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Leveling the Playing Field: A Virtual Summer Camp for Women of Color

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Leveling the Playing Field:
A Virtual Summer Camp for Women of Color

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Abstract

People of color are underrepresented in science, technology, engineering, and mathematics disciplines (STEM). The number is even smaller for women of color who enter into STEM fields. Based on current projections, it is estimated that by the year 2044, underrepresented minorities (Black, Hispanic, LatinX and American Indian) will comprise over 50% of the overall population in the U.S. However, underrepresented minority (URM) youth lag significantly behind their white and Asian American counterparts in their interest in STEM. Lower representation of URMs in STEM can be attributed to a variety of factors including, a lack of institutional commitment, a lack of representation throughout students' upbringing, ineffective cultural recruitment/outreach efforts, educational discrepancies throughout PK-12, and social expectations, among others. A large portion of government efforts to address this problem focuses on initiatives and training to overcome negative perceptions and attitudes towards STEM and entice more URM youth into STEM pathways. For the United States to maintain a competitive position in innovation and technology, the disparity must be reduced.

The Women of Color Summer Engineering Camp (WOCSEC) was developed to address the disparity. The camp was composed of six outreach components to provide engaging, critical thinking and uplifting experiences for all its participants. The components include: Engineer Spotlight Interview; Engineering Design Challenge; Empowerment Session; Design Lab; Interactive Forum and Panel; and College Readiness.

Due to Covid-19 the camp was transformed from an in-person face to face experience to a virtual experience. Online learning is an effective method of instruction, provided that devices and technology platforms are accessible and screen time is monitored and limited. WOCSEC includes workshops for standardized testing, the college application process, scholarship resources, shadowing opportunities, summer internships and the required high school courses required of most collegiate engineering programs. Students were given a pre-survey the first day of the camp to assess their attitudes and perceptions towards entering STEM fields. In an effort to measure student's change in perception, students completed a post survey. In addition to the pre-post survey, a semi-annual quantitative and qualitative inquiry tool will be administered to camp participants throughout high school to measure their interest in engineering, intent to major in STEM and overall college readiness. In this paper we will describe how the program was implemented, the experience of the participants and share the data from the pre-post survey.

Keywords: *pre-college, gender, race/ethnicity, engineering*

Introduction

Creating equitable access to science, technology, engineering, and mathematics (STEM) education and career opportunities should begin at a pre-college level in order to reduce gender gaps and racial/ethnic disparities. The United States government has invested in STEM disciplines to address the low presence of URMs (African Americans, Hispanics, and Native Americans, Pacific Islanders) in STEM fields and the STEM workforce [1]. STEM is predominantly white, with more than 50% enrollment in post-secondary institutions conferring undergraduate and graduate degrees as of 2014 compared other an ethnic and racial group combined [1][2][3]. Lower representation can be contributed to numerous factors, including a lack of institutional commitment, a lack of representation throughout students' upbringing, inappropriate cultural recruitment/outreach efforts, educational discrepancies throughout PK-12, and social expectations among others [4]. In addition, it is observed that females pursue STEM at a lower rate than males, especially females of color, and it is disproportionate in engineering fields [1]. For the United States to maintain a competitive position in innovation and technology, the disparity must be reduced.

To increase access and representation for underrepresented groups, it is important to address recruitment and outreach efforts. The aim of this paper is to provide insight to the effects of a pre-college outreach program on female students of color interest and intent to major in engineering and applied science, while providing proper representation and an inclusive environment which are not always seen in PK-12 STEM education.

The pattern of lower representation of underrepresented groups in STEM is seen not only in people who chose a science-oriented career but also on their performance in science courses ranging from elementary school to post-secondary schools. Minorities have always shown less interest and achievement in the science community [5] [6]. Educational researchers and anthropologists have observed the culture of STEM education and noted that it is mostly best suited for white males than other ethnic groups.

For the United States to maintain a competitive position in innovation and technology, the disparity must be reduced. A more racially and culturally diverse STEM community fosters different perspectives that impact the way research is done and creates opportunities for new advances, technologies, and discoveries. The impact of low enrollment in underrepresented groups in STEM, particularly in engineering and applied science, is significant. Lower representation affects the demographic structure of the educational institution, as well as the corporation seeking to hire diverse STEM talent.

Role models and representation help students see potential in themselves, and girls who see women working in engineering careers are more likely to consider doing the same [7]. With female engineers of color occupying a small number of seats in our nation's innovation hubs, laboratories, scientific think tanks, corporate suites, and board rooms, it is challenging for young women of color to envision themselves as engineers.

Experiences, both negative and positive, can profoundly shape an individual's thoughts and ultimately who they become. Espinosa [4] examines the potential benefit of the college

experience, including experiences of women of color pursuing STEM careers. She acknowledges, like many others, that there is an issue with representation in STEM. Espinosa posed a feministic view and focused on women of color only. Exciting to note, is the effect that healthy and positive learning experiences have on students. If a student had positive educational experiences, engaged in STEM-related activities (as most STEM majors should) and created relationships with other females in STEM, the students were likely to persist in their field. The ability to create meaningful experiences to foster and cultivate STEM interest and build an early foundation in STEM is not a novel concept and one that can start as early as high school.

Experiences with STEM-related activities, during high school or formative years, also create long-lasting impact and affect a student's decision to study STEM [7][8]. Both role models and activities have positive outcomes in the persistence of minority students in STEM majors [4][7]. Educators have noted the significance of incorporating hands-on activities that encourage girls to use creativity and science to solve everyday problems. Hands-on, problem-based learning activities provide students with a unique perspective and experience on a STEM discipline, while increasing their potential to major in STEM [7][8]. Females of color are less inclined to like science and math at an early age, resulting in less girls stating they enjoy math and science as early as fourth grade [8]. A range of factors often discourage females' interest in STEM, from microaggressions from educators, family, lack of role models, to societal portrayal of girls in the media [9]. It is important to engage students in outreach efforts that include hands-on science-based challenges, that are often unavailable to them in school or in their home. Research indicates that such outreach activities involving early STEM-related activities help students select STEM majors in college [7].

