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Engineering Technology and Engineering Program Comparison of Underrepresented Students in the Same Institution

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Dr. Lucietto has focused her research in engineering technology education and the understanding of engineering technology students. She teaches in an active learning style which engages and develops practical skills in the students. Currently, she is exploring the performance and attributes of engineering technology students and using that knowledge to engage them in their studies.

Dr. Lesley M. Berhan, University of Toledo

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Engineering Technology and Engineering Program Comparison of Underrepresented Students in the Same Institution

Engineering programs include far fewer African American students than engineering technology students enrolled in four-year programs at universities offering both ABET accredited programs. Several studies show this contrast, suggesting that further research in this area is warranted. The rationale for the higher population of students consistently in one program over the other is generally unknown. While researchers study the engineering population, the engineering technology population goes relatively unnoticed. The effects of a student's past and current environments in engineering technology are relatively unknown.

Researchers developed a survey to gather data from underrepresented populations in universities that meet the noted criteria. While the premise for this survey was to learn more about these students, their demographics, community and school support and preparation for the university experience, as well as their plans for the future, due to the demographics of this population most of the respondents were white. Research shows that learning in the informal community and family environments influences and supports student choices, and success. Originally it was anticipated that students meeting similar demographic criteria in the engineering and engineering technology programs would be compared within each of the universities studied with both ABET programs. Considering the responses obtained using the survey, the focus of this work is intended to learn more about this student population, their path to engineering technology, and to better understand the impact of differing institutions.

Introduction

It was reported that in 2016 a higher number of bachelor's degrees were awarded to Black or African American students in engineering technology than in engineering [1-3]. The rationale for this trend is unknown, and the amount of research on this very small part of the academe does not explore the issues that affect the decisions made by these students as they confront the question of what to do with their careers. Various techniques employed by recruiters at different institutions have diverse results, while academic, and environment, may have a role in the choices made by these students. Understanding these students, their similarities within an institution, as well as between programs is anticipated to provide greater ability to recruit, retain, and encourage more diversity within these student populations.

Literature Review

This is a small population of students as it is reported that there are far fewer bachelor's degrees awarded in engineering technology than in engineering. When comparing the number of graduates, there are fewer than 10% of the degrees awarded in engineering technology programs[2, 3]. To clarify the differences between majors, and define underrepresented students, the following was developed to support the rationale for doing this work and the significance of furthering our understanding of this small, but worthy student population. The focus of this paper is on the 4-year engineering technology program and the students graduating from them.

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Engineering Technology. A lesser known program, engineering technology attracts students in areas where there are universities offering these majors. While the attraction to these programs tends to be regional, students generally don't always choose these programs right after high school, but transfer in from a variety of places. In many cases, they may have matriculated straight out of high school through the influences of teachers and advisors they knew and respected. Other options include those that transfer into programs from community colleges with engineering technology programs, and other reasons, including poor grades in engineering, desire for more hands on laboratory experiences, or learning that the engineering technology major is interesting and they may learn different things. Some students report being more "hands on," which supports the assertion that engineering technology is an applied program as opposed to the more theoretical program of engineering. At times there is confusion regarding what engineering technology is[4], and what it takes to major in the field.

Engineering. As the better-known and available program, engineering attracts many students. The focus is on the theoretical, understanding the basis for a variety of phenomena, and is found in universities in every state in the United States[3]. There is a broad offering of specific disciplines, and it is a major that is recognized throughout the world.

Underrepresented Students. Current reports state that the population in the United States is no longer as diverse as it once was[5]. As people have emigrated from all parts of the world, cultural groups are represented in much different percentages than 10 years ago. Over the last century much of the diversity evident in the early 1900's has assimilated into what is referred to as a melting pot, constantly changing. However, universities do not reflect the type and level of diversity of the current population[2, 3]. Both of the engineering and engineering technology programs, despite higher levels of one underrepresented group or another, still has much higher levels of white students. Thus the general population that was once in the minority are moving to a more balanced number as related to the population of whites, but not being similarly represented in university populations in engineering or engineering technology.

ET vs. E – Underrepresented Students. Often the discussion regarding the comparison of engineering technology and engineering focuses on the applied nature of engineering technology, and the more theoretical nature of engineering[1, 6]. However, the assumption is often heard in casual discussions that under-represented students generally do not persist in programs like students in the majority. This is not the case. In a study done on data focused on universities with higher number of underrepresented students, it was found that students drop out across all races at the same rates[7]. Further unpublished work in this area shows that this is the case for both engineering and engineering technology programs.

