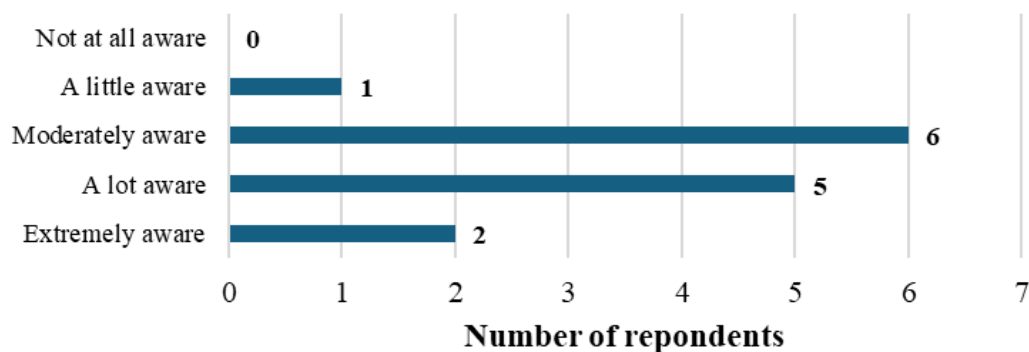


Figure 5: Respondent awareness about career choices available in the construction of agricultural infrastructure (n=14).

From the perspective of the *likelihood of selection of a career* in the construction of agricultural infrastructure, the responses varied significantly, with 5 students selecting “*somewhat unlikely*” followed by 4 students selecting “*somewhat likely*” (Figure 6). At the same time, it is worth noting

that none of the students selected “Extremely unlikely,” whereas 2 students selected “*Extremely likely*” (Figure 6).

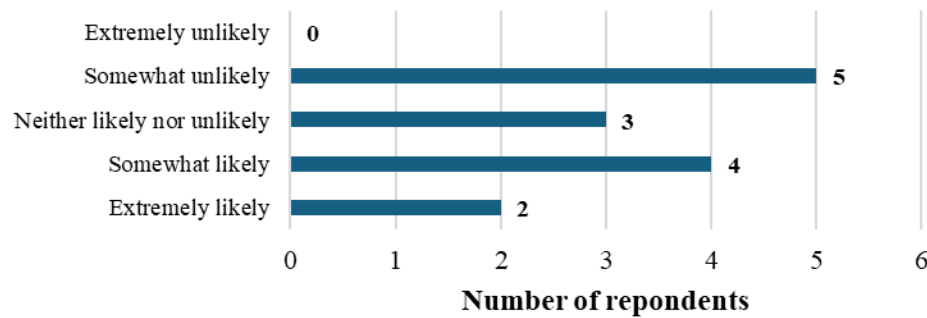


Figure 6: Likelihood of selection of a career in the construction of agricultural infrastructure (n=14).

Impact of Summer Camp on Actionable Outcomes to attain STEM career choices

Actionable outcomes of the intervention (summer camp) toward attaining STEM career choices were measured by whether students created an account and submitted an application on the state portal for community colleges and/or universities. Participants were asked about the influence of attending summer camp on their career aspirations in STEM fields, and an overwhelming majority of respondents (11 out of 14) reported having “*somewhat positively influenced a STEM career*” (Figure 7).

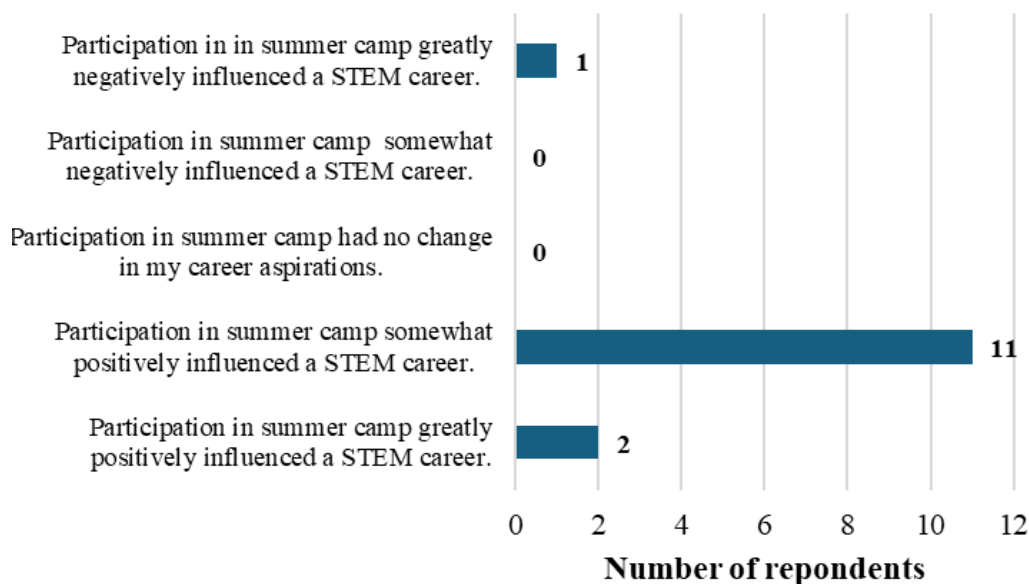


Figure 7: Impact of the intervention on respondents' career aspirations in STEM fields (n=14).

