Impact of Summer Camp on Minority High School Students on STEM Career Perceptions

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Abstract

In today's rapidly evolving technological age, the role and relevance of STEM (Science, Technology, Engineering, and Mathematics) education cannot be understated. For the US, the quality and breadth of its STEM education will shape its future role on the global stage, driving innovation and addressing pressing challenges from Artificial Intelligence to climate change resilience, advancing healthcare, agricultural solutions, and others. However, the country lacks active participation from young minds in STEM fields. This problem is particularly true for students who are minorities, economically disadvantaged, or from rural areas due to the existence of multiple barriers. Although numerous summer camps have been employed to some degree of measurable success to facilitate a positive outlook toward STEM career choices for some time, limited studies investigate how such summer camps impact female students from Rural Independent School Districts (R-ISD), especially the ones that are few hours from the country's southern border. Further, summer camps offer students exceptional opportunities to engage in learning experiences, explore advanced technologies, establish meaningful connections with like-minded peers, and better understand future career choices. Therefore, given the benefits of intervention via summer camps and the lack of research in the identified geographical region, this research aimed to determine the impacts of summer camps developed on a previously published framework to determine if the intervention enhanced the participant's STEM and soft skills, knowledge, future career, and educational choices of female students from R-ISD. The participating students were subjected to a pre-test to determine the baseline at the beginning of the summer camp. A post-test was conducted at regular intervals to measure the summer camp's impacts on the knowledge, future career, and educational choices of participating female students from R-ISD. Both pre and post-tests were conducted online using Qualtrics, as it allowed for quicker data collection and value. The findings indicate a change in the female participant's outlook after the summer camps. Therefore, as the country solidifies its position as a global STEM powerhouse, tapping into the potential of all its citizens is paramount. Our study suggests that targeted interventions, such as summer camps, can play a significant role in this endeavor, particularly for underserved demographics.

Keywords: Summer Camp, Minority, High School Students, STEM Career Perceptions

Introduction

In today's rapidly changing educational landscape, it's essential to cultivate an early interest in STEM (Science, Technology, Engineering, and Mathematics) fields to shape the future workforce and enhance global competitiveness. Students often choose their educational and career paths based on their experiences and knowledge [1]. However, American secondary students' lower math and science scores compared to other industrialized nations are concerning, as it could impact the US job market's ability to remain at the forefront of innovation [3].

Furthermore, students from Rural Independent School Districts (R-ISD) often face limited resources and limited access to specialized academic programs or exposure to high-tech industries. To address this issue, STEM summer camps have created a positive perception and informed participating students about STEM career choices among high school students [3].

This study seeks to address the existing gaps in understanding the effectiveness of summer camps, using a developed comprehensive theoretical framework (SumEx-TLC) to enhance the educational choices and career aspirations of minority students from R-ISD. The geographical focus on areas located hours away from the southern border is because these areas have limited economic opportunities, impacting funding for schools and educational resources, or larger student populations and resource distribution challenges [4].

The primary objectives of this study are to:

a. Investigate the impact of summer camp based on the SumEx-TLC framework for educational choices and career aspirations of the participating High school minority students.
b. Identify the participant's perceptional changes after participating in a summer camp based on the SumEx-TLC framework in STEM and soft skills, as they broaden students' understanding of technology, contribute to students' career awareness, and increase their tendency to choose professions in STEM fields for the future [5].
c. Identify the changes in participants' soft skills development, including teamwork, leadership, and communication skills, as they are the top necessary skills identified in multiple papers [6] [7].

Literature Review

In 2021, underrepresented minorities (including Hispanic, Black, and American Indian or Alaska Native individuals) constituted 32% of the skilled technical workforce compared to those who were employed in STEM (Science, Technology, Engineering, and Mathematics) fields with at least a bachelor's degree (16%). Schools provide various career counseling and exposure programs during middle and high school. At the same time, parents and career professionals can also significantly impact a student's career choice [2]. An effective way to influence students' career choices is by providing opportunities through summer camps. Over the years, several universities (such as Auburn University, Texas A&M, Virginia Tech., and others) have offered summer camps for high school students focused on Architecture Engineering and Construction (AEC) education [8]. Participation in STEM camps sparks interest in these disciplines and serves as a means for colleges and universities to increase enrollment by establishing connections with potential future students [3] and serve the industry need for a qualified STEM workforce.