Choosing a Path Forward - Student Choice of Major. Studies show that women first choose majors in subjects that interest them and secondly, those in which they have a proven aptitude [8]. Others have found that when a field or pursuit is associated with brilliance females move away from these choices, while men are attracted [9]. Considering Malgwi's [8] assertions, they found that men consider career advancement, job opportunities, and compensation as reasons to

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choose a major. Others cite environment as a factor[10], as well as other influences. Thompson [11] cites gender of the advisor as a reason for choice of major.

The questions used in the survey are intended to probe students' paths to their current major, understand how far along they are in pursuing the degree, and those that influenced those decisions. The comparison between the two institutions with differing culture and relationship between engineering and engineering technology provides more insight into the role the institution plays in student decision making.

Research Questions

As suggested in the previous section, understanding more about students in engineering technology, as well as contrasting institutions to see if there are similarities or differences will help future recruitment and retention efforts in engineering technology programs. While the research population is limited in this study, the following questions provide insight into this population.

- *Who are the students in engineering technology, in particular those that responded to a survey identified as probing for information from under-represented students?*
- *What path was followed by students choosing to pursue engineering technology at the two institutions studied?*

Methods

To obtain information on these student populations, a survey was developed using techniques found in Van Selm [12], Fink[13], and Blair[14]. The survey resulted in multiple sections divided into the areas of interest – demographics, home environment, preparation for higher education, and future plans.

Survey Development. Recognizing a trend of under-represented students choosing engineering technology as a major in far greater percentage than engineering, the authors developed an online survey of engineering technology students. The overall goal of this work and later research is to discover more about engineering technology students, the choices they make, and the things they are considering for their future.

An outline was developed to address the research questions, particularly designed to assure that answers to the research questions would be available for analysis. A combination of multiple choice questions were designed to obtain demographic data, while other question types were utilized to obtain data and open-ended responses to questions relevant to this work. While open-ended questions are not always ideal, the researchers agreed that this method of obtaining data was best suited to gather the needed data [12].

Collection Methods. IRB (Institutional Review Board) approval was sought at both authors' universities once the survey was developed. A link to the survey, along with a letter indicating

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IRB approval was distributed to engineering technology and engineering students at both of the authors' institutions. The students were informed of the intent of the project and a link to the survey distributed to minority groups at both study institutions.

Data Analysis Methodology. Responses to the Quatrics survey resulted in 123 responses to 48 questions which are noted in Appendix A. After removing data without location, identifiers used to determine institutional relationships, there are 115 responses. From these 115 responses, one university has 51 responses while the other 64. The institution with 51 responses (Purdue University) has a program with engineering technology and engineering programs in different colleges, while the other institution (University of Toledo) with 64 responses has a college with both programs. Percentages are noted when using descriptive statistics to show survey results, and are based upon the noted number of responses for that particular answer. Microsoft Excel was used to complete a compilation of data into the figures used to compare the different institutions.

Findings

Purdue University – Demographics. This section reviews the student reported demographics of current engineering students at this large Midwestern University. This university has two very distinct programs in engineering technology and engineering, each in their own college. This section provides insight into students at this university.

Gender. Based on the students represented in this data, a far greater percentage of female students responded than are in the engineering technology program at this college. The current enrollment is approximately 14% with 23% of the respondents of this survey being female. Figure 1 provides this data.

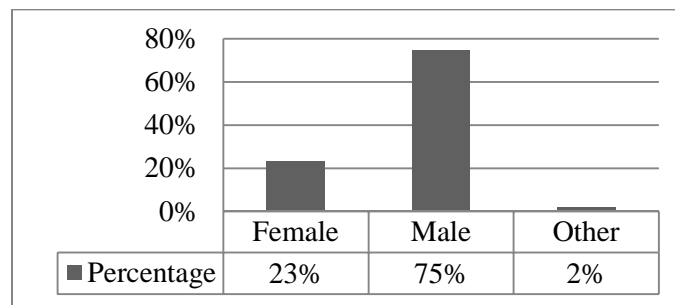


Figure 1. Responding Students By Gender (Purdue University)

Age-by Gender. The majority of students responding to this survey are of traditional college age, as seen in Figure 2. This data aligns with a past study of engineering technology students done previously comparing students from the main campus to other campuses around the state [15].

