



Examining the Engineering Attitudes and Experiences of URM Summer Camp Participants

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Abstract

Existing research studies provide an overview of the programmatic outcomes of academic intervention programs that target underrepresented minority (URM) populations, but lack empirical evidence about the personal experiences of program participants. To address this deficit, in summer 2017, we conducted a pilot study in which we examined the experiences and attitudes of participants of the University of Michigan's Wolverine Pathways (WP) program. Wolverine Pathways is an academic intervention program serving high school students from metro Detroit. Specifically, the study population (n=14) consisted of 11th graders who participated in a weeklong, engineering and healthcare focused summer camp held at the Ann Arbor campus. In this research inquiry, we used an explanatory mixed methods approach to collect quantitative data (pre- and post- surveys) and qualitative data (semi-structured interviews). Descriptive statistics were used to draw inferences from the data. Then, interview data was analyzed to identify trends and insights. Preliminary results indicated that participants completed the program with more positive attitudes toward engineering. Future research will focus on increasing and diversifying the sample population by including participants from other grade levels to provide a comparative analysis of participants' experiences across various ages.

Introduction

Despite a plethora of research studies about science, technology, engineering, and mathematics (STEM) intervention programs, there is a clear gap in research studies about participants' experiences and changes in participants' attitudes towards STEM fields. Research studies show that summer academic intervention programs target deserving students that are labeled as first-generation, low-income or underrepresented. In these programs, participants learn about different aspects of STEM majors along with skills and knowledge required for applying to college. Because these programs are sponsored by external funding and networks, they can expose participants to STEM opportunities and careers. Understanding participants' attitudes towards, and understanding of, engineering and engineering careers can provide insights on how to gauge the students' and the community's understanding of STEM. Thus, these programs have the potential to broaden participation in STEM fields and increase the STEM workforce [1].

It will be important, moving forward, to be able to identify the critical experiences of students in these academic programs that contribute to their post-secondary pursuits, particularly as they relate to their interests in engineering. The purpose of this pilot research study is to establish a preliminary understanding of Wolverine Pathways participants' experiences in the academic boot camp and to examine any changes in their attitudes towards engineering after the camp's conclusion. We hypothesized that Wolverine Pathways camp participants will have a change in their attitudes towards engineering and engineering careers after participating in the camp.

Background

In 2014, the Supreme Court upheld the Michigan constitutional amendment that banned the University of Michigan's affirmative action policy ("U. of Michigan launches program to boost diversity efforts," 2015). This action contributed to a substantial drop in the enrollment of

underrepresented minority (URM) students. Following this, programs and initiatives were implemented to increase the pipeline for URM students, including the University's Hail Scholarship and Wolverine Pathways Program.

The Wolverine Pathways (WP) is a free, year-round academic intervention program for junior high and high school students focused on developing skills in English, mathematics, and science. Participants begin the program in the fall of their 7th or 10th grade year, and are set to continue through until 12th grade. The Wolverine Pathways program aids students from the Detroit, Southfield, and Ypsilanti communities in both identifying and cultivating their personal strengths and interests. The partnership between the families, schools, and communities in these cities provides learning experiences that will help students succeed in school, college, and future careers. The program's launch in 2015 corresponded to the University's largest enrollment of underrepresented minorities since 2005 [2] ("U. of Michigan launches program to boost diversity efforts," 2015). In the summer of 2017, the University of Michigan (UM) hosted its first cohort of 11th graders in a Wolverine Pathways summer camp. During the weeklong camp, students participated in activities and learned about engineering and engineering careers. We conducted a pilot study about the experiences of Wolverine Pathways summer engineering academic camp to provide insight regarding these academic intervention programs' impact on URM students' attitudes toward engineering and engineering careers.

Academic Intervention Programs

Academic intervention programs are increasingly used to promote diversity for colleges and universities. There are many different types of programs, ranging from institution-wide programs, such as the University of California's Early Academic Outreach Program (EAOP) and the University of South Florida's College Reach-Out Program (CROP), to state- and government-funded programs, such as Gaining Early Awareness and Readiness for Undergraduate Programs (GEAR UP). There are even specialized subject intervention programs, such as Mathematics, Engineering, Science Achievement (MESA) School Program (<http://mesa.ucop.edu/program/mesa-schools-program/>). These programs share the common goal of helping low-income and/or first generation students successfully prepare for college. It is very difficult to determine if these programs are truly successful in getting students enrolled into college; however, there are additional efforts in place to increase college enrollment for these students, and to fill the STEM career position gap.

