Diversity Trends in STEM Summer Camps Over the Last Two Decades

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Abstract

Student proficiency in Science, Technology, Engineering, and Mathematics (STEM) subjects is a significant concern among agencies nationwide. A reported decrease in student proficiency levels as students progress through school impacts the ability to meet the market demand for qualified engineers and specialists. Further, some STEM fields have diversity issues, with lower participation from women and underrepresented minorities due to numerous reasons. STEM Summer Camps can alleviate this concern by exposing participants from diverse backgrounds to the topical areas, encouraging participating students to pursue STEM-based careers, and helping the nation meet the need for a STEM-focused workforce. Thus, given the need to ensure a diverse set of student participants in summer camps, including women and underrepresented minorities, and the ability of Summer Camps to alleviate the problem, this research determines the diversity of STEM summer camp attendees in the US over two decades. The three-staged research included sample selection, parameter development, and descriptive statistical analysis. Sample selection was dictated by factors such as the ASEE article and publication date (in twenty years). Parameter development included identifying five parameters, "population, race, gender, age, and targeted population," as they are integral for obtaining insights into the summer camp attendee diversity. The research presents the findings of a meta-analysis of ASEE articles published from 1998-2017 that influenced 1,795 students. Although some of the summer camps targeted minorities, most did not meet their target. The preliminary analysis of the compiled data indicates that the STEM-based summer camps influenced more than 1,700 students. The preliminary results also indicate limited minority participation (gender and race), with most participants demonstrating positive feedback and interest in pursuing STEM. These findings are significant as they help facilitate enhanced participation from minorities in the STEM fields both in education and as a possible career choice, and in the process, contribute towards solving the problem of limited high-quality workforce in these fields.

Keywords
STEM summer camp, metanalysis, minority and low-income students, participant gender and race

Introduction

Attracting students to the Science, Technology, Engineering, and Mathematics (STEM) fields is a challenge that needs to be addressed at all levels of K-12 education [1], [2], especially with the increased reliance on technology [2] and scarcity of candidates fulfill the STEM jobs that are available in the US [1]. Summer camps allow participating students to gain a unique experience in different subjects and encourage them to enroll in STEM-based courses and programs [3] and, in the process, help produce future leaders who have a significant interest in STEM fields. Literature indicates that most STEM summer camps increase student interest, knowledge, positive attitudes, and awareness in areas supporting STEM [4], [5]. Such camps can be designed or conceptualized in such a way that participants can have fun and enthusiasm can be maintained while engaging and

teaching campers new skills. Besides academic content, the camps allow participating students to interact socially and intellectually with peer participants. The free-time conversations among the summer camp participants and other stakeholders (instructors, staff, counselors, and others) enhance participant understanding of the benefits of pursuing a STEM-based degree and career path, which can potentially boost participant's self-confidence [6]. Researchers have examined the value and benefits of camp experiences mostly from the perspectives of campers or staff, and most studies have uncovered positive outcomes on various development dimensions [6], [7]. Therefore, to summarize, summer camps can help alleviate some of the issues with student perception, create awareness among students for possible career pathways, enhance knowledge, and possibly motivate them to pursue career pathways into STEM-based careers. This, in turn, can contribute to building a high-quality STEM workforce that supports the country's needs.

In the last three decades, there has been some progress in women and other underrepresented minorities earning engineering bachelor's [8]. At the same time, it remains difficult for women to gain representation in STEM fields even though they have historically contributed to them [9]. The first step in balancing gender inequality is to remove stereotypes as early as possible - a process that society has begun by educating young children in several ways as research indicates that females in elementary and high school are equally capable and prepared to pursue STEM careers as their male counterparts [10]. Encouragement may still be needed to take the step to pursue a career so they can overcome several stereotypes during early education. These encouragements can be in the form of summer camps/experiences that have historically shown improvements in generating perceptional improvements among participants. In addition, studies and practice indicate that schooling is "*necessary but not sufficient*" for supporting positive outcomes, including academic success [11], [12], thereby necessitating the need for additional programs such as summer camps for medium and high school students to pursue STEM education.

Thus, given the background and the need to ensure a diverse set of student participants in summer camps, including women and underrepresented minorities, this research aims to determine the diversity of STEM summer camp attendees in the US.