The workplace of the 21st century is becoming more diverse and collaborative, with people from different cultures and backgrounds working together [9]. Companies now recognize the importance of well-rounded profiles that combine technical expertise with interpersonal skills [10]. As a result, there is a need for candidates who possess not only technical competencies but also soft skills, such as effective communication, leadership, and teamwork [11]. Therefore, STEM education emphasizes science, technology, engineering, and math to promote critical thinking and rational thought from an early age [12].

Summer camps are a valuable tool for fostering holistic development. Summer camps have a rich history of providing experiences that enhance social skills, self-awareness, spirituality, leadership, connection to nature, and personal values [13]. Soft skills have traditionally played a secondary role in technical hard skills in workplace evaluations, but contemporary employers increasingly recognize the importance of soft skills [14]; Unlike hard skills, which encompass technical proficiency, experience, and specific job-related expertise that contribute to productivity [14].

To provide students with a great experience, it is vital to establish a framework that allows for modifications to the summer camp, and to repeat successful camps. For this summer camp, the "SumEx-TLC framework" was used to develop activities for construction summer experiences that target specific "Knowledge" in a particular "Context" desired by the educator [8]

Most summer camps lack a clear framework [15]. Although some summer camps use design thinking and inductive reasoning to connect what they have learned with what they already know; however, little attention is given to how well participants understand the topics covered or how this understanding impacts their perception of engineering [16]. Other summer camps have adopted Cognitive Apprenticeship (CA) as a framework for creating the camp [17]. STEM-based activities should start early, but immersion in a guided environment alone is not enough to develop scientific reasoning. Explicit instruction is required for all ages to develop reasoning skills successfully [17].

Many academic institutions offer summer camps to introduce students to areas and fields of study they might be interested in. Therefore, the research aimed to determine the impacts of summer camps developed on a previously published framework to determine if the intervention enhanced the participant's STEM and soft skills, knowledge, future career, and educational choices of minority students from R-ISD.

Research Methodology

Participants: The study was conducted during a summer camp, targeting female Hispanic high school students from R-ISD. This demographic was chosen to address the underrepresentation of women, particularly those from minority backgrounds, in STEM fields.

Quasi-Experimental Design: The research conducted aimed to determine the impacts of summer camps developed on a previously published framework to determine if the intervention enhanced the participant's STEM and soft skills, knowledge, future career, and educational choices of female students from R-ISD. Quasi-experimental research involves the manipulation of an independent variable without the random assignment of participants to conditions or orders of conditions. Among the important types are nonequivalent group designs, pretest-posttest, and interrupted time-series designs [18]. The decision to use a quasi-experimental approach is based on the type of study being conducted. The information is mainly derived from survey responses collected from a group of participants (students). Quasi-experimental designs are useful in educational research as they allow for manipulating an independent variable, such as the introduction of AR while acknowledging the challenges of randomization in real-world settings.

Data Collection: The data for this study were collected through an online survey. The survey included a pre-survey before the summer camp to establish baseline data and a post-survey after the summer camp. The Qualtrics online survey platform was used to administer both the pre- and post-surveys electronically to ensure consistency and efficiency. Also, the post-survey will mirror the pre-survey structure. The survey primarily comprised closed-ended questions that concentrated on how summer camp influenced the participants' career aspirations, particularly in the STEM field. It also aimed at determining any improvements made in the participants' soft skills development and STEM knowledge.This approach facilitated the quantitative analysis of the collected data.

Results and Discussion

Shifting Career Perceptions

Analyzing the pre- and post-surveys facilitates the evaluation of shifts in participant's perceptions of career choices related to fields supporting STEM, such as the construction of agriculture infrastructure. The research identified a significant change in perception among the participants, with more participants willing to enroll in an Agriculture infrastructure-related course (Figure 1). The significant shift in participant perception can indicate that the summer camp increased their interest or confidence in pursuing courses related to the field.