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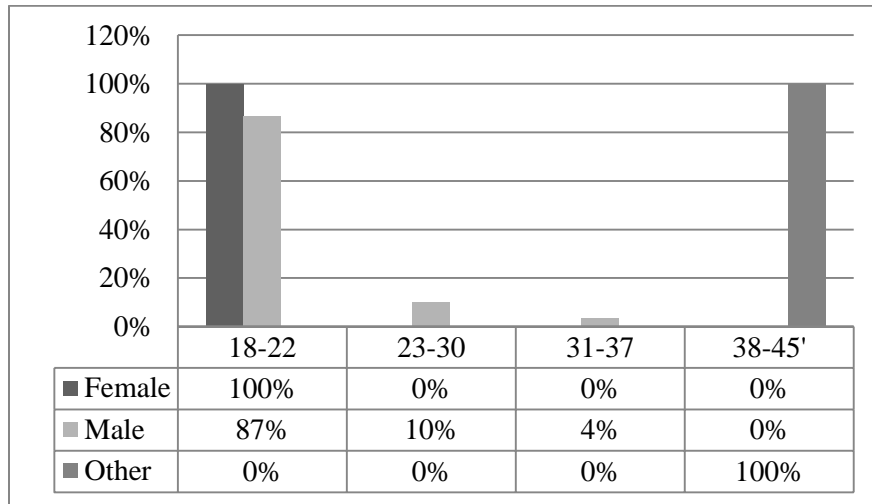


Figure 2. Age By Gender (Purdue University)

Race – By Gender. Often comparisons of student enrollment include examining the number of students by race and gender. Data available from the two universities allows that examination. Regardless of gender, it is obvious that there are more white students. When examining the data retrieved by this survey, it is also very clear that Native American and Hispanic/Latino students most often cite two or more races. While Asian, black, and white students generally identify as one race or another. In Figure 3 the data is presented percentages as compared to the female, male, and other declared genders.

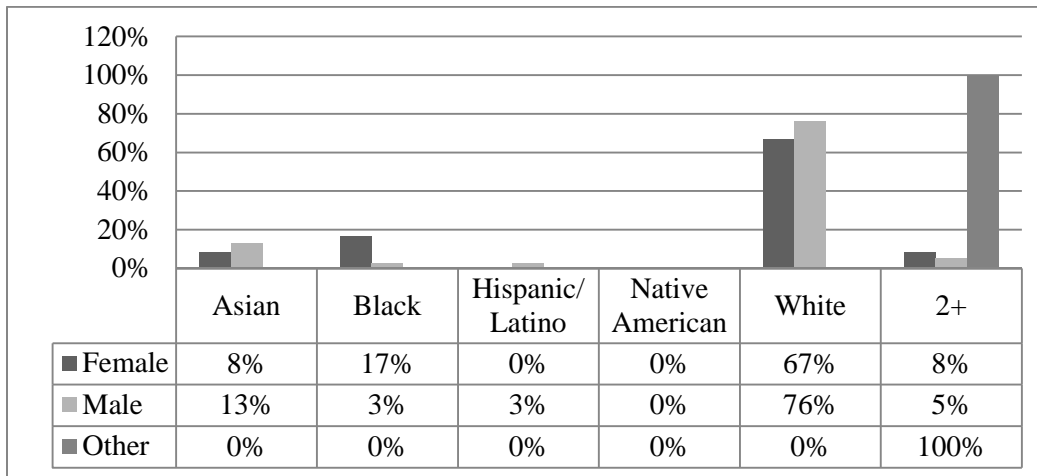


Figure 3. Race – By Gender (Purdue University)

Number of Students Attending HS in US or US Territory. Nearly 14% of the engineering technology students at Purdue University went to high school outside of the United States and US Territories.

Major – By Gender. Students responding to this survey at Purdue University appear to be most attracted to Mechanical Engineering Technology as a major. While the one student responding

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other is enrolled as a Mechatronics Engineering Technology major. Mechatronics Engineering Technology is a relatively new major. In comparison, male students find Mechanical Engineering Technology most interesting, followed by Electrical Engineering Technology, and a small number of students in other areas. Figure 4 provides the comparison of available data.

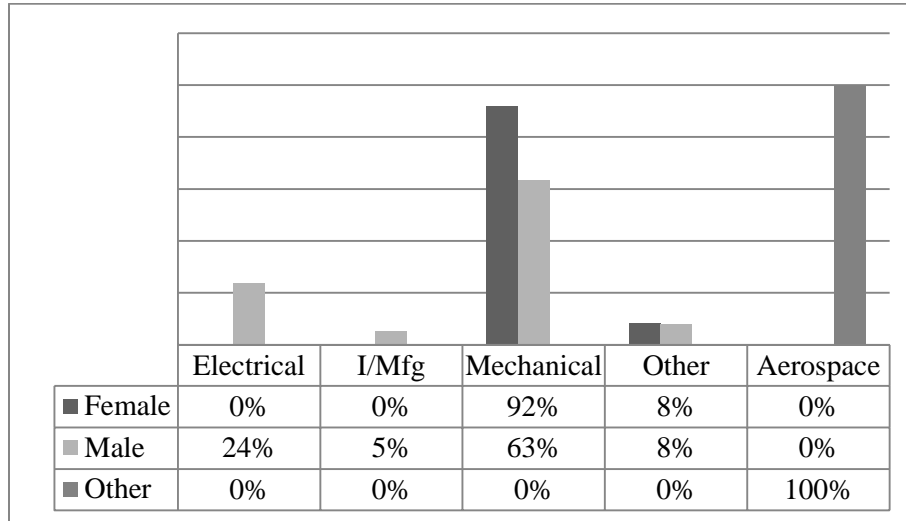


Figure 4. Major – By Gender (Purdue University)