Efforts to provide URM students with equal access to STEM education is essential to advancing diversity in the STEM workplace and promoting inclusion in the global economy. Diversity is needed in STEM; a more diverse environment in STEM helps increase insight, technological advancements, and discoveries as Audrey Meador [7] pointed out. However, many institutions do not have targeted recruitment and outreach efforts to attract women of color to STEM. The Women of Color Summer Engineering Camp (WOCSEC) was designed to provide a virtual outreach experience within engineering and applied science for diverse female students of color from rising 9^{th} to 12^{th} grade.

Theoretical Framework

Our perspective of education, history and society is commonly viewed through a white lens, which often diminishes the experience and contribution of people of color. This paper uses Critical Race Theory (CRT) as a framework to address why outreach programs such as the WOCSEC are critical to dismantling the barriers in STEM reinforced by institutional and systemic racism [10] [11]. As mentioned earlier, to address low representation of females of color, particularly in engineering and applied science, we must examine the relationship of race, power and STEM education. There are five major components or tenets of CRT: (1) the notion that racism is ordinary and not aberrational; (2) the idea of an interest convergence; (3) the social construction of race; (4) the idea of storytelling and counter-storytelling; and (5) the notion that whites have been recipients of civil rights legislation [10].

- *Racism is ordinary and not aberrational*- Racism is not an anomaly. To the contrary, racism is deeply embedded and normalized in social structure thereby allowing it to go unaddressed [11][12].
- *Interest convergence* -The interest of the dominant group merges with the oppressed group. In such instances, whites are commonly engaged with social justice initiatives when whites stand to benefit [10].
- *Social construction of race*- Race is a social construct created by the dominant group to perpetuate white supremacy. It is commonly recognized as categorizing individuals by social characteristics designed to label the oppressed group "different" than the dominant group, with the goal to make them inferior [10][12].
- *Storytelling and counter-storytelling*- Storytelling is the powerful sharing of experiences and stories of those people whose experiences are often excluded. This is juxtaposed with counter-storytelling which can be used to expose, analyze, and challenge narratives of racial privilege [12].
- *White recipients of civil rights legislation*- The premise that whites have benefited from policy created to bring equality to people of color [10][11].

Student retention, low representation of people of color, inadequate sense of belonging, among other issues affecting STEM education, become more complex with systemic racism [10]. Regardless of the academic level in STEM education, institutional and systemic racism affect the change and diversity that STEM Education needs to achieve equality. Critical Race Theory provides a lens for issues in STEM education to be revealed with the aim of addressing them. As mentioned above, STEM has been an area where whites have benefited from policies and programming aimed to address the low representation of Blacks, LatinX/Hispanics, Native American and Pacific Islander. Increased diversity initiatives have allowed white female students to gain access to disciplines historically dominated by white males. New initiatives to increase female representation in engineering have been impactful, but females of color have been disproportionately affected by such initiatives.

Narratives are important as they share the experiences of others. Due to socialization established in our society, STEM education has excluded people of color [10] [11]. To increase the number of people of color in STEM fields, it requires a change of narrative both at the academic and social level. The stories shared in the classroom are impactful. Depending on the narrative, a particular story could convey a message that people of color do not belong in the engineering field. In addition, such narratives may create stereotypes that educators continue to perpetuate. WOCSEC provided a safe place for female engineers of color to act as storytellers as they shared their experiences while in college and in their careers. Their stories were impactful and provided a space for counter-narratives that were rich with authentic discussions regarding the realities of matriculating as a female of color in engineering.

University Initiative

In 2018, the University of Cincinnati adopted a strategic plan with three major platforms: academic excellence, urban impact, and innovation agenda. Each platform is supported by

directives to promote diversity and inclusion. In support of the University's inclusive excellence and urban impact platforms, the University of Cincinnati College of Engineering and Applied Science developed WOSEC, the first camp of its kind for female high school students of color. Specifically, WOCSEC serves as an outreach initiative that aims to increase female students of color intent to major in engineering and applied science by providing hands-on activities and critical thinking challenges, as well as hosting empowerment sessions and exposure to female engineers and scientists of color. With most camp participants residing near campus, WOCSEC relates to the urban impact platform as the institution works to increase its physical, social, and economic connection to the surrounding community. Increasing the number of females of color in underrepresented fields like engineering and applied science, not only promotes diversity and inclusion in the STEM workplace but also creates social mobility to community members. The aim of WOCSEC is to create a pipeline of students positioned to study engineering in college and to embark on successful engineering careers. WOCSEC aligns with the University's strategic plan to create change: providing access, increasing representation, and empowering the community through social mobility.

Participants

The 2020 WOCSEC was the first engineering camp of its kind offered by the University of Cincinnati for female high school students of color. The camp was advertised as a free, five-day summer camp (Monday through Friday) located at the University of Cincinnati, with an over-night residential option for those students who lived more than fifty 50 miles from campus. Marketing consisted of sharing camp details with high school students, counselors, and teachers, as well as utilizing social media. Interested students were required to complete an on-line application. Thirty-eight (38) rising high school 9th through 12th grade female students applied to attend the camp.

