Evaluating the Impact of a Summer Engineering Program Using the National Student Clearinghouse (Evaluation of Program)

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Introduction

STEM education, encompassing science, technology, engineering, and mathematics, is crucial for elementary and secondary students. It plays a pivotal role in cultivating vital skills like critical thinking, teamwork, and creativity, preparing students for the demands of a competitive 21st-century society. This holistic educational approach equips students with the essential knowledge and abilities needed to navigate future global challenges.

The pursuit of a STEM degree offers students, especially those from disadvantaged backgrounds, opportunities for economic mobility. However, there is a pressing need to attract underrepresented minority and first-generation college students to STEM disciplines, as current representation from these groups remains low [1]. An obstacle to the production of STEM graduates in the United States is the challenge to develop students' interest in math and science [2]. In many K–12 systems, there is a disconnect between math, science, and other disciplines, to the real world and students often fail to recognize the links between their studies and potential STEM careers [2].

One way to foster students' interest in math and science is to use informal learning to connect these subjects to real-world contexts and careers [2]. By engaging students and teachers in activities outside the traditional classroom, they can develop their skills and see the relevance of math and science to their lives. Research has shown that such programs can have a positive impact on STEM interest and achievement [2].

Increased enrollment in STEM education courses has been linked to several positive outcomes, including a higher likelihood of choosing a STEM major, earning a degree in a STEM field, and pursuing a career in a STEM-related field [2],[3],[9]. This correlation underscores the importance of early exposure and engagement in STEM education for shaping students' academic and career trajectories. By actively participating in STEM courses, students not only develop foundational knowledge and skills, but a deeper interest and passion for STEM disciplines, thereby influencing their academic and professional choices in the future. Furthermore, the findings from Shaw and Barbuti' (2010) highlight the influential role of high school performance in science and math in shaping students' persistence in STEM majors at the college level [4]. Strong performance in these foundational subjects not only indicates a solid grasp of fundamental STEM concepts, but also reflects students' dedication and commitment to pursuing STEM-related fields. This underscores the importance of early academic preparation and support in fostering a conducive environment for students to thrive in STEM disciplines throughout their educational journey.

Additionally, short-term STEM program interventions, ranging from 2 to 5 weeks, have demonstrated significant impacts on student achievement [5]. These brief interventions provide students with focused learning experiences and hands-on opportunities to engage with STEM

concepts, resulting in measurable improvements in academic performance and conceptual understanding. Such interventions play a crucial role in supplementing traditional classroom instruction and addressing gaps in STEM education, exposure, and aspirations particularly among underrepresented student populations.

Background

This paper evaluates a summer engineering program whose aim is to ignite the interest and curiosity in STEM disciplines, particularly among underrepresented student groups. The program addresses the challenge of exposing students to STEM education through a multifaceted approach, providing a comprehensive three-week exploration of science, technology, engineering, and mathematics. This initiative actively engages secondary education students in daily hands-on engineering design activities, facilitated by mentor teachers. By combining theoretical learning with practical application, the program cultivates a deeper understanding of STEM principles and fosters a passion for these fields.

In 2015, the program attracted over 3,400 registered participants across ten different cities in the United States, including Atlanta, GA; Birmingham, AL; Boston, MA; Detroit, MI; Harrisburg, PA; Houston, TX; Jackson, MS; Los Angeles, CA; New Orleans, LA; and Denver, CO. Facilitated by 220 mentors/instructors, the program's curriculum emphasized active learning and inquiry-based learning experiences. These mentors, many of whom were engineering majors, were dedicated to promoting professional excellence and community engagement through their work with the students.

The breakdown of the 2015 participants by grade level and race/ethnicity illustrates the program's diverse reach and inclusive nature, with a significant representation from various backgrounds. This diversity enriches the learning experience and underscores the program’s commitment to equity and accessibility in STEM education.