First Major. Students responding to the survey generally indicated that their first major was engineering technology. While nearly a quarter of the female and male students transferred in from other majors, such as business administration, engineering, and physics. Figure 5 shows the comparison between genders and first majors.

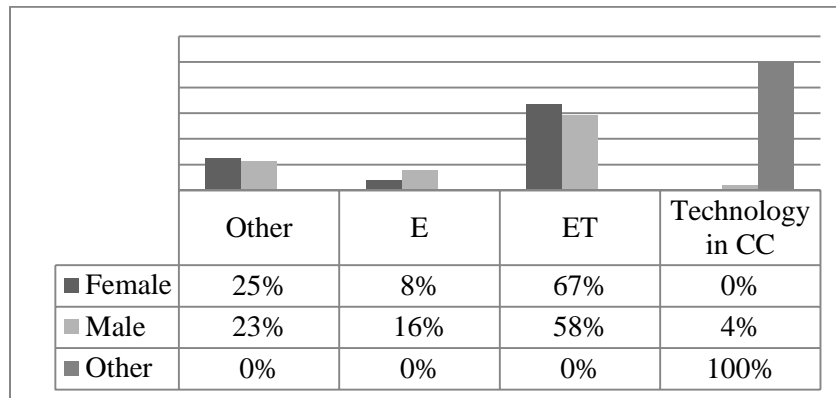


Figure 5. First Major of Engineering Technology Students (Purdue University)

University of Toledo – Demographics. The student reported demographics of current engineering technology students in another large Midwestern University is represented by University of Toledo. This university differs from the one represented by Purdue University in that both engineering technology and engineering are administered from the same department. This section is intended to provide insight on who the students are at this university.

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Gender. Based on the students responding to the survey, fewer students are female than in the response population for Purdue University. Figure 6 shows the comparison of genders reported by those responding to the survey.

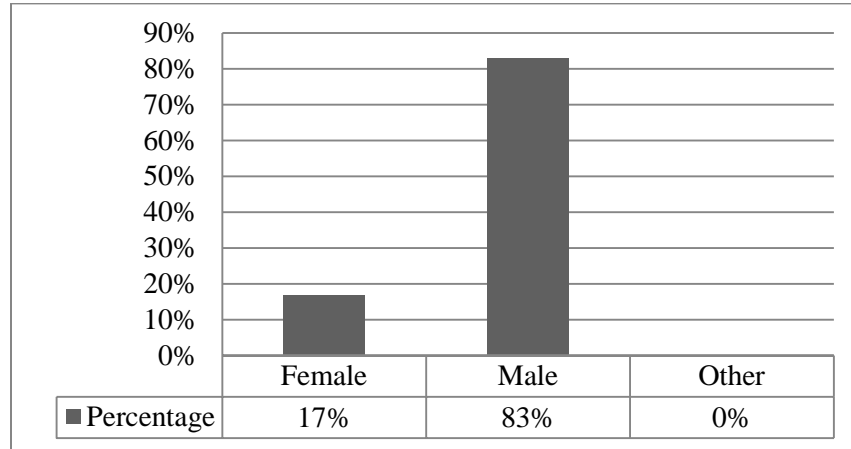


Figure 6. Gender (University of Toledo)

Age – By Gender. Students at University of Toledo appear to be traditional, most in the age group that soon follows high school graduation. Figure 7 shows the comparison.