Literature Review

During the 20th century, the US saw an increase in the number of students earning high school and college degrees, and an expansion of economic development, including a skilled workforce, in an era of technological diffusion [7], [13]. Despite the improvements, there is a decline in students completing higher education degrees in STEM areas. Approximately 40% of students entering college to earn a STEM degree complete it [7], [13]. In 2019, only 41% of fourth and eighth-grader students and 21% of twelfth-grader students could be considered "proficient" in mathematics [14]. A perception of poor performance in STEM education, rankings of US students on international STEM assessments, increased education attainment in other countries, and the ability of the domestic STEM education system to meet domestic demand for STEM labor exists [14]. Further, there are not enough engineers in the US to meet the market demand in the majority of these disciplines [15].

Higher educational attainment can be a potential barrier to entering the STEM workforce [16], transitioning to effective recruitment and retention. At the beginning of elementary education, male and female students are excited about STEM-related courses. However, STEM-related courses' perceptions alter as students transition towards middle and high school [17], with males more interested in STEM courses and females towards other course types [18], [19]. Resulting in males outnumbering females in the STEM fields when it comes to earning degrees and careers [20].

Several factors are involved in this issue, specifically, gender stereotypes, which are quite well ingrained when females reach high school [21], [13]. A study of 6000 students completed in 2012 found that males are 2.9 times more likely than females to become interested in STEM careers during high school [21], [13]. Gender gap reduction is possible, and research suggests that female career interests during their early years may be influenced if the curriculum features appeal to female intrinsic motivation to improve the lives of others [22]. Taking advantage of this inclination is possible through engineering outreach, which offers students an opportunity to explore complex ideas in a group setting in a way that is often not possible in traditional classrooms. It is common for these groups to focus on a particular age group or gender. In addition, perception towards technology education, lack of female mentors and role models, loss of interest in technology classes after middle school, teacher discouragement and impacts of guidance counselors, lack of confidence and self-efficacy, and others are some of the significant barriers for low involvement among females, as per the literature [18], [23]–[25]. It is possible for the environment to enhance the sense of belonging among participants in engineering education by providing a sense of community for them [22], and STEM summer camps can do so.

Summer camps have a long history, with organized programs dating back more than 150 years [26], and have evolved significantly over the decades. They are used to introduce school students to STEM disciplines and are one example of creating positive perceptions, awareness, and knowledge among the participants. Numerous educators have conducted summer camps focusing on various engineering fields to deliver engineering design lessons from different branches of engineering [5], [27], [28]. Some of these camps offer their programs mainly to urban area students [28]. According to research, students who participated in science-focused summer camps were more likely to choose science and engineering as their career field than those who did not [29].

It is possible to assess a student's and community's STEM understanding by understanding their attitudes toward and understanding engineering and its careers. Therefore, these summer camps can increase the number of STEM workers and encourage participation in enrolling STEM majors [30]. There are up to 40 different engineering degrees [15], and attracting students to STEM fields is a challenge that needs to be addressed at all levels of K-12 education. Outreach programs aim to attract talented and motivated young students into careers focused on STEM [3].

Research studies show that summer academic intervention programs (Summer camps) target deserving students that are labeled as first-generation, low-income, or underrepresented [30]. In these programs, students gain the knowledge and the skills required to apply to college along with different aspects of STEM majors. Due to their funding sources and networks, these programs can provide participants with access to STEM career opportunities and opportunities in the field [30].

The discriminatory pattern of tracking students invocational, general, and college preparatory tracks has declined officially over the years, but scholars still find that students of color, girls, and women, and students with disabilities often are steered out of STEM coursework and career paths [31].

Youth development organizations have a common commitment to young people's physical, emotional, and educational growth and their communities benefit from well-designed and implemented youth-centered programs that consciously utilize a youth development model [32]. Most camp programs are considered part of the positive youth development movement and aim to offer experiences that are not only safe and enjoyable but also aid in children's progress toward adulthood [32]. Research on gender differences in education and associated outcomes within racial and ethnic groups can help us better understand differences in educational attainment and opportunities [31]. Thus, indicating the need to analyze the diversity of STEM summer camp attendees within the US.