As a result of COVID-19, the University of Cincinnati required all summer camps to be cancelled or held virtually. The decision was made to host the camp virtually. Each student and their parent received notification of the change to a virtual format. Of the 38 students who registered, a total of 27 students participated in the camp. Prior to the start of camp, each student received a package which included a welcome note, drawstring backpack, camp shirt, college brochure, and products related to a planned activity.

The camp participants self-reported an average GPA of 3.73 (4.0 scale). The high school level of the students is set forth in Figure 1 below.

High School Level	Number of Students	Percentage
Freshman	6	22%
Sophomore	5	19%
Junior	7	26%
Seniors	9	33%

Figure 1. High School Level of Camp Students

The race and ethnicity of the students is set forth in Figure 2 below.

Race/Ethnicity	Number of Students	Percentage
African American or Black	21	78%
Asian or Asian American	4	15%
Hispanic or Latinx	2	7%

Figure 2. Race and Ethnicity of Camp Students

The camp participants attend nineteen different high schools. 14 of the students attend public school, 9 attend private school and 4 of the students did not disclose their school they attend. The majority attend schools located in Cincinnati, Ohio, and surrounding cities such as Wayne and Dayton. A few students attend high schools in Cleveland and Columbus, OH with 1 student from Washington, DC.

Format

Virtual camp instruction requires internet access, scheduled "down time" to eliminate excessive screen exposure, and the integration of highly interactive instructional tools and components to maintain student engagement. Research indicates that on-line learning can be an effective method of instruction, provided devices and technology platforms are accessible and screen time is monitored and limited [13]. To ensure accessibility, prior to the start of the camp, each student completed a survey regarding laptop or desktop computer access, as well as internet access.

To balance screen time, the camp included a two-hour morning and a two-hour afternoon segment. A two-hour lunch break was scheduled between the morning and afternoon segments. "Brain Breaks" were incorporated throughout the day to allow students to pause and shift attention away from the screen. A representative camp schedule is set forth in Figure 3.

Morning Segment	Activity
9:00 am – 9:15 am	Welcome/Engineering Overview
9:15 am – 9:55 am	Engineer Spotlight Interview
9:55 am – 10:00 am	Brain Break
10:00 am - 10:30 am	Design Challenge
10:30 am - 11:00 am	E- Moment of Empowerment
11:00am - 1:00 pm	Lunch Break
Afternoon Segment	Activity
1:00 pm - 2:00 pm	Design Lab/College Readiness Workshop
2:00 pm – 2:05 pm	Brain Break
2:05 pm - 3:00 pm	Forum and Panel Discussions

Figure 3. Representative Camp Schedule

The following on-line platforms and tools were utilized as a method to support camp assignments and deliver daily instruction:

Webex – Webex is an on-line platform, utilized by our university, to host real-time, virtual meetings and large-scale virtual events. Webex Events, a tool offered by Webex, provides access to features such as web-polling, Q&A, and chat. By utilizing WebEx Events our students were

able to participate in fun and interactive polling, post questions to instructors, as well as chat with participants.

Canvas – Canvas is an on-line course management system, utilized by our University Professors, to post grades, class information, and assignments for enrolled students. Each camp participant received a Canvas account which allowed them to access daily camp schedules, assignments, and tasks.

Flipgrid – Flipgrid is a website that allows students to post video content that appears in a tiled grid display. Students utilized Flipgrid to upload their *Engineer Your Vision* video assignments which were viewed on the last day of camp.

Both the camp schedule (Figure 3) and on-line platforms were shared with parents and students during the virtual camp orientation held one-week prior to the start of camp.

Components

Careful consideration was taken to incorporate camp components that provide instruction; maximize engagement; encourage critical thinking; integrate hands-on learning and create a fun, uplifting experience to empower young women. WOCSEC included 6 components: Engineer Spotlight Interview; Engineering Design Challenge; E-Moment of Empowerment; Design Lab; Interactive Forum and Panel; and College Readiness.

Engineer Spotlight Interview - Each morning began with an Engineer Spotlight Interview with a female engineer of color. The engineer acted in the role of a mentor and supporter, as they shared their stories of resilience and success, along with aspects of their careers, such as their current research, as well as how their job impacts society [7]. The interview was an optimal method to successfully engage and inspire the students to recognize the diverse and fulfilling experience awaiting them in engineering. For example, an engineer explained how she used her love of math and engineering background to become an expert in the financial industry. On another day, an engineer shared how her passion for coding fueled her desire to create a tech camp for girls, while studying for her doctorate in human computer interaction. The daily interviews of female engineers of color provided a sense of belonging and allowed the students to envision themselves in various engineering careers.

Engineering Design Challenge - To counter early societal messages about females in the engineering workplace, each morning included a Design Challenge. The challenges encouraged the students to use problem-solving skills, engineering concepts and science fundamentals. For example, a civil engineering assignment required the students to design a shake table to assess durability during a potential earthquake. A shirt-folding activity involved the development of a quality control system to design the most efficient method for folding to maximize space. The engineering design challenges allowed the students to fully conceptualize how engineers solve everyday problems with innovative solutions [7].

E-Moment of Empowerment - To cultivate students' engineering interest and affirm their ability to succeed, each morning segment included an E-Moment of Empowerment Session. Experts

from around the country shared inspirational messages of courage and resilience which are essential to build confidence and affirm their abilities. For example, an engineer shared her experience as a college drop-out and how she became a dean of a college of engineering. On another day, an emotional intelligence expert shared the importance of building strong social skills, practicing self-awareness and self-advocacy as women of color in a white, male dominated industry. These sessions were designed to build students' confidence and create an expectation of success [14].