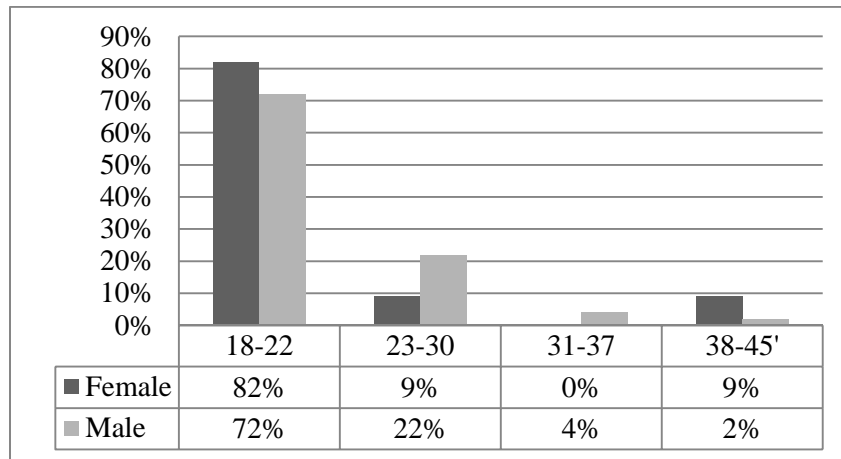


Figure 7. Age – By Gender (University of Toledo)

Race – By Gender. Figure 8 shows the students declared racial distribution by gender. Noticeably there are far more white students than other students reporting from this program.

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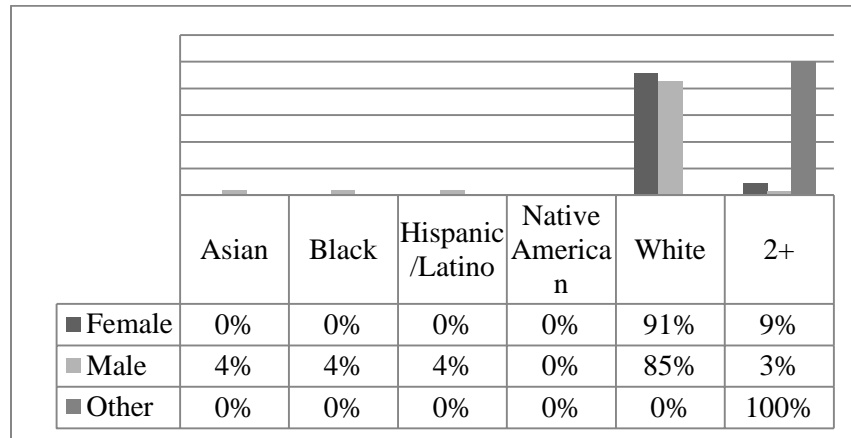


Figure 8. Race – By Gender (University of Toledo)

Number of Students Attending High School in US or US Territory. Nearly 97% of the students responding from University of Toledo attended high school in the United States or US Territory.

Major – By Gender. Students responding to the survey from University of Toledo reflect the higher preference for electrical and industrial/manufacturing engineering technology by the female respondents and lower preference in all other areas except construction. Male students prefer mechanical engineering technology over other fields, and also showed preference for construction and computer engineering technology. The totals by percentage are shown below in Figure 9.

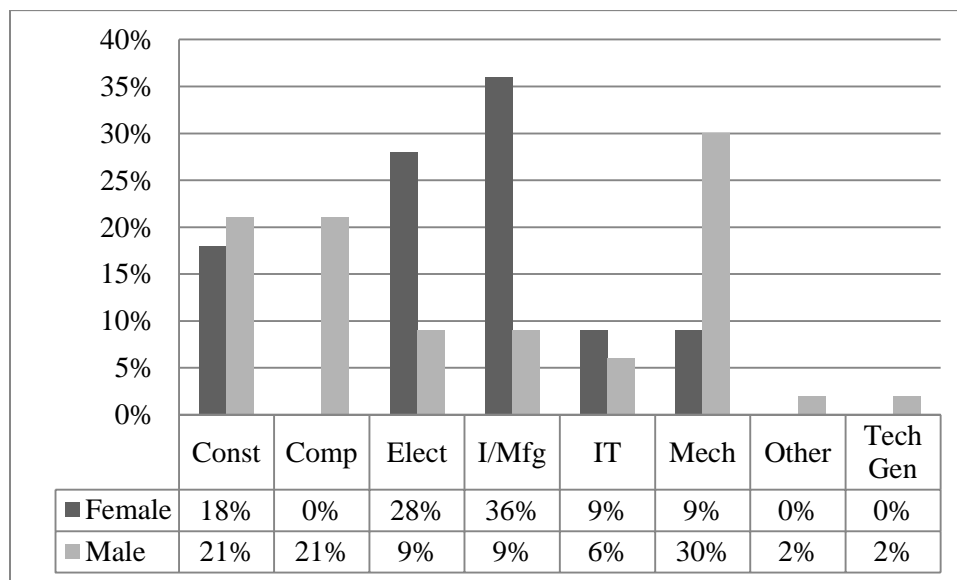


Figure 9. Major by Gender (University of Toledo)

First Major. After reviewing this data, it was determined from the University of Toledo responses that only white students started in engineering. One student who began in IT and then

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transferred into engineering technology was of Asian descent. Figure 10 shows the breakdown of responses by percent related to gender.

