

An Examination of Black and Latinx Female Youth Experiences in STEM in an Informal Engineering Summer Camp

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Alisha M. Bailey serves as Program Manager in the Caruth Institute for Engineering Education within the Lyle School of Engineering at Southern Methodist University in Dallas, TX. She also leads and manages the undergraduate mentorship initiative within the Lyle School to increase retention and representation of underrepresented minorities in Engineering. Alisha previously worked for the government in the environmental health field as an Environmental Compliance Specialist in Atlanta, GA. Specifically, she worked in public drinking water compliance and regulations, regularly leading audits and inspections. Alisha also previously served as a 6th and 7th grade mathematics teacher. Her current career interests include identifying and integrating real-world problems in STEM learning and increasing diversity and representation in the STEM field.

Mr. Alain Mota, Southern Methodist University

Alain Mota is the STEM Development and Implementation Coordinator at RME and a Program Manager at the Caruth Institute for Engineering Education. In this role, he works across schools supporting the research and implementation goals of several projects at the unit and the institute. As a coach he supports campus leaders and science teachers in the delivery of classroom lessons that focus on the integration of STEM and active learning techniques through individualized coaching, co-planning, facilitating and co-facilitating Professional Learning Communities, and actionable feedback after classroom observations. One of the coaching roles is part of the STEM Academy for Science Teachers & Leaders initiative that is intended to increase student achievement in science, student interest in STEM careers, and students' persistence in STEM coursework by supporting teachers' professional knowledge, skills, and campus administrators' instructional leadership skills. Through coaching he has also supported teachers implementing intensive intervention of Algebra readiness through Project STAIR: Supporting Teaching of Algebra Individual Readiness in middle school. His collaboration on the project has allowed him to contribute to a multi-University effort to increase teacher efficacy support of students. Alain has also supported projects through his experience with design thinking. He has collaborated in the conception and facilitation of workshops aiming to understand the usability of assessment prototypes in the MMarS project: Measuring Early Mathematical Reasoning Skills.

As part of his goals to contribute across the University Alain also supports Engineering and Science undergraduate students as they serve as camp counselors in his work at the Caruth Institute for Engineering Education. He directly manages the deployment of STEM integrated activities that surface Engineering to Middle and High School students in the Dallas area in an informal learning environment through the Hammon Engineering camps. He is also engaged in outreach programs that are seeking to serve underrepresented populations in Engineering. In his program manager role at the Institute, he contributes in fostering relationships and developing STEM activities for Voices of Hope and Jubilee Park. He is also part of the Maker Education project as his previous experiences developing teachers at the STEM academy leveraged the SMU MakerTruck as part of the training and outreach, one of the major goals to make Engineering accessible for the institute.

Before joining the University Alain worked at the Dallas Independent School District as both a mathematics and science instructional coach for elementary and middle schools. He served as the inaugural STEM department head for the Barack Obama Male Leadership Academy and was a science campus coordinator for Henry B. Gonzalez Elementary. Prior to becoming an Educator Alain worked in Environmental consulting. In this space his experiences ranged from aquaculture management and research for an aquatic toxicology firm to doing statistical analysis for the nutrient criteria standards at the Texas Commission of Environmental Quality. Alain has a Master of Science in Interdisciplinary Environmental Studies with a focus on Environmental Engineering, Geophysics and Public Health. His research doing microbial risk assessment of import products from Mexico is published on the Journal of Food Safety. He is currently enrolled in the Master of Arts in Design and Innovation at Lyle.

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An Examination of Black and Latinx Female Youth Experiences in STEM in an Informal Engineering Summer Camp (Work in Progress)

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Abstract

Due to the underrepresentation of women of color in STEM (science, technology, engineering, and mathematics)¹, we look to focus our attention and efforts on increasing the value and competency beliefs of Black and Latinx female students by analyzing and comparing their survey responses to all other participants in informal STEM summer camp experiences over a 2-year period. All student participants represented North and South-Central Texas school districts. A total of forty-two 7th through 12th grade female student participants were surveyed. This study will explore and examine the following: (a) relationships among participation in informal summer camp learning experiences in Engineering and (b) its influence on students' perceptions of value and competency beliefs in Engineering and STEM in Black and Latinx female middle and high school students, and (c) students' pre-exposure to STEM before enrolling in a STEM focused informal learning opportunity. By utilizing survey responses to compare changes in value and competency beliefs before and after participation in an informal learning STEM experience, this study looks to examine evidence gathered from the STEM Learning Activation survey. The analysis of quantitative data will be used to compare Black and Latinx female students' responses to the Activation Lab (AL) instrument responses, specifically focusing on values and competency beliefs with the specified set of participants. The anticipated intent and outcome of the informal learning summer camp experiences is to continue to understand how to build programs that increase the interest and engagement of Black and Latinx female students in the STEM fields.

