

Bridging the STEM Gender Gap through Women-focused Outreach

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Jalonda Thompson has more than 13 years of progressive experience in STEM research and higher education. She is the inaugural Director of the Women in Engineering Program at the University of Tennessee, Knoxville (UT). Before this role, she has served as the Assistant Director of Engineering Diversity Programs in the Tickle College of Engineering (TCE) at the University of Tennessee, Knoxville. In her role, Thompson advises senior leadership and oversees programming that contributes to women's recruitment, retention, and graduation within the TCE. Thompson has mentored student leaders throughout her career, most recently with women-centric organizations in the college. She has served as a Chancellor appointed member of UT's Commission for Women and a board member with NASPA's Center for Women. Thompson has received numerous recognitions and honors, including the 2017 NAMEPA Outreach Program Award, 2017 NAMEPA Wings to Succeed Award, 2014 Outstanding New Professional, 2014 NACADA Region III Excellence in Advising – New Advisor (NC), and 2012 Gold Winner-Student Health, Wellness, Counseling and Related-Excellence Award.

Thompson earned a Master's degree in business administration from the University of Tennessee, Knoxville, and a Master's degree in higher education from the University of North Carolina at Greensboro. She received a Bachelor's degree in biology and psychology from Salem College.

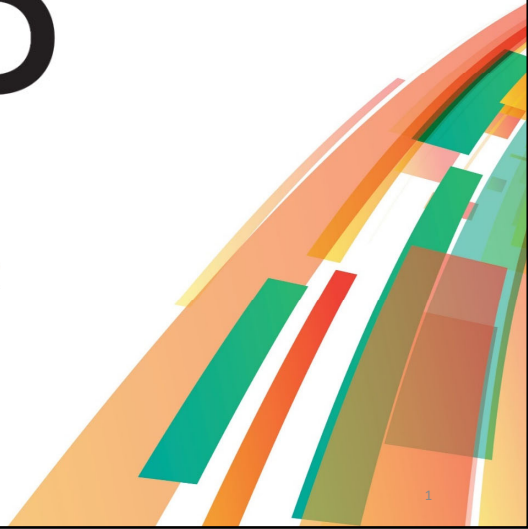
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4th Annual Conference of CoNECD
Collaborative Network for Engineering and Computing Diversity

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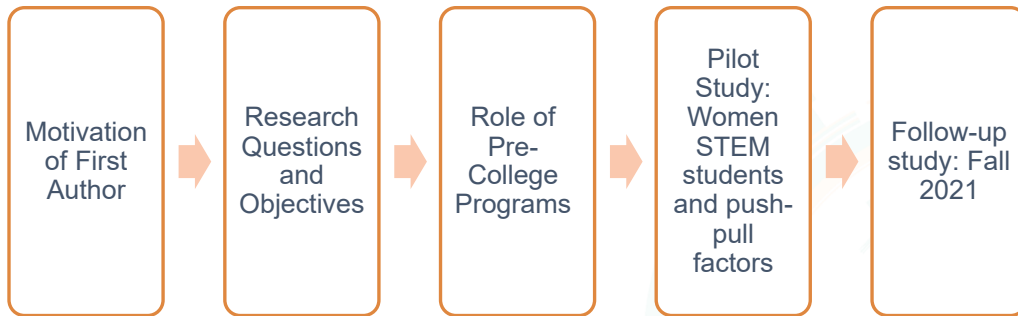
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Overview



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Our presentation will proceed as follows:

- We will discuss the motivations of our first author for conducting this study.
- We will then introduce our research questions and objectives, which are inspired by the experiences of our first author.
- After that, we will share a similar trajectory to that of the first author through PreCollege programs into undergraduate education. The University of Tennessee Tickle College of Engineering (UTK-TCE) has had several precollege summer programs targeted towards middle and high school students, one of them specifically for women. We believe that, because PreCollege is a critical element in the pathway for engineering, it is important to highlight our success here – especially as it relates to our first author.
- Finally, we will introduce our pilot study, and the results from it, before showing the future directions we will take with our larger study that rolled out in September 2021.



Motivation

- First Author's experiences
 - Pre-College Programs
 - High school STEM program
 - Engineering household

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The motivation for this study is rooted in the first author, an engineering student, and her experiences with STEM enrichment programs in the past.

She was able to participate in programs and classes that allowed her to learn about career options and have early exposure to different areas of study. Through her participation in both PreCollege programs at our college of engineering, she was able to learn more about each of the fields of engineering, as well as connect with students and staff members in those departments.