Table 1

Grade	Boy	Girl	Grand Total
3rd grade	383	492	875
4th grade	586	692	1278
5th grade	479	574	1053
6th grade	104	66	170
8th grade	43	45	88
Grand Total	**1595**	**1869**	**3464**

Table 2

Race/Ethnicity	Count	Percent
American Indian or Alaska Native	25	0.7%
Asian	36	1.0%
Black or African American	2910	84.0%
Hispanic or Latino	333	9.6%
Native Hawaiian or Other Pacific Islander	10	0.3%
Other	80	2.3%
White	70	2.0%
Grand Total	**3464**	**100.00%**

Purpose of the Study

The purpose of this study is to explore the educational journey of summer engineering program participants by investigating their college attendance and enrollment in STEM and other degree fields. Understanding these aspects is essential, as college attendance, persistence, and graduation are key educational outcomes evaluated by researchers, educators, and policymakers to assess the impact of education [6].

Utilizing data from the National Student Clearinghouse, this paper delves into the undergraduate pathways of participants who attended a 2015 engineering summer camp. The analysis focuses on various factors such as academic major, institutional type, and demographic information to provide comprehensive insights into the educational trajectories of these individuals. By examining these elements, the study aims to contribute valuable information to the broader understanding of the impact of educational interventions, particularly in the context of STEM programs and initiatives.

Observing these pathways and where they lead can help better understand access to higher education and how we might improve it. Additionally, examining the enrollment patterns in STEM fields can provide insights into the effectiveness of similar programs in encouraging students to pursue STEM education. The findings of this study can inform policymakers, educators, and program administrators about the effectiveness of STEM initiatives and interventions aimed at underrepresented student populations.

Methods

The National Student Clearinghouse is a nonprofit organization established to provide directory information about students, including enrollment and degree verification within the higher education student population [5]. Serving over 1,000 institutions, it encompasses more than 92 percent of the nation's students and over 90 percent of both 2-year and 4-year institutions [7].

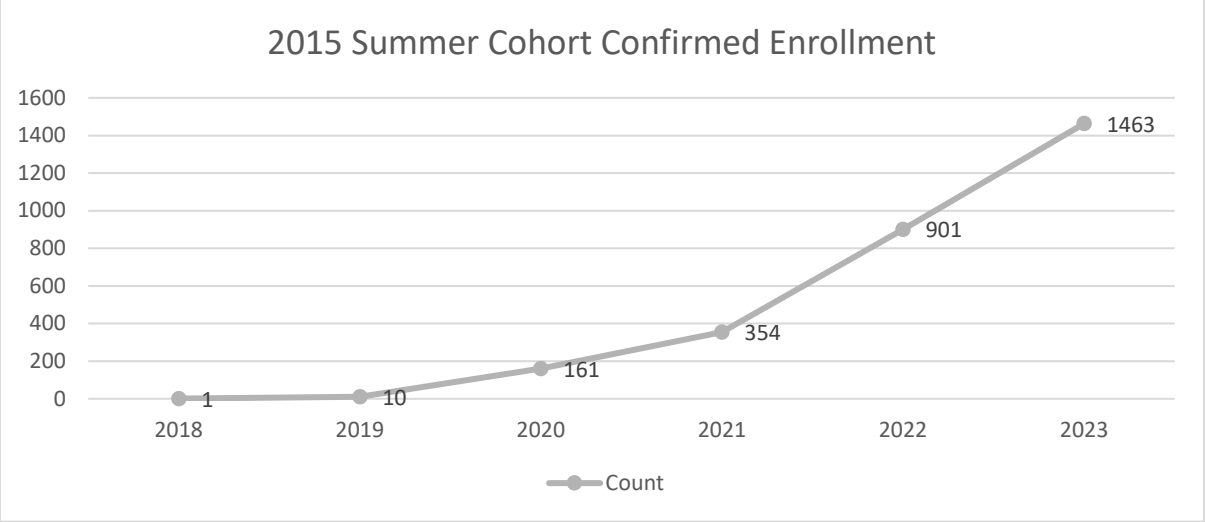
Data is returned through StudentTracker, which empowers institutions to enhance their measurement of educational outcomes by tracing students across institutions using the NSC enrollment and degree database [7]. The NSC supplies directory information on students who have not opted out of having their information disclosed. The file contains various data elements, including details on the institution of enrollment, enrollment dates, degrees earned with corresponding dates, as well as information on majors and class standing.