Institution-sponsored intervention programs offer a combination of a summer camp, weekly workshops, and a parent support program for deserving students enrolled in 7th grade through high school graduation. The University of Michigan uses a congruent structure for its Wolverine Pathways program. The University of California (UC) has made their Early Academic Outreach Program (EAOP) a success since 1976. The EAOP has had over 40,000 participants annually since its initiation (<https://eaop.ucsd.edu/>). Studies show that students who have been in the program are two times more likely to complete college prep materials and be accepted into UC than those who have not participated [3]. Most of the students who participated in the program would argue that they gained more confidence for applying to large universities, such as the University of California, after completion of the program [3]. The College Reach Out Program is a state-funded program offered in Florida with a very similar structure to the EAOP in California. In an evaluation of the academic intervention program for two sets of participants in

Northeast Florida during different years, the attitudes of students during their self-evaluation of school and the CROP program were explored. The participants completed four questionnaires consisting of the responses in form of a dichotomous scale, 4-point frequency Likert scale, 5-point Likert scale, written response [4]. These were evaluated for the most common and the least frequent answer choices. The highest agreed question by students was given in response to the statement, “An education is important to me in order to achieve my goals”. This question yielded 95% agreement. “Strongly agreed” was selected by 81% of participants and “Agree” was selected by 14%. The remaining percentages were summoned under “unsure”. While this study provides information in regards to students’ attitudes towards academic intervention programs and school in general, it does not represent the attitudes of students towards engineering or STEM fields.

The GEAR UP Program

The GEAR UP program, a state- and government-funded program for pre-collegiate students, was approved by Congress in 1998. The overarching goal of GEAR UP is to increase postsecondary attendance and the success of low-income students, by focusing on college readiness, mentoring, and general academic support [5]. The GEAR UP program structure closely resembles that of the Wolverine Pathways program, wherein program services are set to persist from the fall of participants’ 7th grade year, all the way to high school graduation. GEAR UP even partners with local schools, districts, communities, and post-secondary institutions.

Annual GEAR UP program evaluations use data from surveys given to participating students and their parents to better understand service impacts on individuals. Parts of the survey focus more on programmatic outcomes like graduation rates, GPAs, and test scores. Other survey aspects quantify student and parent expectations and attitudes about postsecondary education, as well as student behavior.

Survey items regarding student attitudes rely on the notion that student attendance is an indicator of student attitudes about school. Unfortunately, there was no strong correlation between participation in the GEAR UP program and class attendance. The same is true for responses about student expectations and intentions of pursuing education after high school. A slim majority of students agreed with the statement, “*I will definitely go to college*”, with no discernable difference between GEAR UP and non-GEAR UP participants. Though correlations between the program and student responses were low, responses from parents were much more optimistic. Survey results indicate that parents who participate in the GEAR UP program have more conversations with their children about college than non-participating parents, and have higher expectations for their children’s college pursuits. Research shows that parents who have higher expectations for their children, in turn, have children who perform at higher levels than their peers [5]. The Wolverine Pathways program also acknowledges the significance of parental involvement in academic intervention programs. However, the aforementioned survey results provide good reason to begin looking further into the experiences of participating parents and how those experiences can impact the attitudes of their children about engineering.

Other types of academic interventions are student-focused. In a study on the comparison of study habits and study attitudes between low achievers and high achievers, results show that the high achievers, which made up almost 6% of the sample, have better study habits than low achievers

[6]. Better study habits yield greater attitudes to college and softens the barrier for students completing their college courses. In short, universities that offer college preparation that includes developing good study habits increase their potential pool of candidates to more likely to do well in collegiate programs. The Mathematics, Engineering, Science Achievement (MESA) School Program aims to help middle and high schoolers transcend in math and science to be capable for admittance to rigorous institutions. In the MESA School Program, middle and high school students are given access to resources in 11 states [7]. These additional resources positively impacted students' attitudes towards performing better in STEM related subjects and applying to college.

While data showing how students' experiences impact their attitudes about college seems readily available, there still lacks a connection between students' experiences and their attitudes about engineering and engineering careers. The survey measures of our study and the in-person interviews of Wolverine Pathways student participants help bridge this gap and connect the two.

Research Methods

This mixed methods study consisted of both quantitative and qualitative data, specifically survey data and interview data, respectively.

Sample Size and Recruitment

For this UM Institutional Review Board approved pilot study, we chose to study 11th grade camp participants in a 2017 Wolverine Pathways summer camp. The participants were African American. The total number of camp participants was 14. For the pre-survey responses, n=13; for the post-survey responses, n=14; and for the interviews, n=9.