Throughout her high school's 3 course STEM program, she was able to get hands-on experience with CAD and using power tools, as well as experience developing a concept project to propose to the community.

Another influential factor in her decision to pursue STEM comes from her father's work as an electrical engineer. These influences led her to conduct this study to ensure more women have access to outreach programs and chose to pursue STEM careers.



Research Question and Objectives

Research question: What influences more women undergraduates to go into STEM in general and engineering in particular?

- What changes can be made in undergraduate programs to retain women in engineering and to facilitate women entering an engineering career?
- What role do pre-college programs that serve K-12 populations have in creating the pathway to engineering majors?

Research objective: To learn more about the factors that influence undergraduate women in engineering and leverage that knowledge to create a better, more supportive pathway for women engineers at our college of engineering from K-12 through college

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The role and presence of women in careers related to science, technology, engineering, and math is something that has changed dramatically over the past few decades. However, representation is still highly unequal for multiple reasons. This study will seek to discover the most influential factors that contribute to women choosing to either pursue or avoid a career in STEM. The survey will be targeted toward women currently pursuing or working in a STEM field. It asks demographic questions and requests participants to rate how much different factors influenced them to choose a STEM career path. Additionally, it will ask what the challenges or disadvantages are that cause women to have hesitations about entering the STEM field. The survey will be distributed to various groups of females in STEM at the University of Tennessee, Knoxville.

The science behind women in STEM fields is something that has been highly researched and discussed by individuals in many different areas. This type of research explores biological and personality differences between men and women that contribute to the inequality of representation in certain job areas. While there are a multitude of sources all giving slightly different perspectives on the topic, they each have a factor in common: that women are not treated or represented equally in STEM fields. It is clear that changes need to be made in order to fix this problem. As stated in the book *Women in STEM Disciplines*,

“If gender equality in STEM continues to progress at today’s rate, it will take at least 40 years before women can contribute equally to science and technology” [1]. Though it is true that the situation has improved significantly for women in STEM, there is still much to be done in order to close the gap of inequality.

However, the overall goal of this study is to determine what changes can be made in undergraduate programs or even in primary school to help facilitate women in entering a STEM career. This is important because it could help decrease the disparity of women in STEM fields and the negative stigma toward them.

*These overall lead to a question of what changes can be made in order to improve the situation for women pursuing STEM careers. It is important to ask this question in order to create more equality between men and women, thus advancing our society.



Middle and High School Programs

- Tickle College of Engineering:
 - 2 middle school summer programs
 - Adventures in STEM - girls only
 - 2 high school summer programs

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The K-12 education system plays a critical role in shaping the major choice and career trajectory of students. UTK-TCE has a Precollege outreach program designed to introduce engineering to women and students from underrepresented minority groups. Some of these programs include a NSF-funded middle school girls camp coordinated by the second author, and several programs developed by the third author within the college that bring middle and high school students to campus to work on projects. For example, our college diversity office has several pre-college summer programs that received national and international awards/recognitions from the National Association of Multicultural Engineering Programs Advocates (NAMEPA) and Airbus Global Engineering Deans Councils. Through these programs, over 1,650 middle and high school students from underserved communities and underrepresented backgrounds are able to bridge the gap in knowledge, major exploration, and career readiness needed to pursue jobs within the growing STEM professions.



Adventures in STEM

- Week-long summer camp by NSF-funded research centers
- Focused on STEM topics (math, biology, engineering)
- Combination of project and game-based learning and field trips to STEM careers (vet school, local engineering firms, etc)
- Feedback overwhelmingly positive

Student Feedback: "I liked it because I got the chance to bond with the other people and I felt more confident about myself around them"

Parent feedback: She liked the experiments the most, especially the solar cooker and has made them for all of her friends and family. She said there was only one thing that she didn't like and that was when the week was over."

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Our UTK-TCE outreach programs for women in engineering start in middle school. A summer camp run two NSF-funded research centers (NIMBioS, CURENT) from 2012-2019 exposed girls in grades 6-8 to engineering, math, and biology in a week-long summer day camp. The girls participated in a variety of engineering, biology, and math hands-on projects and activities like the engineering design process as they worked in teams throughout the camp to build and then test their designs. Student teams collaborated, worked together to form a beginning design, took notes after testing to discover how best to move forward, and then improved their design until it was sufficient. The process of learning from each test and recognizing that failure is an essential part of progress was emphasized.

The week also set aside one day devoted to learning outside of the classroom. On the final morning, the girls interviewed scientists and engineers to hear about numerous individuals' personal experiences in these professions. Each student then prepared a poster summarizing one activity that was completed during the week and presented it to their peers, parents, and faculty and staff. This allowed the girls not only to display what they learned throughout the week in the program but also provided crucial practice in presenting and public speaking that is so imperative in the world of academia.