Key Words: Gender, Engineering, STEM, Ethnicity, competency belief, value

Introduction

Women are underrepresented in the United States in STEM (science, technology, engineering, and mathematics)¹. By increasing the representation of women of color in STEM, this can help support

diversity and innovation within the STEM field¹. Research shows that while Blacks represent 11% and Latinx make up 16% of the workforce in the United States, they represent 9% and 7% of the STEM field^{2,3}. While some opportunities to address the lack of diversity within the engineering field have recently become available, through this work youth had the opportunity to focus on varying engineering design challenges through informal summer camp experiences. This study will examine the relationships among participation in informal learning experiences in Engineering and its influence on students' perceptions of value and competency beliefs in Engineering and STEM in Black and Latinx female students in middle and high school.

Brief Literature Review

Previous Research on Underrepresented Students in Engineering Camps

Various literary works have examined the viewpoints and practices of racial minority women in the engineering field⁴. The literature provides experiences from various women of color, but the focus of this study will be on Black and Latinx females. With a growing number of research studies examining Black and Latinx female experiences in STEM and engineering, more efforts are underway to support the advancement of underrepresented females in STEM. Studies have suggested that students' persistence in STEM is directly related to their feelings of acceptance, gender, ethnicity, and feeling a sense of belonging in their chosen academic field.¹ Through the research and suggestion of various studies, it is important to consider if informal learning summer camp experiences can support the interest and engagement of Black and Latinx female students in engineering.

Out of School and Informal Learning Experiences

Informal and out of school learning can influence student experience not only inside of the classroom, but also outside of the classroom⁵. According to Roberts et. al, for youth that struggle with traditional school learning environments, they often tend to be more attentive and interested in hands-on informal STEM learning⁶. Through research and input of various educators, STEM education programs and hands-on learning approaches goals have been to promote and improve learner outcomes⁵. Summer camps support the development of students learning important 21st Century skills that they can use in their future careers or within the workforce⁷. In examining prior research, efforts are underway to support Black and Latinx female students in their exploration of hands-on out of school and informal learning STEM and engineering camps.

Theoretical Background

The basis of this study looks upon the STEM Learning Activation survey, where the Lawrence Hall of Science is a significant partner. The STEM Learning Activation survey is designed for youth ages 10-14 years old and assesses youth across multiple dimensions of STEM learning activation⁸. The survey measures each youth's value and competency belief at the time the survey was collected. The STEM Learning Activation measures four scopes related to science learning that include: *competency beliefs, fascination, innovation, valuing*. Within the STEM Learning Activation survey, this study draws upon two scopes (*valuing STEM* and *competency beliefs in STEM*). Similar to Wieselmann et. al evaluation of all four learning activation measurements for underrepresented

students, their study looked to assess the measurements on the basis of biological sex and grade related to their disposition toward STEM⁹. This study will assess value and competency on the basis of grade, self-reported/self-identified ethnicity, and biological sex.

Valuing STEM refers to youth's ability and importance of completing STEM activities and capability to meet personal goals and value of their community⁸. *Competency beliefs* references a learner's belief in their ability to succeed in various STEM learning challenges¹⁰. By evaluating both valuing STEM and competency beliefs together, this will provide relevant information that drives youth's participation in STEM learning and their ability to continue to do STEM related activities. In looking at youth long term engagement with science, studies show that an early informal science learning experience in addition to a positive or negative school science learning experience supports youths long term engagement or disengagement.^{9,11}

Design/Methods

Context and Participants.

This study was situated within the context of engineering camps for middle and high school students in the North and South-Central Texas school districts in the United States. A portion of the camps were conducted during the 2020 Sars-Cov-19 pandemic which prompted the engineering camps to be deployed virtually during the summer of 2020. The deployment of the camps during these sessions were conducted in real time virtually during two 1.5-hour sessions for five days. The participants during the virtual session participated in the activities during the morning session, had a specified amount of time to continue working on their own, then participated in an afternoon session to troubleshoot any challenges with their tasks and prototypes. The second part of the study pertains to face to face camps deployed during the summer of 2021 at a university campus. The on-campus engineering camp was a 5-day experience with approximately 7-hour engagement daily time. All of the camps content exposed students to engineering topics related to electrical, mechanical civil and environmental, and computer science, and product design. The activities maintained a focus on hands-on experiences that mirror the engineering design process that prompted collaboration and communication. For example, one of the virtual camps encouraged students to build a prototype of a wind turbine that included circuit components, so the blades would spin when wind was applied. Undergraduate engineering students served as camp counselors and facilitated both the virtual and face to face camps. All of the participating students were from disadvantage schools and received full scholarships to attend the camps. A total of 42 camp participants were included in this study.