Information that NSC uses to match student records are students' names and date of birth. Thus, a file with 2589 names and birthdates of 4th, 5th, 6th and 8th, grade students who participated in summer 2015 was sent to NSC. NSC then returned a file of enrollment information of those students searching for records beginning August 1, 2015 and forward. The data file was then joined with participant program information. Students that were in 3rd grade at the time of the 2015 camp were excluded as it was estimated that they were less likely to have matriculated to college within 8 years. The clearinghouse then returned the enrollment information NSC returned a file of 1564 records as of January 30th, 2024 indicating a match rate of approximately 60 percent. Though this paper references that at least 60% percent of students enrolled in post-secondary education, the estimate could possibly be higher due to the impact of blocked records or incorrect names or birthdates.

Results

Descriptive analysis was performed to ascertain the enrollment status of participants from the 2015 camp, along with institutional types and fields of study. As previously indicated, it was found that 60% of students had enrolled in college. Remarkably, the first record of enrollment in post-secondary education occurred in 2018, merely three years after participation in the enginnering camp, with enrollment records continuing through 2023. The figure below illustrates the ongoing college matriculation trend up to 2023 (Figure 1).

Figure 1



Notably, over 60% of female students enrolled in either a 2-year or 4-year college, whereas approximately 53.6% of male students did the same. Regarding race/ethnicity, statistics indicate that 61.8% of Black students, 56% of Asian students, and 48.6% of Latino students enrolled in post-secondary education by January 2024. Additionally, detailed breakdown by grade level reveals that a majority of 5th and 6th graders (64% and 65%, respectively) enrolled in college, while the enrollment rate for 8th graders was notably lower at 44% (Table 3).

Table 3

Enrollment by Demographic	**Any college**	
	n	%
Proportion enrolling in	1564	60.4%
Sex		
Female	902	65.5%
Male	649	53.6%
Race/Ethnicity		
American Indian or Alaska Native	9	45.0%
Asian	14	56.0%
Black	1352	61.8%
Hispanic or Latino	117	48.6%
Native Hawaiian or Other Pacific Islander	3	50.0%
White	19	41.3%
Other	37	60.7%
Grade at time during camp		
4th grade	724	56.7%
5th grade	677	64.3%
6th grade	111	65.3%
8th grade	39	44.3%

The analysis further indicates that a majority of students, accounting for 73%, opted to enroll at 4-year institutions. The attendance of students were across various institutions, including minority-serving institutions. Approximately 34% enrolling at Historically Black Colleges and Universities (HBCUs), 36% at Hispanic-Serving Institutions (HSIs), and 30% at other minority-serving institutions (Table 4).

Table 4

Institutional Enrollment and Major	**Any college**	
	n	%
Proportion enrolling in		
Any college	1564	60.4%
Institution type		
4-year college	1297	82.9%
2-year college	590	37.7%
MSI status		
Historical Black College or University	527	33.7%
Hispanic Serving Institution	568	36.3%
Other Minority Serving Institution	472	30.2%
Discipline		
STEM Field	309	28.2%

In terms of academic majors, it is noteworthy that just under a third of students (28%) enrolled in a STEM discipline. The top STEM field majors include: Biology (n= 106), Mechanical Engineering (40), Computer Information Sciences (n = 31), Computer Science (n = 28), and Civil Engineering (n= 16). However, General Studies (n= 132) and Liberal Arts (n= 120) emerged as the most commonly chosen majors (Table 5). This observation may suggest that students have not yet accumulated sufficient academic credits to enroll in their primary college or major.