In their pre/post-camp surveys, participants expressed positive attitudes about women's

abilities to pursue and succeed in STEM careers. Participants felt like the camp gave them the chance to be around other girls their age with similar interests. One participant stated that “I liked it because I got the chance to bond with the other people and I felt more confident about myself around them.” Parents also gave positive feedback, stating that their students appreciated the camp and had fun. One parent made the following comment: *“She wanted more science. Also, our child doesn't talk about her day much so the fact she talked at all is significant.”*



High School Introduction to Engineering Systems for 12th Graders (HITES12)

- Weeklong residential programs supported by various funding sources
- Focused on engineering awareness and college readiness
- Faculty, staff, and current engineering students serve as mentors
- The Pre-College Network
 - Alumnae Update: *"So I'm a GTA now for an intro to nuclear engineering course for the department. I was introducing myself to the class today and saw one of our [pre-college] students from Summer 2020 in the class. His name is [omitted], and I thought it was so cool that he decided to come to UT for nuclear engineering and that I get to be his TA."*

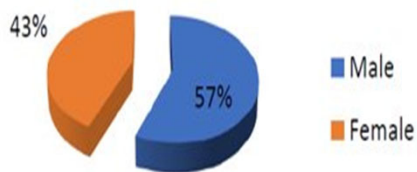
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Middle school exposure alone is not sufficient to encourage persistence in STEM. Under a diversity office's leadership, the office's first pre-college summer program for middle school students was founded in 1997. Bridging upon this program's success and need for ongoing enrichment programs for coed groups, our college of engineering expanded its programs to engage high school women, underserved, and underrepresented populations in STEM activities since additional inventions, breakthroughs, patents, and innovations would be discovered if there was equitable access and fewer barriers to entry.

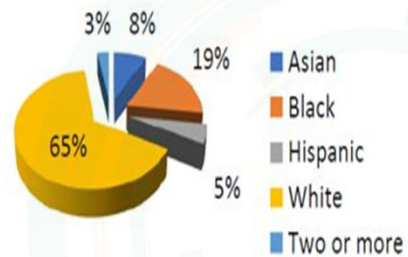


HITES 12 Example Demographics - 2018

Gender Make-Up



Ethnic Make-Up



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This slide shows sample data from our high school program for rising twelfth graders. The underrepresentation of women and underrepresented minorities are seen at greater rates during this program than our seventh to tenth grade program.

As we examine the discrepancies in numbers, we acknowledge barriers to entries such as lack of college knowledge and other hindrances that deter women from pursuing engineering.



HITES12 (cont.)

Program Year	# Participants	# Admitted to COE	# Enrolled in COE
2016	52% (24 women out of 46 total participants)	67% (16 women out of 24 women admit)	69% (11 women enrolled out of 16 admitted women to COE)
2017	45% (20 women out of 44 total participants)	85% (17 out of 20 women admits)	76% (13 women enrolled out of 17 admitted women to COE)
2018*	42% (16 women out of 38 participants)	81% (13 out of 16 women admits)	62% (8 women enrolled out of 13 admitted women to COE)
2019	43% (13 women out of 30 participants)	77% (10 out of 13 women admits)	62% (8 women enrolled out of 13 admitted women to COE)
2020**	51% (22 women out of 43 participants)	59% (13 out of 22 women admits)	38% (5 out of 13 admitted women to COE)
2021	37%^ (19 out 51 participants)	TBD	TBD

*feeder programs were discontinued (Summer 2018) | **COVID-19 (online program) | ^ women were split across two programs

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Each year we strive to increase the number of women participating in our program. We have had a measure of success, but there is still much work to be done. It is our hope that this study will help us to better understand why women are attracted to engineering and our college of engineering. Alternately, we must also understand what hinders women from pursuing engineering or declining their admissions into our college of engineering.



Methodology

Pilot Study: Spring 2021

- Anonymous survey sent using QuestionPro to female or female-identifying students involved in Society of Women Engineers and the Alpha Omega Epsilon STEM sorority
- Members of each group were provided with the link for the survey through GroupMe.

Full study (Fall 2021 roll-out)

- Sent to all female or female-identifying first year students in our college of engineering

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The survey was called “Women in STEM” and it was created through the QuestionPro service. It was designed primarily to be answered by female college students who are pursuing a STEM degree. The survey began with some demographic questions and logic settings to send people who are not females and/or not in a STEM major to a different question set. This way, the questions that were most closely related to the research questions were only answered by those to which they most applied. The survey also asked about the individual’s status pertaining to an internship or research position. The principal questions of the survey asked participants to rate the most significant push and pull factors for women when considering to pursue a STEM career.