Participants were recruited for participation in the study during registration on the first day of the camp's orientation. The lead camp instructor gave the parents an informed consent form with details about the study and their child's possible participation. Parents signed and returned, or declined to sign, the consent form before leaving their child for the camp. The lead instructor made copies of the informed consent forms to give to the parents and students on the last day of the camp, and returned the originals to the principal investigator. In addition, participants were provided with informed assent forms with details about the study.

Data Collection

A pre- and post- survey was administered to camp participants. The survey consisted of six demographic questions and twenty 5-point Likert scale questions. The demographic questions inquired about gender, academic level, age, GPA, citizenship, and race. The Likert scale questions assessed students' attitudes towards and knowledge of engineering careers. These questions were adapted from the Attitudes to Engineering Scale [1]. An example of a question is "*I think that engineering could be an interesting career*". An identical survey was administered at the beginning and end of the camp. Out of the 13 participants that completed the survey, 9 participants completed an interview. Interview questions were developed to allow WP participants to discuss their experiences in the camp and to elaborate on how and why their attitudes towards and knowledge of engineering fields did or did not change.

The lead camp instructor administered the electronic pre-surveys to the students who were given parental permission to participate. The survey was given in a separate computer room and took about 5 minutes to complete. On the survey, students were given the option to consent to participate in the study. Those who did were asked to complete the survey at both the beginning and end of the camp. They were also able to indicate whether or not they were interested in participating in the informal interviews.

On the last day of camp, the students who took the pre-survey took the survey again as a post-survey with the exception of one student who was not present for the pre-survey. Additionally, those who indicated interest on the pre-survey were interviewed by the research staff. The interviews took place in a nearby closed room separate from the room where the camp activities were taking place. Each interview lasted approximately 10 minutes. The interviews were audio taped and conducted in a private office or conference room. Pseudonyms were assigned to the student's interview data for privacy and to protect their confidentiality. Audio recordings were transcribed by the researchers.

Data Analysis

To analyze the survey data, the Likert scale responses were converted to a numerical scale with 0 representing strongly disagree, and 4 representing strongly agree. A descriptive statistical analysis was performed on the data using Excel. The interview transcripts were read and re-read to identify participant quotes that tied to emergent themes.

Findings

There were three major themes that emerged from the analysis of the data: (1) a consensus about capabilities related to gender and race; (2) a lack of knowing about engineering; and (3) shifts in attitudes after workshop completion. In the following paragraphs, we provide details about each of the individual findings.

Gender and Racial Perceptions

One interesting aspect of the results was participants' attitudes related to engineering regarding their perceptions about gender and race. For example, participants had the highest agreement on both pre- and post- surveys about women succeeding in engineering (i.e., "*A woman can succeed in engineering as easily as a man can*"). Specifically, 86% of respondents indicated that they strongly agree in comparison to the 14% who selected agree. Also, participants expressed gratitude for the camp personnel selecting mentors that looked like them. "*I feel they picked doctors from Southfield and a lot of Black Michigan students to come talk to us. I'm grateful of that*", said one participant.

In addition, participants indicated that their attitudes towards engineering are also influenced by their parents. One participant said:

"[My mom] wants me to do engineering so bad, so it was more than that, it's more than just science and math, it's the way you think and the way you do things and so I was a little "iffy" at first but it turns out that I actually like it and I feel like it's a... well I want to go into the medical field, so I feel like it's a good gateway there".

A Lack of Knowing about Engineering

Another interesting theme emerged regarding what participants thought about the knowledge that engineers need to have and what engineers do. The participants had significant disagreement on both surveys related to the statement: *“Engineers don’t really need to know much about engineering”*. 57% of respondents indicated that they strongly disagree in comparison to selecting disagree and neutral with results totaling 36% and 7% respectively. Participants also expressed their lack of familiarity with engineering. One participant said:

“I thought that engineers only (...), were like builders. I didn’t know that making apps is considered part of engineering”.

Another participant indicated that the camp helped them to learn more about engineering. He said:

“I learned that there is a wide variety of engineering. I thought there was only, like, four parts of engineering in the career section, but I learned that there is a lot more and they all do different things and it’s not just building stuff”.

Another participant indicated a change in his understanding about how engineering can be used. He said:

“I thought engineering was mostly math and like mechanical things but I didn’t know that you can tailor engineering to business”.