Data Collection and Analysis.

This study utilized the STEM Learning Activation survey instruments as a measurement of camp participants experiences specifically focused on the competency beliefs in STEM and valuing of STEM. The two main areas were a major source of interest to understand how our chosen population of Black and Latinx females change their responses in the STEM Learning Activation survey after experiencing the Engineering camps. As such the participants were administered the same survey before the Engineering camp experience and at the conclusion of the camps as an exit survey. The choice of utilizing the STEM Learning Activation survey was derived from the previous work conducted by Wieselmann et. al 2020⁹ which describes the use of the STEM Learning Activation surveys in their study. As previously explained in their study the survey instruments have items that

have responses on a four-point Likert scale. The competency belief scale has 12 items (i.e., *I can do the math problems I get in class; I think I am very good at coming up with new ideas when working on projects*), and the values scale is composed of 13 items (i.e., *How important is it for you to learn about engineering; I think scientists have the most important job in the world*).

Results

The survey responses revealed insight on how students of interest change their perceptions before and after the engineering camps in both the virtual and face-to-face camps.

Virtual Engineering Camps

Of the virtual camps, 50% of the participants increased in their competency belief to conduct their own project after school. The same percentage of participants increased their beliefs in explaining their solutions to mathematic problems. Of the participants, 33% increased in their belief that they could understand the science in books for adults. The same percentage of respondents increased their competency beliefs in coming up with new ways to solve technical problems.

Face-to-Face Engineering Camps

The face-to-face participant surveys also revealed some interesting responses. The highest percentage of responses that increased after the participants experienced the face to face camps were from the STEM competency beliefs with 42% of our respondents increasing their belief in coming up with new ways to solve technical problems. The next indicators that showed increase at 37% were from both STEM values and STEM beliefs. These include the value statement on the importance and relevance of technology, and knowing Math helps them understand how the world works. The STEM beliefs statement included students increasing their thoughts on their efficiency in solving problems. The next items of increase with 32% of our participants improving their belief of being the technology expert in their household and their belief they could understand the science in adult books and the value of knowing science is important to being a good citizen.

Table 1. Self-Reported and Self-identified Engineering Camp Survey Respondents

Engineering Camp	Black	Latinx	Black/Latinx	Other
Introduction to Engineering (7 th /8 th grade) 2020 (virtual)	0	3	0	1
Introduction to Engineering (7 th /8 th grade) 2021 (In person)	4	4	0	0
Engineering Design Experience (9 th /10 th grade) 2020 (virtual)	0	5	0	0
Engineering Design Experience (9 th /10 th grade) 2021 (In person)	5	2	0	2
Advanced Engineering (11 th /12 th grade) 2020 (virtual)	0	2	0	2
Advanced Engineering (11 th /12 th grade) 2021 (In person)	3	7	1	1

Summary and Next Steps

This study revealed changes in self-perceptions of engineering camp participants that indicate some increases in the beliefs and value of STEM for Black and Latinx females based on the STEM Learning Activation survey. Observation of participant responses yielded some interesting data which will continue to inform the design and deployment of the engineering camps. The intent is to continue to understand what the experiences mean for the students that have attended camps over a period of several years. There is particular interest in the relevance the experiences provided by the camp present for Black and Latinx females. Further understanding and using instruments that particularly address engineering identity would provide information that would serve to re-design the content of the camps, how the camp counselors are trained, and the diversity of the camp counselors facilitating the camps.

Upcoming Camp Design and Training

Based on the findings of our current research, the goal is to redesign future engineering camps. The future research studies will focus on several aspects of the redesign process of the engineering camps. As we continue to strive to support Black and Latinx females, the diversity of our camp counselors will seek to align to our camp attendees. We will continue to enrich the experiences of the attendees by exposing them to STEM undergraduate and graduate students that connect to their ethnic and cultural background. The goal is for undergraduate and graduate students to facilitate the informal learning experiences for the summer camp participants. The intentional hiring of camp counselors will also be matched by intentional professional development that will give a baseline understanding of the facilitation of the camp content to also address increase self-efficacy, value, and STEM and Engineering identity throughout the camp deployment. The training will also be redesigned by having camp counselors understand and apply specific items of the survey instruments during facilitation to leverage their interactions with the students attending the camps. The camps will also serve as prototypes for community outreach engagement programs to start establishing a pipeline of camp counselors as the camp attendees advance in age in the hopes to establish the next generation of camp counselors based at their communities. Finally, we will continue to research survey instruments that will help the researchers understand the needs of a diverse, equitable, and inclusive population of camp participants to actively develop the camp content.

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Proceedings of the 2022 ASEE Gulf-Southwest Annual Conference
Prairie View A&M University, Prairie View, TX
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