Design Lab - Each afternoon segment began with an activity in the Design Lab. In the Lab, students were presented with a hands-on activity which correlated to an earlier discussion during the Engineer Spotlight Interview. For example, during a morning Engineer Spotlight Interview, an engineer and scientist from a manufacturing company, shared their research, science, and development for a leading hair shampoo. During the Design Lab, the students were asked to design a marketing plan for a beauty product, followed by product testing and development. The assignment required the students to analyze the complexities in creating a product, by applying chemistry, engineering design, art, and marketing concepts. On another day, students participated in a coding challenge which related to an earlier discussion led by an engineer who works in the technology industry. The Design Lab experience provided students with a glimpse of how an engineer's research and design may lead to the production of a product that is seen on major retail store shelves or the creation of computer coding language to interface with everyday gadgets [15].

Interactive Forum and Panel - Research indicates that girls who see women working in engineering careers are more likely to consider doing the same [7]. With female engineers of color occupying a small number of seats in our nation's innovation hubs, laboratories, scientific think tanks, corporate suites, and board rooms, it is challenging for young women of color to envision themselves as engineers. To remove this barrier, each afternoon segment included an Interactive Forum and Panel dedicated to preparing high school students to become engineering students and to embark on successful engineering careers. For example, students had the opportunity to talk with female college students about succeeding in the college environment as one of only a few females in a math class or science lab. Female engineers, with a wide spectrum of backgrounds and career experiences, shared their difficult but successful journeys in college and as corporate professionals. The conversations that transpired during the panels, provided the students with a realistic picture of the challenges and a road map to a successful journey [16].

College Readiness - Educators have shared that college preparedness is essential for female women of color who intend to major in engineering [17]. Our College Readiness Workshop included a session designed specifically for rising 9th and 10th grade students and a separate workshop for rising 11th and 12th grade students. The workshops included information regarding standardized testing, the college application process, scholarship resources, shadowing opportunities, summer internships and an overview of high school math, chemistry and physics courses required for admission to most collegiate engineering programs.

The final day of camp was devoted to individual student presentations titled "Engineer Your Vision." "Engineer Your Vision" was an opportunity for students to utilize *Flipgrid* and vision boards to share their vision for their future including college choice, major, and career goals.

Vision boards are a creative tool to promote communication and identification of future goals utilizing images and words that spark motivation, values, goals, or dreams [18]. Parents were invited to watch presentations. For example, one student shared her plans to study chemical engineering at University of Cincinnati, along with the university mascot. She concluded her presentation with her dream job as a chemical engineer at a leading cosmetic company. The vision board project allowed the students to verbalize their future and to visualize their success as engineers.

Positionality

The following research was conducted by three females of color, all with STEM backgrounds. Each researcher brings their unique experiences and insight into this study. The first researcher is a biomedical engineer, first Black woman to receive her doctorate in Biomedical Engineering at her institution, an academic, activist and educator. The second researcher is a Black woman with a degree in electrical engineering and a law degree. Both researchers are active in their community and understand first-hand what it is to be a female of color in engineering. The third researcher is a bilingual Latina scientist turned educator, who acknowledges experiences of inequities of being a female of color in STEM.

Results

A mixed method approach of qualitative and quantitative survey methods was used to assess the impact and effectiveness of the camp. It is acknowledged that all the students did not respond to each of the survey questions.

Prior to camp, students were emailed a series of 6 statements (Figure 4) and were asked to indicate their degree of agreement with or endorsement of the statement utilizing a Likert Scale with continuum responses from “Strongly Disagree to Strongly Agree”. At the completion of the camp, the students were asked to indicate their responses to the same 6 statements.

Statements
I know what engineering is.
I am familiar with or know female engineers who look like me.
I understand why it is important for women of color to become an engineer.
I know the requirements needed to be admitted to college to study engineering.
I want to study engineering in college and become an engineer.
I know the type of engineer I want to be.

Figure 4 Survey Statements Regarding Engineering

Quantitative Data -The students’ responses to the above 6 statements formed the quantitative pre- and post-camp assessment survey responses, set forth in Figures 5 through 10 below.

Prior to camp, the participants response to the statement “I know what engineering is” was as follows: 4% strongly agree, 80% agree, 4% neither agree or disagree and 12% disagree. After camp, it was observed that 47.1% agree and 52.9% strongly agree with the previous statement

(Figure 5). The second statement "I am familiar with or know female engineers who look like me" received the following response before participants attended camp: 26.90% strongly disagree, 42.31% disagree, 3.85% neither agree or disagree, 23.10% agree and 3.90% strongly agree. After participation in camp, the response to the second statement showed an increase in strongly agree and agree, 29.40% and 70.60% respectively, with 0% in the neither agree or disagree, disagree, and strongly disagree categories (Figure 6).

The importance of representation was assessed in the statement "I understand why it is important for women of color to become an engineer." Before camp, participants responded as follows: 3.90% disagree, 42.30% agree, and 53.90% strongly agree. After camp, 41.20% agreed and 58.80% strongly agreed with the statement "I understand why it is important for women of color to become an engineer" (Figure 7). Participants' college readiness was observed in Figure 8 through the statement "I know the requirements needed to be admitted to college to study engineering". Prior to attending camp, 7.70% strongly disagree, 46.20% disagree, 3.90% neither agree or disagree, 34.60% agree and 7.77% strongly agree. It was noted that after camp, the result to the previous statement shifted to 5.90% neither agree or disagree, 35.30% agree and 58.80% strongly agree (Figure 8).