The participants included members of the STEM sorority at our college of engineering as well as our SWE chapter. These individuals were the target audience for my survey because they are representative of undergraduate women in different STEM majors and have unique experiences and backgrounds.

The survey was distributed primarily through GroupMe for each of the groups of interest. The survey is confidential and only collects contact information if it is provided by the participant. The survey posed no risks to participants and was entirely optional.

In order to later be able to better analyze the data, I supplied several factors for participants to choose from that were likely applicable factors in their decision to pursue STEM. They were asked to rate how much each of the factors applied to them personally. The next question asked them to explain the most significant factor, which provided a unique insight into each participant's situation. These written responses were extremely helpful in fully understanding individuals' situations and attitudes.



Pilot Study: Results

N=35 female-identifying students in STEM fields

4 Major Themes:

- Pull: Intrinsic Motivation
- Pull: Past Experiences
- Push: Maternity Leave/Family
- Push: Misogyny

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Of the 38 completed responses, 35 of them were individuals who identify as female and are currently pursuing an undergraduate degree in a STEM field.

For our data analysis, we looked at both the quantitative survey data as well as the open-ended qualitative data. We coded the qualitative data using in-vivo coding [2] to see what themes emerged. The final themes that we found were: intrinsic motivation to pursue STEM; concern about future family and maternity leave; concerns about/experiences with misogyny; past experiences in STEM; and improvements.



Theme: Intrinsic Motivation as a Pull Factor

“I felt led to be an engineer because of my love for a challenge. I struggle like most with the courses but **it feels great to solve problems**. I want to solve problems for a living. It makes me happy and happiness is my ultimate goal.”

“I think life goals and aspirations is probably the number one reason I’m an engineering major. I’ve always had an inclination for math and science and knew that **with an engineering degree I’d be able to go in the direction I desired to.**”

“My dad brought home Arduino and wires home when I was 11. He taught me how to make creations out of my younger brothers’ legos and code them to move and make noises. **I have wanted to do something in computer engineering since.**”

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Of the five pull factors supplied for participants to rate by their importance, the most highly rated factor was to fulfill career/life goals. The written responses provided useful insight into individuals’ reasons for pursuing a STEM career. Some of the more insightful responses include:

First, the fact that the majority of women’s reasoning for pursuing STEM is intrinsic is reassuring for the future. Many of the comments written by the respondents indicated that it was their own desire to pursue STEM, that they had always excelled at math and science and were interested in it. However, there were still several instances of extrinsic motivations such as parents and past teachers. This common trend is reassuring, that young girls are becoming interested in science and do not feel pressured to choose it from other’s unwanted influence. It is important to balance the difference between allowing girls to explore their passions and then pushing them to pursue something they do not wish to pursue.



Theme: Past Experience as a Pull Factor

“My math teacher was a retired female engineer and she heavily influenced my college choice.”

“My experience within my high school’s STEM program made me fall in love with engineering as a whole and ultimately was my deciding factor in pursuing it in college.”

“My dad brought home Arduino and wires home when i was 11 He taught me how to make creations out of my younger brothers legos and code them to move and make noises. I wanted to do something in computer engineering since.”

“My mom encouraged me to be curious about it and pursue it; along with my mom’s encouragement I thoroughly enjoyed all my math and science classes throughout school and I think having good teachers contributed to that.”

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Past Experiences

One trend that was discovered through data analysis came from a cross tabular analysis of people who were in a STEM program in their high school and then how much positive past experiences had an impact on their decision to pursue STEM (shown below). The opposite was also true- those who did not have a STEM program at their school mostly listed past experiences as not at all influential in their decision.



Theme: Maternity/Family Leave as Push Factor

“My dad has the viewpoint that moms should stay home and that a woman shouldn’t stay in engineering after having kids, **so I feel guilty/conflicted** about the fact that I will probably always have to work since my fiancé won’t make enough for my family to live to the degree I would like...”

“Knowing that I may have to choose between spending time creating a family or maintaining a position at work.”

“Knowing in the future I would have to balance my aspirations and goals of becoming a vet while also being a mother/wife.”