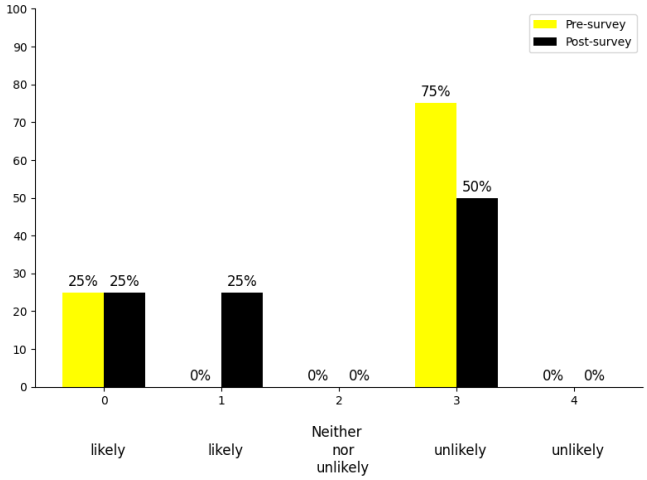

Figure 1. Likelihood of selecting an Agriculture infrastructure career (Pre- and Post-Institute Experience)

Along with perception changes for career choices (Such as the construction of agricultural infrastructure) related to STEM, the participants also indicated a higher likelihood of enrolling in agriculture infrastructure-related courses after their participation in the summer camp (Figure 2). This shift could imply that the summer camp had varying effects on participants' perceptions of pursuing a career in Agriculture infrastructure. While a portion of participants maintained or increased their enthusiasm ("Extremely likely" and "Somewhat likely" categories), a notable portion shifted towards uncertainty or decreased likelihood ("Somewhat unlikely"). Further investigation could provide insights into specific aspects of the summer camp that influenced changes, which could help in future summer camps.

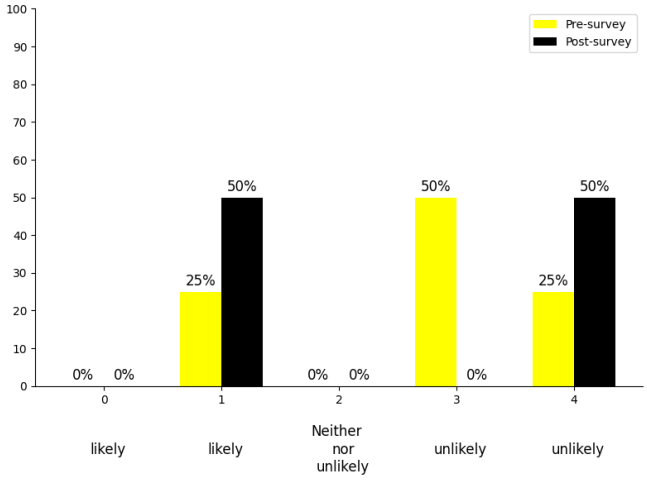

Figure 2. Likelihood of enrolling in an Agriculture infrastructure -related course (Pre- and Post-Institute Experience)

The participants in the summer camp showed a change in perception regarding career choices and the likelihood of enrolling in agricultural infrastructure programs related to STEM. They also indicated a higher level of awareness about their career choices (Figure 3). This shift in awareness suggests that the summer camp had varying effects on the participants. Some participants maintained or increased their awareness, while others showed a significant improvement.