Participants' intent to pursue engineering was observed in the statement "I want to study engineering in college and become an engineer." The survey data was reported before the camp as follows" 3.60% strongly disagree, 15.40% disagree, 19.20% neither agree or disagree, 35.60% agree and 26.90% strongly agree. Post- camp survey date showed 5.90% strongly disagree and disagree, while 23.50% neither agree or disagree, 17.70% agree and 47.10% strongly agree to the statement "I want to study engineering in college and become an engineer" (Figure 9). The last statement in the pre-and post-camp survey was "I know the type of engineer I want to be" which showed 23.10% disagree, 30.80% agree and 19.20% strongly agree before camp; while the post-camp survey demonstrated 17.70% disagree, 58.80% agree and 23.53% strongly agree (Figure 10).

Figure 5. Pre-and post-survey results for the statement "*I know what engineering is.*"

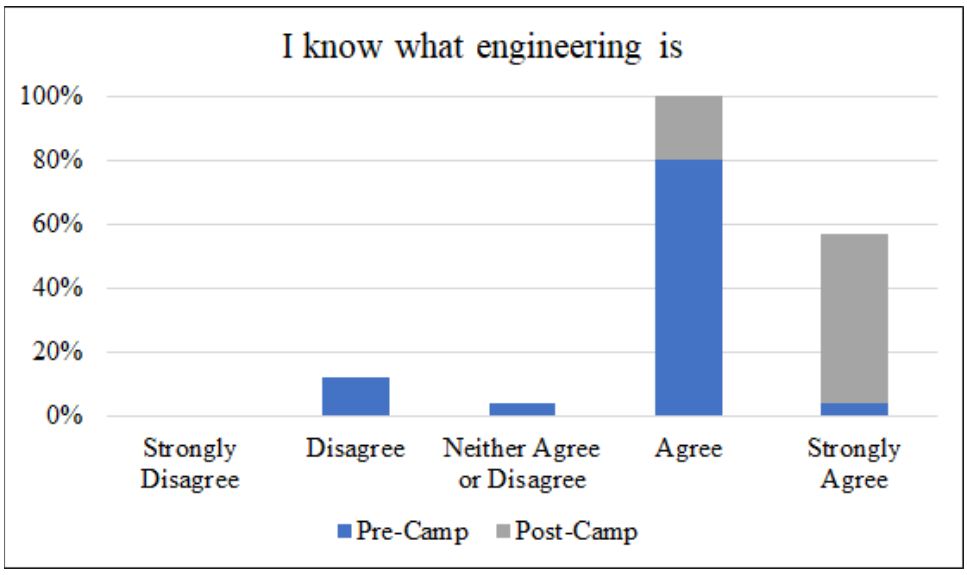


Figure 6. Pre-and post-survey results for the statement *"I am familiar with or know female engineers who look like me."*

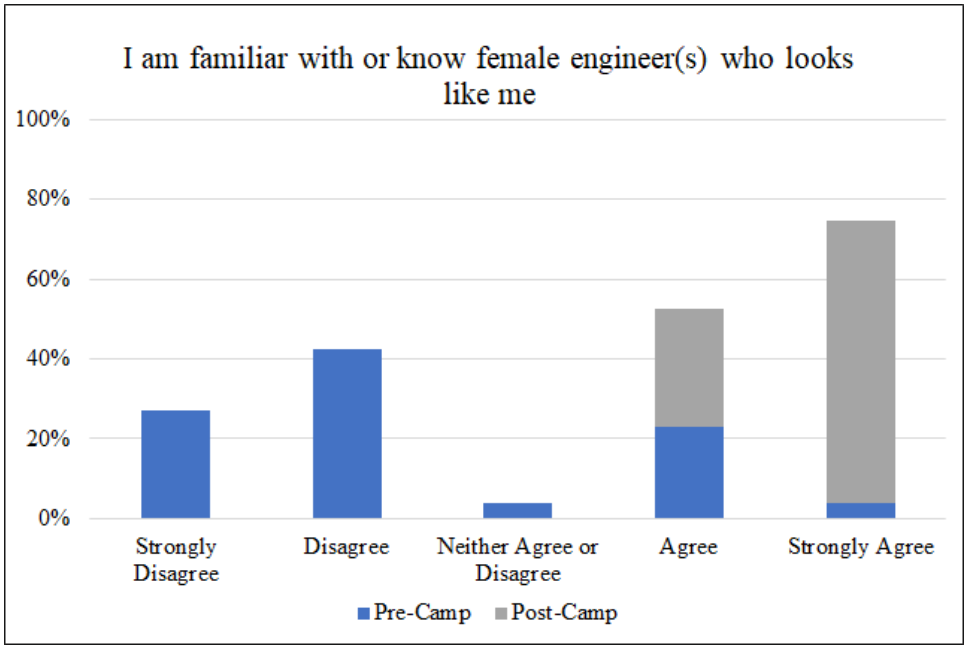


Figure 7. Pre-and post-survey results regarding the statement "*I understand why it is important for women of color to become an engineer."*