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The second-highest ranked reason for hesitation about a STEM career is the difficulty of the profession and having a family. Several respondents brought forth their doubt of being able to balance having a family and also a demanding career:

Another idea that can be gathered from the survey responses concerning the push factors for women pursuing STEM is that one of the primary hesitations is from an institutional source. This is problematic, as the United States’ maternity leave policies are something that should not be what prevents a woman from being in the career she wants. While it is true that any job a woman holds while being a mother could present difficulties, those troubles seem more acute in STEM-related fields.



Theme: Misogyny as a Push Factor

"When I got into my program at university, my dad was upset at me for wanting to go to a school so far away and study something 'so medical and gross, that's not for women.' He refused to help me financially so I had to take out massive loans to pay my tuition. I'm worried about making enough money to pay them off in the future."

"I am worried that I will always be a second choice to a male with the same experiences and qualifications that I have."

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Of the five push factors supplied for participants to rate by their influence (male-dominated industry, gender discrimination/sexism, lack of female role models in STEM, difficulty with having a family, and demanding hours and profession), the most highly rated factor was gender discrimination/sexism.

The fact that the most common response for push factors of STEM is gender discrimination/sexism is concerning. As seen in the sample of responses listed above, many women were greatly affected by parents or other significant figures in their lives doubting them. They are also under criticism from their male colleagues who may feel as though they are more capable and deserving of positions. These attitudes displayed by others are harmful in many ways and only contribute to the societal view that women are the lesser sex. It likely leads to self-doubt in many women –something also mentioned frequently in the survey responses– which is arguably the most powerful reason to avoid something.



Preliminary Takeaways

Pull factors

- Women tend to pursue engineering when they experience positive feelings about their abilities (self-efficacy) and have positive role-models and programs that foster their individual growth

Push factors

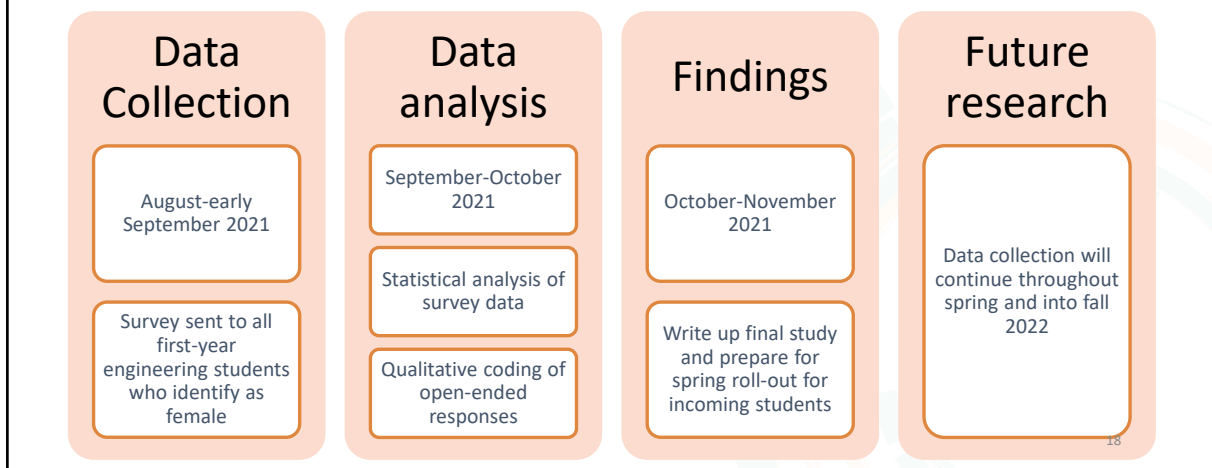
- Women tend to struggle with their choice to pursue engineering when they feel like family members are not supportive or that engineering may hinder their future family goals

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Overall, the results of the survey seem to support the general understanding that misogyny and gender discrimination are the most significant holdbacks preventing women from being equal with men in STEM fields. The survey also revealed what were the most significant push and pull factors for undergraduate women in a STEM major. This likely extends to be a general assumption about all undergraduate women in STEM in the United States, perhaps with slight regional or cultural differences.



Study Design: Fall 2021



After the pilot study, we decided to continue our data collection with a much larger study focusing on first-year students in our college of engineering. Using internal data, we sent the survey to female and female-identifying students within our college of engineering and collected the data using QuestionPro online software. Because this is the beginning of the fall semester and we have a period of time where students often change majors or drop courses, we will not finish data collection until after Labor Day.

The next step of our analysis will be to analyze our quantitative data for statistically significant responses, and to code our open-ended questions. We will use the codes that emerged from the pilot study as part of our coding scheme, but we will also allow for new themes to emerge during analysis.