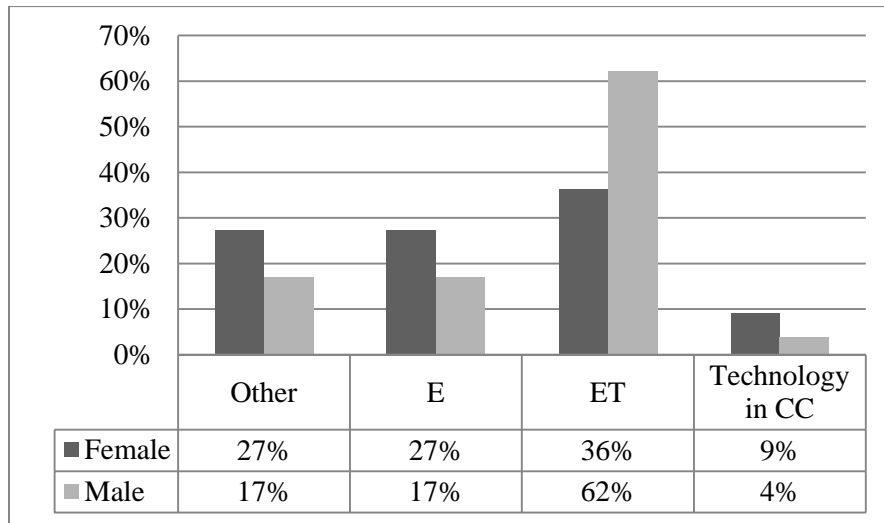


Figure 10. First Major (University of Toledo)

Purdue University - Path to Major. In this section the researchers intended to learn more about the engineering technology students' time in the major, if they matriculated directly or after starting elsewhere. Students respond to a closed question regarding their choice of major and how they first learned about engineering technology.

Years in Engineering Technology. Students responding from Purdue University were fairly well distributed throughout the program with the exception of those with 5+ years. This university has made an effort to graduate students in 4 years. Figure 10 shows that distribution.

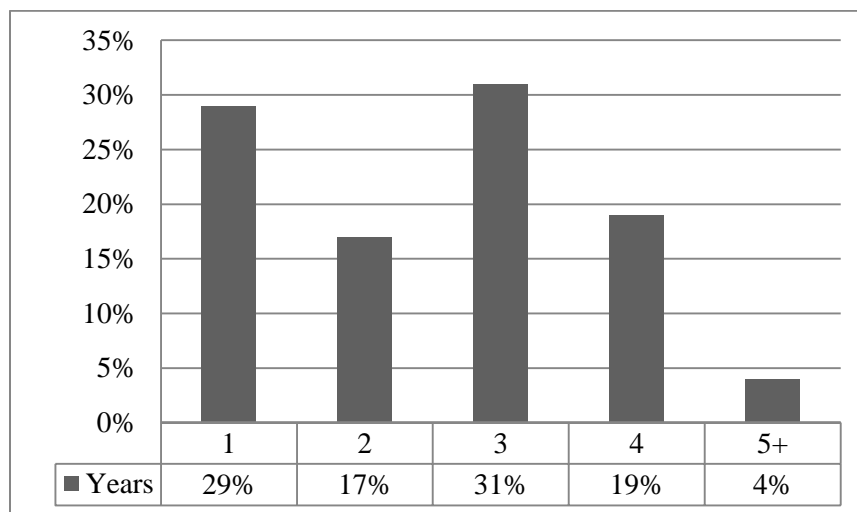


Figure 10. Years in Engineering Technology (Purdue University)

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Path to Engineering Technology. Seventy-seven percent of the students responding to the survey at Purdue University stated that they had applied and matriculated into engineering technology after high school, while 19% of the responding students transferred within the same university, and all but one between colleges. These students transferred from engineering majors, the first year engineering program when they had not joined a disciplined engineering college, physics, and computer science.

One of the respondents indicated they transferred into engineering technology after freshman year and another directly matriculated into engineering technology after working in industry.

Choice of Engineering Technology as a Major. Fifty percent of the students at Purdue University indicated they were hands on, another 25% stated they preferred hands on learning and less calculus and theory. While slightly more than 8% chose no cubicle as their reasoning for choosing engineering technology. Six percent of these students indicated that it was a high demand job, while slightly more than 10 % chose other and indicated all of the choices applied to them.

First Learned About Engineering Technology. Students at Purdue University indicated that 25% of them had learned about engineering technology upon admittance to the program, and others chose academic advisor or other staff, or knowledge of an engineering technology grad. Students choosing other indicated a broad means of learning about engineering technology, including web searches, fraternity brothers, summer camp, college tours, engineering technology clubs, flyers, and engineering friends. Table 1 shows the distribution of responses to this survey question.