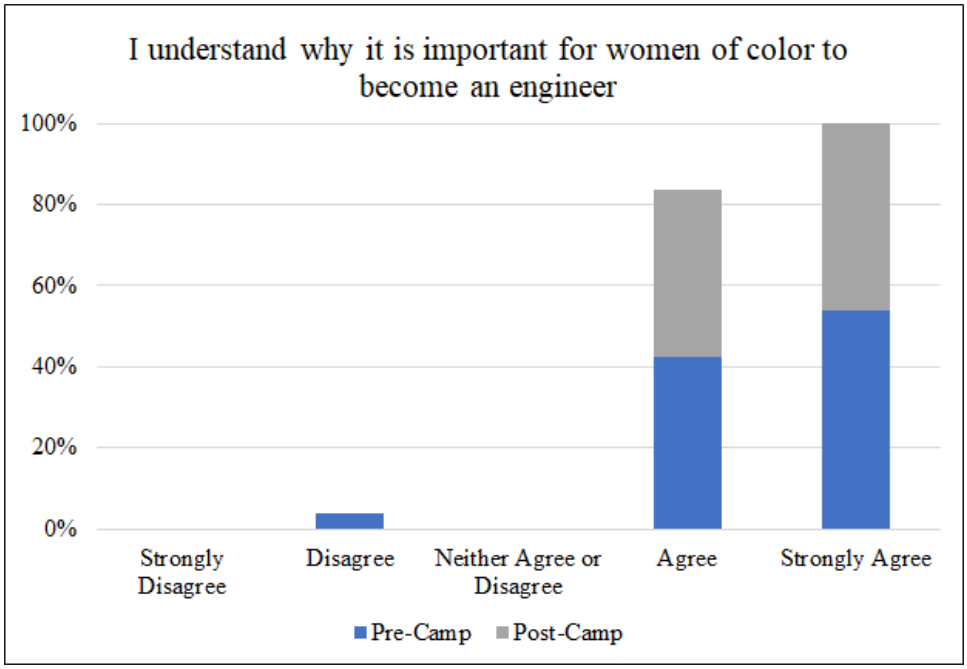


Figure 8. Pre-and post-survey results regarding the statement *"I know the requirements needed to be admitted to college to study engineering."*

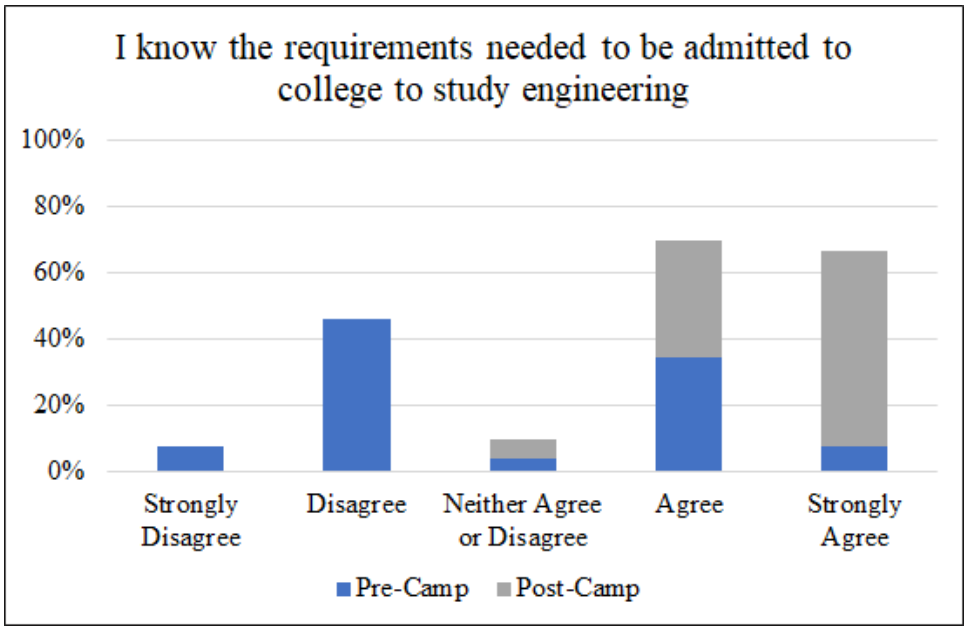


Figure 9. Pre-and post-survey results regarding the statement *"I want to study engineering in college and become an engineer."*

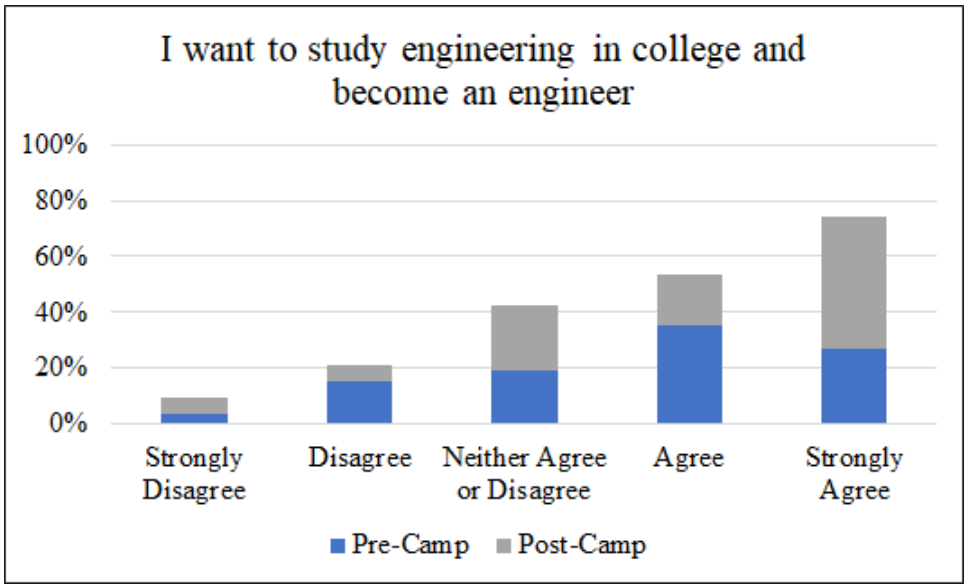
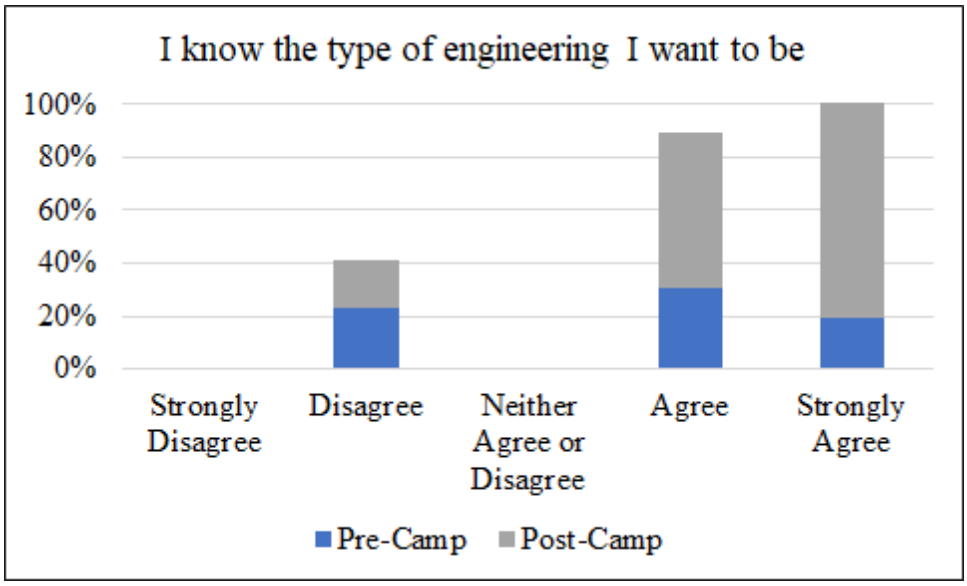