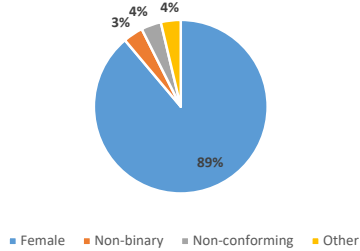
Our intention is to keep sending this survey to female and female-identifying students who enter our college at the beginning of new semesters, and to use the data we collect to help make programmatic decisions to increase the likelihood of women remaining in engineering and earning their degree, as well as identify the push factors within a larger data set.



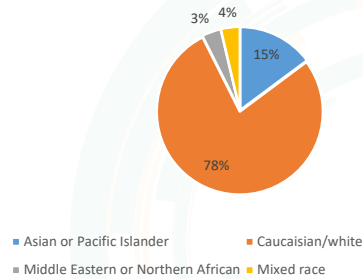
Fall 2021: Survey Demographics

N=27 (10% response rate)

Demographics - Gender



Demographics - Race/Ethnicity



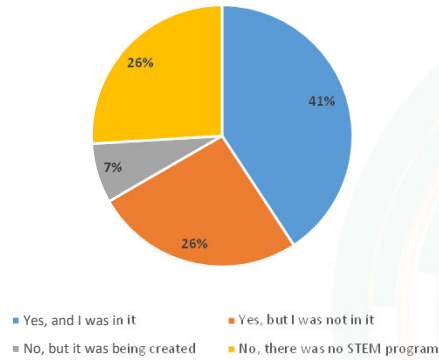
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We sent out our survey to over 250 first-year students who identified as female in their application and registration information. 27 responded, which is a 10% response rate. While most of these students identified as female, some also identified as non-conforming, non-binary, or other. Demographically, most of those who responded were Caucasian/white, but we also had some students who identified as Asian (15%), Mixed race (4%), or Middle Eastern/North African (3%). No one who took our survey self-identified as black/African American or Hispanic, which is something we will have to consider as we progress with future iterations of this survey.



Background information

Did your high school have a STEM program?



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We noticed that 41% of our students who took the survey participated in a STEM program during high school, and 26% of students who responded knew of the existence of a STEM program but did not participate. The fact that 26% of our respondent had no access to a STEM program is notable because we have found that access to STEM in high school often leads to STEM in college.



Findings

- Pull factor: Intrinsic motivation (and some extrinsic)
- Push factor: Sexism/misogyny
- Mixed finding: the role of K-12 STEM programs
- New finding: becoming/finding female role models

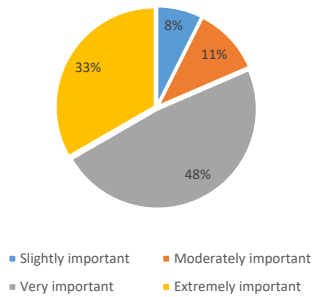
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We found two significant results from our initial study. These results mirror what we saw with our pilot study: intrinsic motivation is a major pull factor into engineering, whereas sexism (as our participants this time referred to it) was a major push factor. We also had mixed results as to the importance of STEM programs in K-12, which differs from our initial study. Finally, female role models was a new theme that emerged from the data. Female role models had been mentioned in the pilot study as a pull factor into engineering, and some participants mentioned that again, but what was different this time was that our participants referenced wanting to be role models themselves, or searching/needing role models in both K-12 and higher education.

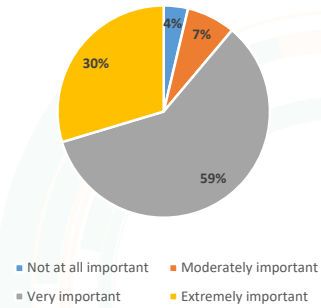


Important Factors

How important is: long-standing interest



How important is: fulfilling life goals



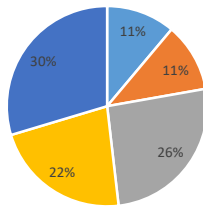
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The two most notable factors that participants identified as influencing their decision to pursue engineering were long-standing interest and fulfilling life goals. Over 80% of students who took the survey rated interest in engineering as being either very important or extremely important. Likewise, nearly 90% of students reported that fulfilling their life goals was an important factoring for pursuing an engineering degree.



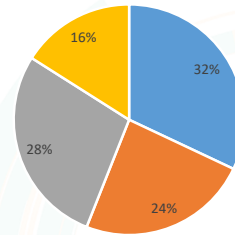
Important Factors

How important is: Positive past experiences from programs/schools



■ Not at all important ■ Slightly important ■ Moderately important
■ Very important ■ Extremely important

How important is: Parental influence



■ Not at all important ■ Slightly important ■ Moderately important ■ Very important

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Students also rated, with varying degrees of importance, participation in STEM programs during high school. 30% rated it extremely important, but 22% only found it slightly important. This may be because students who did not have access to STEM programs in high school may not find the programs as important as the intrinsic motivation of fulfilling life goals or life-long interest.