Table 1. First Learned About Engineering (Purdue University)

Student in Program	8%
Academic Advisor, Success Coach, College Staff	15%
Engineering Professor	2%
Engineering Technology Professor	6%
HS Counselor	4%
HS Teacher	6%
I Know an Engineering Technology Grad	13%
Other	21%
Upon Admittance to the Program	25%

University of Toledo - Path to Major. Students attending this Purdue University are part of a program that covers both engineering technology and engineering in the same college. The following sections provide information for later comparison of the universities.

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Years in Engineering Technology. Students responding from University of Toledo are nearly equal in their distribution throughout the first four years of their program. Figure 11 provides the comparative distribution of responses.

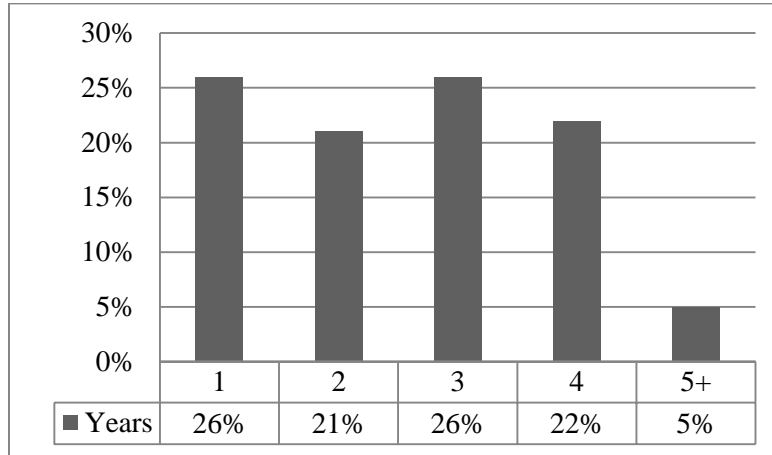


Figure 11. Years in Engineering Technology (University of Toledo)

Path to Engineering Technology. Students were asked to provide information from a list of choices to indicate their path to engineering technology. Nearly 48% of the students responding from this institution indicated they came directly from high school. When compared to their responses to the question regarding where they first heard of engineering technology, all answers were reflected at similar rates.

Nearly 20% of the responding students indicated that they matriculated in another major and transferred into engineering technology. Fifty-eight per cent of these students transferred in from engineering majors. They indicated a variety of engineering majors that they had transferred from, with no major in the majority.

Approximately 8% of the students stated they matriculated directly into engineering technology from a position in industry, while another 8% of responding students indicated that they had transferred in from other 4-year institutions, each coming from business administration, undecided, computer engineering, aero engineering, and music therapy.

Five per cent of the responding students stated that they came after earning associates degrees in business management, HVAC, and operations technology. The last 5% of students came before completing associates degrees in general studies, computer science, and undecided majors.

Choice of Engineering Technology as a Major. Fifty percent of the students responding from University of Toledo indicated they were hands on, while 26% of these students chose other and indicated all of the above. Nearly 24% of the students chose hands on with less calculus and theory. Seven percent of the students indicated they thought engineering technology was a high demand job, while 3% of the students did not want to work in a cubicle.

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First Learned About Engineering Technology. Students at University of Toledo responded that they were advised by someone in an academic setting most often. An even amount of students responded that they learned about the degree when they were admitted to the program, as did students indicating other without specifying.

Table 2. First Learned About Engineering Technology (University of Toledo)

Student in Program	10%
Academic Advisor, Success Coach, College Staff	30%
Engineering Professor	7%
Engineering Technology Professor	5%
HS Counselor	2%
HS Teacher	5%
I Know an Engineering Technology Grad	5%
Other - Not Specified	17%
Other - Boss or Website	3%
Upon Admittance to the Program	16%

Discussion

When asked who the students are in engineering technology, responses from questions aimed at garnering information about the students demographics were compared between the institutions. Per the report prepared by ASEE [2], 13% of the engineering technology bachelor's degrees are awarded to females. The percentage of females responding to the survey's gender question was higher than this figure. Responses to the question of age group found that Purdue University female students were all of traditional college age of 18-22, while University of Toledo female students represented 82% of the female population responding to the survey. Male students at both institutions responded at 87% at Purdue University and 22% at University of Toledo. The researchers find that these figures only represent students responding to the survey and not representative of the student population at each university as a whole.