Figure 10 Pre-and post-survey results regarding the statement *"I know the type of engineer I want to be".*



Qualitative Data – After completion of the camp, students were asked to respond to an open prompt "Share your thoughts about your overall camp experience, including what you liked most, what you would have changed." Following the review of student responses, a coding theory was developed to organize and assess the responses in a structured way. The analysis of the responses led to the emergence of the following themes: representation, college readiness, understanding engineering, self-efficacy, and hands-on activities/structure and virtual format. To increase validity in the coding, multiple researcher triangulation was conducted. The statements set forth in Table 1 below are representative responses of students to each of the emerging themes.

Representation
"I enjoyed hearing about different engineers and black and women excellence."
"It was an amazing experience to meet so many women from all different backgrounds who are so successful."
"I really liked when the women from [manufacturing company] came and spoke to us about what they did. And, when the women came and spoke her computer science journey."
"My favorite part was hearing from the speakers and their wisdom. It opened job opportunities that I had not heard of."
"I loved meeting all of the wonderful speakers and hearing their stories and how they overcame their struggles."
College Readiness
"I learned lots of information about the University of Cincinnati and the admissions process. Now, I feel more confident in becoming an engineer and pursuing my interests."
Understanding Engineering
"Now, I feel more confident in becoming an engineer and pursuing my interests."
Self-efficacy
"I also enjoyed those speakers that helped uplift my spirits and forced me to find something positive about myself."
"And I also enjoyed when the Empowerment women would speak to us."

"I really enjoyed the E-Moment of Empowerment and hearing the stories."
Hands-on Activities/Structure and Virtual Format
"I loved this camp...The virtual walk through of the lab was amazing. I liked the hands-on activities."
"Personally, I would have liked more hands-on lessons."
"I would much rather have shorter classes for a longer period of time then vice versa."
"I don't think I would change anything except hopefully being able to meet in person, since we weren't able due to the coronavirus."
" I had so much fun and I'm so happy the sponsors put in so much effort even though it was virtual:)"
"I am beyond impressed by the output and structure of the camp. I also appreciate the hands-on activity we got to participate in (bath bomb, earthquake simulation) despite the virtual aspect of the camp."

Table 1. Representative responses to each emerging theme.

Discussion

WOCSEC was designed to expose female high school students of color to engineering careers, concepts, and hands-on activities, as well as female engineers and scientists of color, with an aim to increase their intent to major in engineering and applied science. The goal was to ensure that students, even in a virtual format, had the opportunity to learn about engineering and applied science disciplines and concepts; acquire knowledge about the admissions process, converse with female engineers and scientists of color and engage in STEM related activities. The following discussion is a review of quantitative and qualitative data gathered from students prior to and after camp attendance.

On day 1 of the camp, students listened to an overview of various engineering disciplines. Prior to camp and after camp, all most all students responded affirmatively to the statement "I know what engineering is" (Figure 5). Although a high percentage of students acknowledged understanding the concept of engineering, prior to camp only 42% of students understood the admission pre-requisites to study engineering in college (Figure 8). The College Readiness Workshop provided an in-depth review of math and science course requirements for admission to an engineering college. The selected response in Table 1, "*Now, I feel more confident in becoming an engineer and pursuing my interests"* supports the premise that empowering students with engineering course pre-requisite information, allows the students to select specific courses in high school that are needed to study engineering at the college level [19]**.** At the close of camp, 94% indicated that they were knowledgeable about admission requirements to study engineering in college, representing an increase of 52% (Figure 8).

WOCSEC was designed as an exploratory experience, with exposure to activities, female engineers of color, engineering concepts and careers. The overall purpose of WOCSEC was to increase the pipeline of female engineers of color studying engineering in college. There was no requirement that students attending the camp have an intent to major in engineering. Prior to camp, 50% of students acknowledged the following "I know the type of engineer I want to be", compared to 82% at the end of camp (Figure 10), representing an increase of 32%. It is noted at the completion of camp, a decrease of 7.7% with respect to students' interest in studying

engineering in college (Figure 9). As noted earlier, every student did not respond to every question. The decrease in intent to major may have been affected by the actual students who answered the question prior to camp and after the camp.