Parental influence, usually in the form of parents who are engineers or parents who encouraged engineering, was the least important factor in why our participants pursued engineering. Only 16% of students reported that this was very important whereas the rest rated it moderately important or even less important: in future iterations of this survey, we will want to explore this connection further to determine more accurately how many of our students are first generation college students.



Open-ended questions

- What factors influenced engineering?
- What factors make you hesitant?
- What needs to be changed?

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We asked three open-ended questions to our participants to gain more information about what factors influenced why they became engineers, what factors made them hesitant, and what they thought needed to change. These questions were used to determine the themes of the study. We used our prior themes as our coding scheme, as well allowed other themes to emerge while we coded the document.



Theme: Intrinsic Motivation as a Pull Factor

We continued to see intrinsic motivation in our participants responses

“I have always been very interested in science, especially biology, and problem solving, but the real deciding factor was how much I enjoyed my high school engineering classes. If I hadn't been introduced to engineering specifically in late middle school, I would probably be majoring in a general science like bio or chem.”

“I love the opportunity for design in engineering, as well as being able to go so in depth in a subject I'm interested in. Engineering to me has similar appeal as the sciences but the applied aspect and being able to see your work all come together as a system sounds exactly like what I want to do.”

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Like in our pilot study, we once again saw intrinsic motivation as a major pull factor for pursuing engineering. Survey participants mentioned their own experiences and their own drive to become an engineer. This aligns with what we saw in the pilot survey.



Theme: Intrinsic + Extrinsic

We also began to see extrinsic motivation intermingle with intrinsic motivation

“I think engineering is a very secure and powerful major that helps to influence the world in beneficial ways. I'm also just the type of person that likes to go against the norm a little and engineering is not female dominated so that was very attractive to me because I can handle a challenge. It also is very centered in my dream job.”

“I didn't have a very influential factor except for the fact that I was good at math and the careers produce a high salary. I could also be a role model for younger women, which is always a plus and would've motivated me even more when I was young.”

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We also saw more extrinsic factors like salary and job security link into the intrinsic motivation already seen. One participant referenced power and job security (extrinsic motivators) while also mentioning the fact that engineering can be beneficial and that they enjoyed a challenge (intrinsic motivation). Several mentioned wanting to be seen as a role model, which we believe to be both extrinsic and intrinsic motivation at work. This blend of motivational factors isn't unusual, but diverges from what we saw in the pilot study. We will continue to explore this blend in future iterations of our research.



Theme: Misogyny as a Push Factor

Misogyny - which these participants referred to as sexism - was the predominant factor that made women hesitant

“I was most hesitant about entering a male-dominated field because I did not want people to doubt me or my skills due to my gender.”

“As an openly queer women not only do I have to deal with gender discrimination I also have to deal with homophobia, and the idea of having to protect myself from both forms of hate is daunting. **Especially since there is nothing I can do change my gender or sexuality, and it is extremely difficult to reason and coexist with people who see you as less than because of those things.**”

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Sexism was the most dominant factor that made our participants worry about pursuing engineering as a major. Interesting enough, while students reported being worried about sexism, they also seemed resigned that it would happen. A notable quote from a student who self-identified as queer summarizes what most of our participants said: that they don't expect to change anything about them and will have to face anticipated discrimination in their job field because they are female or female-identifying. Self-doubt was another theme that came up multiple times – fearing that being female would make them the representative for their entire gender and hurt other female engineers who came after them.

BA0



The role of prior STEM experiences

K-12 STEM education still played a role with our students, but was mentioned by fewer students.

BA1
"The most influential factor leading me to pursue engineering is my high school STEM program. I had great experiences and opportunities to learn. I wanted to continue on the same path after graduation."

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52% of our participants reported that STEM experiences in K-12 influenced their decision to become an engineer, whereas the remaining 48% found it moderately important to not important at all. We also saw this in our open-ended question responses, where the role of prior STEM experiences was mentioned, but not to the degree that it was in the pilot. Those that did self-report on the role of high school engineering classes still rated them very highly.

A question for future research would be to compare the pilot study, which focused on individuals who are very involved in STEM and may have come from a more STEM-based background, against those who may have not had as much past experiences like that reported in our Fall 2021 study. We are interested to know if having more exposure to engineering in high school may change how students view themselves as engineers and engineering students.