Research Methodology

Three-staged linear research was developed to determine the diversity among attendees of STEM summer camps in the US. The linear stages included sample selection, parameter development, and descriptive statistical analysis. In the first stage, the research team selected the sample of articles that were analyzed. The sample selection was determined by pre-determined factors developed by the research team and included 1) Articles published in 1998 - 2017 and 2) articles published in ASEE as one of the prominent education avenues for education. The application of the factors resulted in the identification of 729 articles. From the initially identified list of 729 articles, 24 articles were randomly selected based on relevance to summer camps within the US. The research team developed a comprehensive list of twelve parameters in the second phase. The twelve parameters included "population, race, gender, age, targeted population, framework, theories used, context, learning outcome, delivery method, effect, and duration," as they are an integral component of any summer camp. Race, gender, age, and targeted population were used as they formed the scope of this research as they are essential to identifying the diversity of STEM summer camp attendees in the US. After identifying the parameters in the third phase, they were used as the unit of analysis for the identified 24 articles. All compiled data were subjected to descriptive statistical analysis to determine the participant demographics of the summer experiences.

Results and Discussion

This study includes the responses of 1795 middle and high school students who participated in 38 camps. Forty percent of the camp participants were identified as female, fifty-three percent as males, and seven percent provided no gender information (non-conforming), as indicated in Table 1.

Table 1. Participants gender

No gender information	Female participants	Male participants	Total
127 (7%)	716 (40%)	952 (53%)	1795 (100%)

Regarding the audience of the summer camps, the majority targeted both genders and only 13.2% of the summer camps targeted “only females” (Table 2).

Table 2. Camps targeted population

Camps targeted both (female/male)	Camps targeted females (only)
33 (86.8%)	5 (13.2%)

From the perspective of ethnicity, a significant number (79.4%) either chose not to specify their ethnicity/race or the camp didn't collect this type of information in their surveys. Approximately 13.1% identified as Underrepresented and minorities (Table 3).

Table 3. Participant race

Underrepresented participants							White	No race provided	Total Participants
American Indian	Asian	African American	Hispanic	Pacific Islander	Minority not defined	Total underrepresented			
4 (0.1%)	22 (1.1%)	55 (2.7%)	122 (6.1%)	0 (0%)	66 (3.1%)	269.36 (13.1%)	117 (7.5%)	1408 (79.4%)	1795 (100%)

Student selection criteria are vital as they can determine who can be impacted by the intervention (Summer Camps). However, most camps didn't provide selection criteria to accommodate the goal of reaching underrepresented students. At the same time, only 13% of summer camps mainly targeted underserved populations (Table 4).

Table 4. Participant economic status

Summer camps targeted economically disadvantaged	Number of summer camps	Total number of summer camps
5 (13%)	33 (87%)	38 (100%)

The data analysis also indicated that the ratio of camps to the camps that tried to target/ or targeted racial and ethnic minorities is almost 3:1. This means that for every three camps, one targeted racial and ethnic minorities (Table 5).

Table 5. Camps have tried to target/or targeted the under-represented groups

Number of summer camps	Summer camps have tried/targeted racial and ethnic minorities
38	13 (34.2%)

From the perspective of participant age groups for the summer camps, a significant percentage of identified attendees (almost 90%) were high school students (Table 6).

Table 6. Camp age groups

Teachers	University	High school	Middle school	Elementary school
0 (0%)	0 (0%)	34 (89.5%)	4 (10.5%)	0 (0%)

Conclusion

There is no better time than summer to increase children's awareness of careers and increase their knowledge about them. Across the country, students lack resources and opportunities to pursue careers in science, technology, engineering, and mathematics (STEM). As part of this study, the outcomes of population, race, gender, age, and targeted population were used to develop the article. The summer camps included various learning environments ranging from traditional classroom teaching with little interaction, to group discussions about concepts and hands-on demonstrations. Many activities were conducted to increase general awareness of different (STEM) aspects and to increase the awareness of students and parents of the specific opportunities available to study different engineering disciplines.

A number of important trends were observed among the twenty-four camps that should be noted. The gender gap between participants was not significant, with forty percent of participants identified as female, and fifty-three percent as male. Nearly a third of the camps addressed minorities of race and ethnicity. Almost thirteen percent of the camps targeted economically disadvantaged students, and the focus of summer camps was on high school students.
Summer camps provide students with an increased understanding of engineering disciplines. However, the more in-depth lab activities may help solidify students' decisions to major in engineering.

Limitations and future research

The number of no-race-provided participants is high (which means the number of minority participants could be higher) which impacts determining how under-represented communities were impacted further, it is presumed that summer camps had a positive impact on participating students' academic careers. However, the actual extent of the improvements and the duration for which the improvements are retained by the participants are unknown and have not been identified by any of the research. Future longitudinal research can investigate the information retention information among the participants along with the impacts on the careers of the participating students.

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