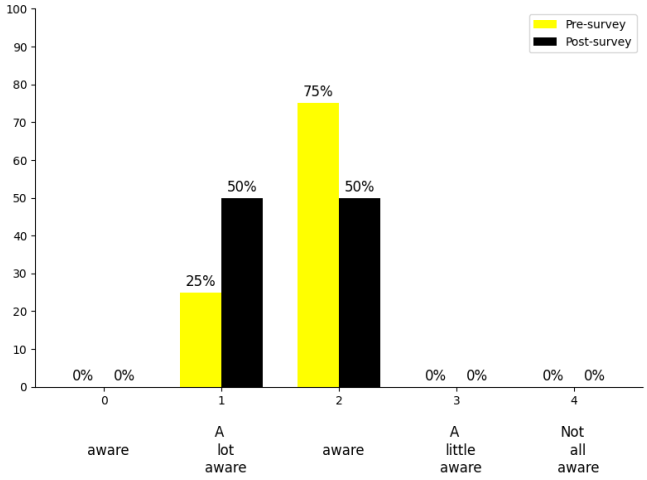

Figure 3. Awareness about career choices (Pre and Post-Institute Experience)

Impact of Summer Camp on STEM skills

For the research, STEM areas of Physics, Geometry, and Technology were addressed. The area of technology was addressed by introducing the concept of 3D modeling and use of technology in the maintenance of agricultural infrastructure. The findings indicate a significant improvement in the participants' skills in some areas, such as geometry and 3-D modeling, as indicated in Figures 4 & 5. Figure 4 shows changes in response distribution: in the pre-survey, 50% of participants were "Average," and 50% were "Far below average." In the post-survey, the distribution shifted to 25% "Far above average," 25% "Average," and 50% "Somewhat below average." The summer camp positively impacted participants' geometry knowledge, resulting in diverse responses. Some

showed significant improvement, some maintained their average level, and others experienced a slight increase.

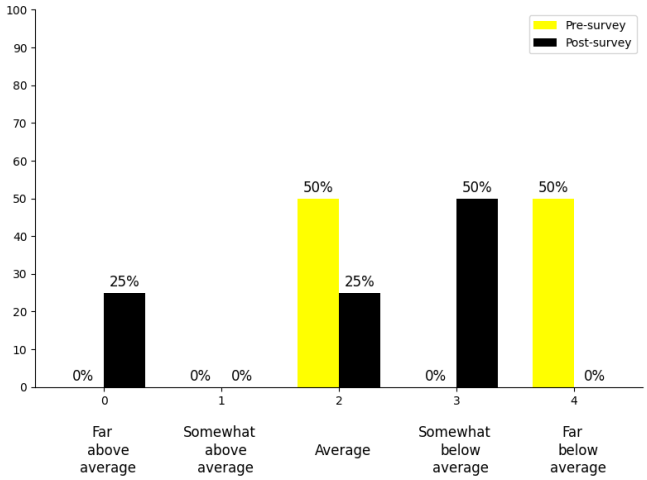

Figure 4. Geometry Knowledge Improvement (Pre- and Post-Institute)

Analyzing "*physics knowledge improvement"* before and after the summer camp. The graphical representation as shown in Figure 5 indicates changes in response distribution: in the pre-survey, 25% of participants were "Somewhat above average," and 75% were "Average." After the summer camp, the distribution changed, with 25% now perceiving their knowledge as "Far above average," and the remaining 75% maintaining an "Average" rating. Overall, the results suggest that the summer camp positively influenced the participants' understanding and proficiency in physics.

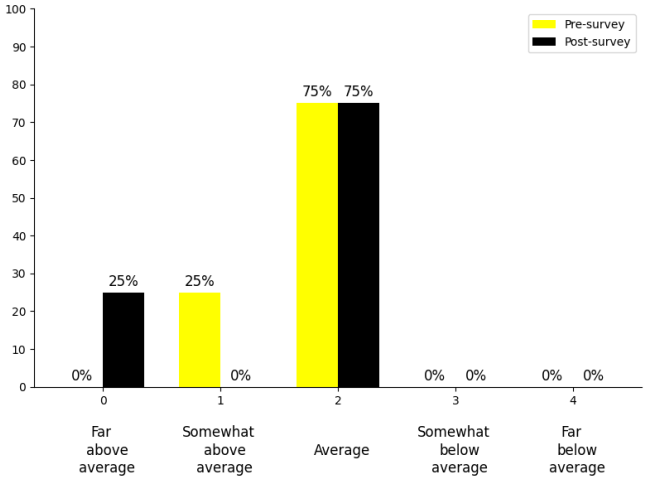

Figure 5. Physics Knowledge Improvement (Pre- and Post-Institute)

The analysis of "*3D modeling knowledge improvement"* before and after the summer camp. The graphical representation as shown in Figure 6. indicates changes in response distribution: in the pre-survey, 50% of participants rated their 3D modeling knowledge as "Far below average", and 50% were "Somewhat below Average". After the summer camp, the distribution changed, with 50% now perceiving their knowledge as "Somewhat above average", 25% as "Average", and 25% as "Somewhat below average". The fact that 50% of participants moved from "below average" to "somewhat above average" suggests significant improvement.