Slide 28

- BA0** [@Skutnik, Anne Leslie] the first quote contradicts the claim that we are making- are we trying to show more of the girls wanting to be role models?
Boyd, Isabel Anne, 2021-11-01T17:54:28.541
- SL0 0** [@Boyd, Isabel Anne] you're right, I don't have the evidence to say that. I revised the slide and the notes to align more with what we are saying.
Skutnik, Anne Leslie, 2021-11-01T17:59:48.940
- SL0 1** Also moved the second quote to the next slide where it fits better
Skutnik, Anne Leslie, 2021-11-01T18:00:41.363
- BA1** self-reported? not sure which one [@Skutnik, Anne Leslie]
Boyd, Isabel Anne, 2021-11-01T18:05:07.325
- SL1 0** [@Boyd, Isabel Anne] how about this?
Skutnik, Anne Leslie, 2021-11-01T18:15:33.325
- BA1 1** perfect, that clears it up
Boyd, Isabel Anne, 2021-11-01T19:06:58.874



What should change?

Participants wanted to see more female role-models: there was a lot of discussion about having female role models in school or being connected to female engineers in industry.

"I think as more women get into engineering and there are more female role models the numbers might even out a bit to make it less male dominated. I think the more engineering classes are pushed in high school the better it will be as well."

"I think more women TAs or just women staff in engineering. Sometimes it's just nice to have a girl to talk to rather than a guy which sounds silly but it's the truth."

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Participants had several things they wanted to see change: more female role-models was most popular, followed by changes in K-12 education and the end of sexism in engineering. The thread of sexism affecting female from pursuing engineering looked different in comments about K-12, specifically how it related to not having enough opportunities or being discouraged from taking math classes because they were women. Future research will have to be more clear if the students who want to see changes in K-12 reported not having a strong STEM program in school, and if they are correlated.



Final conclusions

- Participants expressed both **intrinsic and extrinsic motivators** for pursuing engineering
- Participants worried about **misogyny/sexism** but seemed resigned to it happening
- Participants reported wanting to be a **female role model** and wanted to see increase in female role models (TAs, faculty, and industry contacts)
- Participants were mixed in reporting prior K-12 experience yet also wanted to see **increased K-12 support for female students**

30

Our participants seemed to be deeply affected by sexism and any sort of marginalization for being women in engineering. Because this was mentioned both as a negative (push) factor and as something they would like to see change, we think that this might be something to consider deeper in future iterations of this survey. Likewise, we need to understand more the role of K-12 STEM programs in encouraging female and female-identifying students to pursue STEM.



Next Step

The Women in Engineering Program is taking students' perceptions and experiences in stride as we build new bridges for aspiring engineering students:

- Pond Camp Elementary School outreach led by Society of Women Engineers (SWE)
- Faculty Mixer co-sponsored by Alpha Omega Epsilon (A.O.E.) STEM Sorority

Future research directions: Engineering Identity

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Currently, the Outreach Program and Women in Engineering Program (WIEP) are partnering to address the students' concerns in the study. We have two new initiatives inspired by senior female students and this survey. We have outreach initiatives, including our Pond Camp Elementary after school engineering club. This club was created by the Society of Women Engineers, with support from the TCE Outreach program and other student organizations. This complements the existing programs we have for students in grades 6-12, and will allow a longer pathway to engineering in K-12.

We are providing opportunities for female engineering students to network with female faculty and staff in engineering. Starting in the spring semester, WIEP is co-sponsoring a faculty mixer highlighting undergraduate research as a form of mentoring. The program will consist of a panel discussion with a female faculty member and Director of Women in Engineering Program. Topics for this program include: what is mentoring, how to find a mentor, and benefits of mentoring. The first author of this paper will discuss her experiences being mentored through undergraduate research. Finally, students will have an opportunity to socialize with their peers and female faculty members in a casual setting. We will follow up with students who participated one month later to see if they have connected with a faculty member for research or mentoring opportunities.

Additionally, we will investigate future directions for this research, which might be to

include a validated measure of engineering identity (with permission) with our survey, to see if students who identify more with engineering have different responses than those that do not, and if they have different experiences. There are several measures that exist which we will look through to determine what will work best.

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Slide 32

BA0 Is this all that is needed? Or maybe my year and major? [@Skutnik, Anne Leslie]

Boyd, Isabel Anne, 2021-11-01T18:05:44.081

SLO 0 Yes, add that

Skutnik, Anne Leslie, 2021-11-01T18:15:48.466