Approximately 43% of respondents (6 of 14) indicated they had created an account on the state portal to apply to community colleges and/or universities, while approximately 57% (8 of 14) reported they had not. Among the six respondents who had created an account, 83% (5 of 6)

reported entering information into the state portal as part of the college and university application process, while one respondent indicated that they had not entered any information. None of the respondents reported applying to a university/community college for the upcoming academic year. According to respondents, one of the major reasons they did not apply was that they were currently in high school and planned to apply to a university/community college in the future (Figure 8). Respondents could select more than one response for this query.

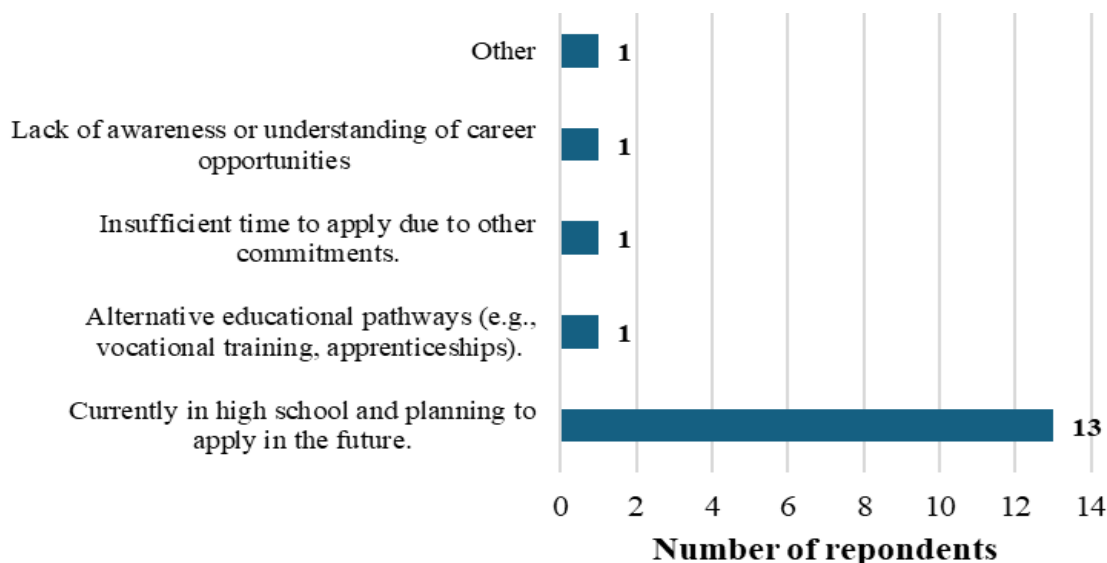


Figure 8: Factors influencing decision not to apply to universities/community colleges for the upcoming academic year (n=14).

Conclusions

The study evaluated participants' (high school students) perceptions and knowledge of STEM subjects, interest in pursuing STEM careers, and actions taken toward higher education to achieve those career goals, six months after the intervention (a summer camp at a public university in Texas). The study used an online survey conducted via Qualtrics to determine the impact; 14 participants responded. Findings indicate sustained impacts of the intervention. The majority of respondents reported increased interest in STEM subjects six months after the program and noted improved perceptions of their ability to succeed in STEM coursework, attributing these changes to the intervention (summer camp experience). Participants also reported involvement in STEM-related extracurricular activities and competitions ranging from occasional to frequent following the intervention. Enhanced perceptions translated into greater awareness and a higher likelihood of pursuing careers related to the construction of agricultural infrastructure. Most respondents reported moderate to high levels of awareness and a greater likelihood of choosing such career pathways. Additionally, several students reported initiating applications through the state higher education portal for admission to community colleges and/or universities. Overall, the findings suggest that the intervention produced sustained effects not only in participants' perceptions,

awareness, and knowledge of STEM, but also in tangible postsecondary outcomes that may contribute to future STEM career pathways.

Limitation

One significant limitation of the study is that it presents data from a small sample (n=14 students), which may limit the generalizability of the findings. At the same time, this number represents 100% of participants who participated in the intervention (summer camp). Although this small sample size limits the use of inferential statistics, it provides insights into the sustained impact of the intervention (summer experience) even after six months.

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