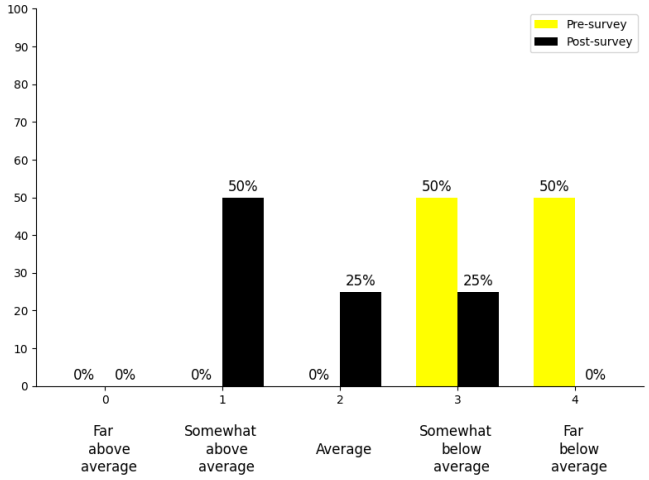

Figure 6. 3D modeling Knowledge Improvement (Pre- and Post-Institute)

Impact on Softskills:

The survey included five soft skills, in this paper the focus is on teamwork, leadership, and communication skills as they are the top necessary skills identified in multiple papers [6] [7]. The analysis of "*teamwork skills"* improvement before and after the summer camp. The graphical representation (Figure 7) indicates changes in response distribution: in the pre-survey, 25% of participants rated their teamwork skills as "Far below average", 50% were "Somewhat above Average", and 25% as "Average." After the summer camp, the distribution changed, with 75% as "Somewhat above average", and " 25% as "Far above average". The results suggest that the summer camp successfully enhanced participants' teamwork skills, fostering a more positive and proficient collaborative environment.

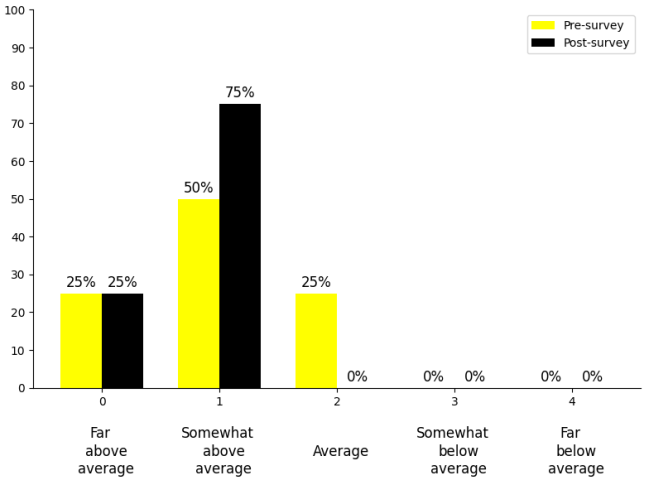

Figure 7. Teamwork Skills Improvement (Pre- and Post-Institute Experience)

The analysis of "*communication skills"* improvement before and after the summer camp. The graphical representation as shown in Figure 8. indicates changes in response distribution: in the pre-survey, 100% of participants rated their communication skills as "Average". After the summer camp, the distribution changed, with 25% as "Somewhat below average", 25% as "Average", 25% as "Somewhat above average, and " 25% as "Far above average". The results

indicate that the summer camp effectively improved participants' communication skills, creating a more diverse and skilled communication environment.