It was reassuring to discover that prior to attending camp, most students acknowledged the importance for women of color to become an engineer (Figure 7). Because female engineers of color are severely underrepresented in the workplace, it was not shocking to learn that only 27% of students were familiar with female engineers of color, prior to attending camp (Figure 2). One of the most notable themes emerging from the review of qualitative responses, is the exposure to female engineers of color. Research has shown that role models and representation help students see potential in themselves [8]. It has been noted that girls respond with success to influence of role models and mentors and that relatable and successful engineers have a very real impact [20].

Statements in Table 1 are representative thoughts regarding exposure to engineers: *"I enjoyed hearing about different engineers and Black and women excellence; "It was an amazing experience to meet so many women from all different backgrounds who are so successful"; and "My favorite part was hearing from the speakers and their wisdom. It opened job opportunities that I had not heard of."* The representative responses underscore the significance of the Engineer STEM Spotlight Interviews and Engineer Panel Discussions. Moreover, the statements strongly suggest that exposure to female engineers of color can influence students' perception of their own abilities and potential. Role models allow students to connect their personal identities to engineering identities, thereby providing students with the opportunity to imagine themselves as engineers [21]**.** At the close of camp, 100% of students responded affirmatively to the statement "I am familiar with or know female engineers who look like me", representing an increase of 73% (Figure 6).

The following representative statements regarding self-empowerment are set forth in Table 1, "*I also enjoyed those speakers that helped uplift my spirits and forced me to find something positive about myself"; "And I also enjoyed when the Empowerment women would speak to us", and "I really enjoyed the E-Moment of Empowerment and hearing the stories"* demonstrate the effect of presentations centered on self-efficacy. Messages of inspiration and empowerment often propel students to think of the possibilities of becoming an engineer and transform the way they perceive their own capabilities [22].

Table 1 includes representative student responses regarding activities, schedule, and virtual format. With respect to hands-on activities, students responded with statements such as *"I loved this camp...The virtual walk through of the lab was amazing. I liked the hands-on activities..."* and *"Personally I would l have liked more hands-on lessons*." The shake table, shirt folding, bath bomb production and coding activities in the Design Lab and Design Challenge allowed the students to increase self-confidence and solve problems, using scientific and mathematical knowledge [23]. Researchers indicate that exposure to engineering challenges create a deeper understanding of the engineering field, potentially increasing students of color intent to pursue STEM majors [7][8][24]. Student responses indicate that hands-on activities were impactful and camp participants may have benefitted from additional engagement.

As stated, the camp included sessions from 9:00 am to 11:00 am and from 1:00 pm to 3:00 pm, with a 2-hour break in between sessions. The following representative response regarding camp structure in Table 1, "*I would much rather have shorter classes for a longer period of time than vice versa",* suggest that consideration may be given to adjusting the time allotted for instructional sessions. Regarding virtual format of the camp, students responded with statements such as, *"I don't think I would change anything except hopefully being able to meet in person, since we weren't able due to the coronavirus;" " I had so much fun and I'm so happy the sponsors put in so much effort even though it was virtual:)" and "I am beyond impressed by the output and structure of the camp. I also appreciate the hands-on activity we got to participate in (bath bomb, earthquake simulation) despite the virtual aspect of the camp.* Such statements indicate that students strongly preferred attending camp "in person" which was the initial plan prior to the onset of Covid 19.

Outreach experiences, such as WOCSEC, create opportunities for participants to engage in science related activities, learn engineering concepts, engage with female engineers of color, all with the purpose of increasing overall interest in becoming an engineer. Of special importance, 9 of 10 seniors who attended camp, submitted applications for admission to the University of Cincinnati College of Engineering and Applied Science. Out of the 9 students who applied, 8 were admitted to University College of Engineering and Applied Science and 1 student was admitted to study Biochemistry in the University of Cincinnati College of Arts & Sciences.

Limitations of the Work

It should be noted that the survey data is subject to some limitations. Participation in the surveys was voluntary and had no impact on a student's continuous participation in the program. Several students chose not to complete the pre-camp and post-camp surveys. The survey results were generated from students who attended a summer engineering camp at a single institution and addressed experiences of only 27 female high school students of color, which represents a small sample size. Moreover, hosting the camp in a virtual format limited the ability of the students to interact directly with each other and the speakers, which may have affected overall camp experiences.

WOCSEC was a five-day virtual camp which included 6 components: Engineer Spotlight Interview; Engineering Design Challenge; E-Moment of Empowerment; Design Lab; Interactive Forum and Panel; and College Readiness. The focus of the camp was to create a pipeline of female students of color interested in studying engineering in college. The survey results are valuable as these students may provide direct insight into the overall impact of a summer engineering experience devoted to exposure, engagement, and college preparedness.

Future Work

To increase the number of female engineers of color, it is critical that female high school students of color have opportunities to participate in events which foster an interest in engineering and exposes them to female engineers that look like them. With this aim, the University plans to continue to host WOCSEC each year. There will be a continued focus on exposing students to a vast number of female engineers of color, which was an outstanding

feature of the camp. Additional plans involve increasing the number of camp participants, increasing the number and variety of hands-on activities, as well as expanding options for corporate tours.

A longitudinal study will be conducted to examine camp participants' matriculation throughout high school, college choice, college decisions, intent to major, college experience and persistence in engineering or other major. To obtain the information for the study, a comprehensive internal student data base of camp participants will be developed, complete with contact information, high school, and graduation year. Additionally, the data base will be used to advise participants of University of Cincinnati College of Engineering and Applied Science activities, such as recruitment and engineering outreach events, as well as multicultural campus activities and programming.

To remove any financial barriers to student camp attendance, our goal is to offer the camp free of charge. Efforts are underway to secure corporate and agency funding to support camp operating expenses.

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