These descriptive findings offer insights into the enrollment patterns and academic pursuits of camp participants, shedding light on their educational trajectories and preferences. Such information is instrumental in informing future program developments and interventions aimed at enhancing college access and success among underrepresented student populations.

Table 5

Top 30 Enrolled Majors in 2023	Total
General Studies.	132
Biology/Biological Sciences, General.*	106
Liberal Arts and Sciences/Liberal Studies.	83
Business Administration and Management, General.	78
Psychology, General.	65
Nursing/Registered Nurse	43
Mechanical Engineering.*	40
Liberal Arts and Sciences, General Studies and Humanities, Other.	37
Computer and Information Sciences, General.*	31
Kinesiology and Exercise Science.	29
Computer Science.*	28
Business/Commerce, General.	22
Finance, General.	22
Marketing/Marketing Management, General.	22
Political Science and Government, General.	19
Sport and Fitness Administration/Management.	19
English Language and Literature, General.	18
Civil Engineering, General.*	16
Engineering, General.*	16
Criminal Justice/Safety Studies.	14
Drama and Dramatics/Theatre Arts, General.	14
Health and Physical Education, General.	13
Multi-/Interdisciplinary Studies, Other.	13
Economics, General.	12
Journalism.	12
Communication Studies/Speech Communication and Rhetoric.	11
Physical Education Teaching and Coaching.	11
Accounting.	10
Chemistry, General.*	10
Other majors	511
Total	**1457**

*Denote STEM major

Discussion

The analysis of data from the 2015 camp reveals significant trends in post-secondary enrollment and degree completion among participants. Out of over 2500 students who attended the camp, over 1500 have enrolled and 1463 were enrolled in post-secondary education in 2023, indicating a high rate of college enrollment among participants.

Furthermore, an examination of the top degrees pursued by participants in 2023 reveals a diverse range of fields. The most commonly pursued degrees include General Studies, Biology, Liberal Arts, Business Administration, and Psychology. While these fields offer valuable opportunities

for academic and professional growth, the absence of significant representation from STEM disciplines suggests a need for further exploration. As aforementioned, the large representation of General Studies and Liberal Arts is possibly due to those who are undeclared or have not formally matriculated to their aspirational degree programs due to lack of academic units earned. This will be monitored in future inquiries.

Overall, the results highlight both successes and challenges in the educational trajectories of program participants. The high rate of post-secondary enrollment demonstrates the program's effectiveness in facilitating access to higher education, the lack of STEM degree attainment underscores the importance of targeted efforts to encourage and support participation in STEM fields among underrepresented student populations. These findings provide valuable insights for policymakers, educators, and program administrators seeking to enhance the impact of STEM initiatives and promote equitable access to educational opportunities for all students.

Conclusion

This summer engineering program is designed to offer underrepresented students access to a STEM curriculum, and to introduce and encourage students to purse engineering careers. The current research investigates the efficacy of Summer 2015 participants, by leveraging data from the National Student Clearinghouse (NSC). The NSC acts as a central repository for student enrollment and degree information from participating institutions across the country, including colleges, universities, and other post-secondary educational organizations. Its primary purpose is to provide accurate and timely information about student enrollment, degree completion, and other academic achievements [8].

This study employs an analysis to track 2500 participants' educational pathways almost 8 years post-participation. The National Student Clearinghouse's comprehensive dataset enables the assessment of college enrollment, retention, graduation rates, and career choices in STEM fields among program alumni. By examining the Clearinghouse data in conjunction with program participant information, this study quantitatively evaluates the program's efficacy. While exposure to STEM education at an early age can increase the likelihood of college enrollment and pursuit of STEM careers [9], there are still challenges that need to be addressed to make STEM education more equitable and effective. The research outcomes are expected to inform program development, facilitating evidence-based improvements, and assist in advocating for resources and funding to support the program's expansion and sustained impact.

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