Shifts in Attitudes after Workshop Completion

Results reflect that participants’ attitudes towards engineering changed upon the completion of the camp. On the post surveys, all participants agreed with the statement that *“A career in engineering would leave me time for family and leisure activities.”* Participants also indicated a change in how they perceive engineering as well as how engineering can be used. In an interview, a participant said:

“When I learned about the engineering design process, I was like “Oh! You know, engineering doesn’t sound that bad”.

Similarly, participants demonstrated a shift to all disagreement statements for negatively phrased statements. Statements such as *“Engineering is boring”* and *“To be an engineer requires an IQ of a genius”* scored some agreement from participants on the pre-test. Those same statements received 0% agreement on the post-test. One student stated:

“Before I got into this program, I really didn't think that much of engineering because in school I took a physics class and that class was a great struggle for me. So, I came out with a B- in that class so I don't really know how I would feel about trying to pursue this career for myself. For others it seems like a cool experience”.

This meant that while she did not want to pursue a degree in engineering, she took note of the participants who did want to be and learned much more about it in the process. Participants were surprised to learn that engineering can be applied to many aspects of society.

Discussion

In reviewing the study's findings, it appears that the Wolverine Pathways participants learned more about engineering and now have more positive attitudes towards engineering and engineering careers. After completing this one-week long camp, Participants strongly believe that there is a strong sense of gender equality regarding engineering capabilities. Most of the participants in this study identify as female, and were strongly interested in the medical field before completing this camp. After completing this camp, more participants indicated that they strongly agree with the success of women and men being equal. Based on interviews, the participants who wished to pursue a career in the medical field seemed to seriously commit to learning more about engineering.

The results from both the post survey and interviews indicate that students learned more about engineering from the camp. Students frequently discussed their reaction when learning that there are different types and careers of engineering. Participants came to the camp with the perception that engineers are very smart and that they only build things. They learned that engineers use the Engineering Design Process to complete their tasks and that this process is similar to the scientific method that they are taught about in their high school studies.

Participants' attitudes about engineering shifted during the camp. On the first day of the camp, one participant stated that they sent a text to their mother saying that engineering is not that bad after all. This was after they completed the task of putting a puzzle together and improving their process to make their steps faster. There were no participants that indicated that they would believe that engineering is boring, not valuable or too complicated. They see engineering as a career that they could possibly explore if they wanted to.

While we do not have any participants that indicated that they would want to be engineers, they feel more comfortable with completing assignments related to engineering and other STEM related areas.

Limitations and Future Research Recommendations

There are two noteworthy limitations for this pilot study. The first is the limited sample size. There were 13 students available to take the pre-survey and 14 students available to take the post-survey. The second limitation is low variance of high school grade levels. Since this is a preliminary study, the purpose of this study was to examine and take notes of findings. For future research, researchers should consider surveying 9th, 10th and 12th grade Wolverine Pathways participants as well.

Another limitation was the duration of the camp. A week elapsed between the pre- and post-surveys. If the camp lasted the entire summer, approximately two months, higher positive results could potentially surface because students would have had the opportunity to learn much more about engineering and engineering careers. For future research, researchers should examine camps that are longer in length.

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References

- [1] L. S. Hirsch, S. J. Gibbons, H. Kimmel, R. Rockland, and J. Bloom, "High school students," 2003, pp. F2A7-12: IEEE.
- [2] W. Times, "U. of Michigan launches program to boost diversity efforts," October 23, 2015 Accessed on: July 16, 2017. Available: <https://www.washingtontimes.com/news/2015/oct/23/u-of-michigan-launches-college-prep-scholarship-pr/>
- [3] D. D. Quigley, "The Early Academic Outreach Program (EAOP) and Its Impact on High School Students' Completion of the University of California's Preparatory Coursework. CSE Technical Report," 2002.
- [4] R. J. Drummond and H. A. Drummond, "Northeast Florida College Reach Out Program: 1995 Evaluation Report," 1995.
- [5] K. Standing, D. Judkins, B. Keller, and A. Shimshak, "Early Outcomes of the GEAR UP Program. Final Report," *US Department of Education*, 2008.
- [6] L. B. Aquino, "Study Habits and Attitudes of Freshmen Students: Implications for Academic Intervention Programs," *Journal of Language Teaching & Research*, vol. 2, no. 5, 2011.
- [7] C. R. Cooper, R. G. Cooper Jr, M. Azmitia, G. Chavira, and Y. Gullatt, "Bridging multiple worlds: How African American and Latino youth in academic outreach programs navigate math pathways to college," *Applied Developmental Science*, vol. 6, no. 2, pp. 73-87, 2002.