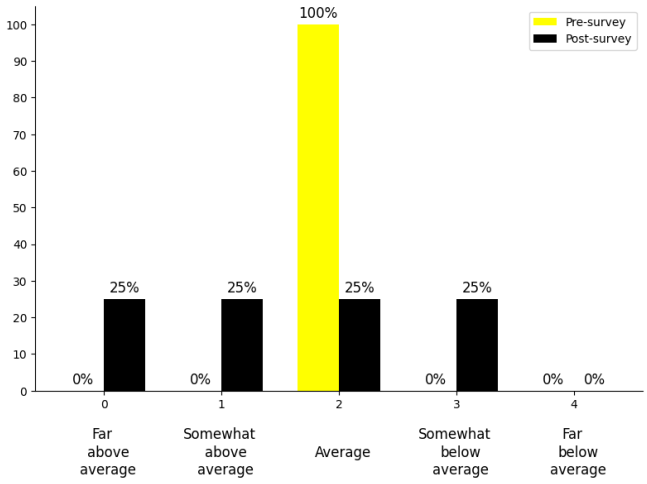

Figure 8. Communication Skills Improvement (Pre- and Post-Institute)

The analysis of "*leadership skills"* improvement before and after the summer camp. The graphical representation as shown in Figure 9. indicates changes in response distribution: in the pre-survey, 25% of participants rated their leadership skills as "Somewhat below average, " 50% as "Average", and 25% as "Somewhat above average. After the summer camp, the distribution changed, with 25% as "Average", 50% as "Somewhat above average, and " 25% as "Far above average." The results indicate that the summer camp effectively contributed to the enhancement of leadership skills for a significant portion of the participants.

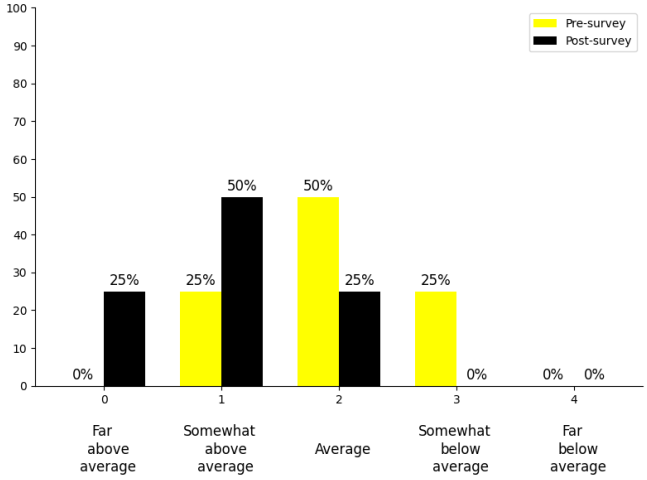

Figure 9. Leadership Skills Improvement (Pre- and Post-Institute)

Conclusion

In conclusion, based on the feedback received from the participants during the summer camp, the analyses of various skill improvements before and after the summer camp demonstrate the program's positive influence on participants' capabilities and perceptions. From shifts in likelihood to enroll in agriculture infrastructure-related courses and selecting careers in this field, to improvements in knowledge and skills such as geometry, physics, 3D modeling, teamwork,

communication, leadership, consensus building, and presentation, the summer camp has proven to be a valuable educational experience. The graphical representations show that the camp effectively addressed participants with varying skill levels and addressed their specific needs. The positive results indicate that the summer camp not only expanded the knowledge of the participants but also improved their practical skills and confidence in different areas. These findings can be used to improve future versions of such summer camps.

Limitations and Future Research

Although this study provides valuable insights into the positive impacts of the summer camp on participants' skills and career perceptions, it's important to acknowledge certain limitations and suggest directions for future research. The study involved a small sample size and, therefore, limited the generalizability of the findings to a broader population. Furthuremore, the study focuses on the immediate response of the participants after attending the summer camp. However, a more thorough evaluation is needed to measure the long-term impact of the camp on the skills, career choices, and educational pursuits of the participants. Tracking the participants over a longer period of time would give us a better understanding of the sustained effects of the camp.

Acknowledgment

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