The original intent of the study was to focus on under-represented students. The data presented by the students responding to the survey indicates that most self-classify as white. Per the ASEE report [2], students graduating in 2015 were slightly more diverse than in previous years. This report indicates that 68.7% are white, not the significant level seen in the survey respondents. Due to this aberration, this report focuses on the pathways to engineering technology.

Focusing more on the results of the choices of major by gender, nearly all of the female students responding at Purdue University were female. Female students responding at University of Toledo had a greater distribution of majors, with over one third pursuing industrial/manufacturing engineering technology degrees. Nearly two thirds of the males at Purdue University chose mechanical engineering technology over the other choices. Males at

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University of Toledo chose mechanical engineering technology most often, but not at the same frequency as those at Purdue University. There is an even distribution of males choosing construction and computer engineering technology degrees and a smaller dispersion over the remaining majors available in technology.

Of greatest interest in this particular work to the researchers is the major at first matriculation. Comparing female students, Purdue University is nearly twice that of University of Toledo when comparing engineering technology as their first major, while male students at both institutions chose engineering technology as their first major at nearly the same rate. Female students at University of Toledo chose engineering first at nearly four times the number of female students at Purdue University. Male students at both institutions chose engineering as their first major at the same rate. No female students at Purdue University pursued a technical degree at a community college, while 9% of the female students at University of Toledo did pursue a degree there first. The same percentage of males at both institutions began their studies in a technical program at a community college.

The comparison of years in engineering school show a more level distribution of responding students throughout their program at University of Toledo, whereas there were more students in years one and three at Purdue University.

Slightly more than three quarters of responding students from Purdue University indicated they had matriculated right after high school, while nearly half of the students from University of Toledo indicated the same. At Purdue University nearly 20% of the responding students had transferred within the university. This university has engineering technology and engineering colleges independent of one another. At University of Toledo, 20% of the responding students had transferred into engineering technology from another major, with 58% of these students transferring in from engineering majors, which are housed in the same college.

Responses to the final question considered in this work address where students first learned about the engineering technology major. Students at Purdue University were more likely to respond "upon admittance to the program" or other, citing a variety of sources that included many of the choices provided with the question. Students at University of Toledo credited their academic advisor, or other school contact, stated other without specifying, and admittance to the program.

Conclusion

Whom are the students responding to this survey? They are predominately white, and did not know about engineering technology as a major before hearing about it from others or being admitted to the program. Without a larger sample it is difficult to ascertain differences between the student populations at the two different institutions. However, upon examination of the data, it bears further examination to see if there are regional differences, or differences because of the administrative structure of the two institutions. Are transfers easier or more difficult due to the

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differences? The researchers ask if female students are more prone to begin in engineering technology if they attend a university that administers these two programs in two different colleges?

When anecdotally reviewing past discussions with students and university advisors, one learns engineering technology students transfer in from many different places and sometimes very different majors. The two institutions show similarities in male engineering technology students beginning their studies in engineering technology at a rate of approximately 60%. One quarter of the female students at both institutions matriculate into majors other than engineering technology and engineering, and those majors range from music theory to business administration. This suggests that there is a possibility that the sources cited earlier, finding female students to first chose majors they are interested in and secondly have an aptitude in [8], may be influenced by external beliefs that the student must be brilliant in the field to succeed [11]. Thus, they begin in another area until they find either they really want to go into engineering technology or they are good at it. The responses indicating students are hands on and prefer that kind of work environment suggest that may be the case.

Future Work

This project will continue with the focus of obtaining more data on students in four year engineering technology programs throughout the United States. Based on the response population for this work, it is necessary to complete further surveys. The target survey audience will need to be tailored to uncover the various issues confronted by underrepresented students in their quest for a major and the best way to provide them with information about the major and the benefit of obtaining one should be explored. This study provides a clearer view that administration, university organization, and practices influence choices students make regarding their future.

Due to the number of under-represented students pursuing engineering technology degrees, specific attention will be given to distribution through professional societies such as National Society of Black Engineers (NSBE), Society of Hispanic Professional Engineers (SHPE), and Historically Black Colleges and Universities (HBCU) throughout the United States. This future work will focus on underrepresented students to further understand these students and provide a foundational understanding to support efforts directed at these students' preparation, choices, and institutional support.

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Appendix A Engineering Technology Student Survey – Questions Used In This Paper

Demographics

- What gender do you identify as?
- How old are you in whole years?
- Did you attend high school in the United States or a US territory?
- What race do you identify with? (mark all that apply)
- What engineering technology degree program are you currently in?
- Where Did You Start College?

Path to Major

- Including the current academic year, how many years have you been enrolled in engineering technology?
- Which best describes your path to your current major?
 - I applied to this program/major directly from high school and was admitted to my current major.
 - I applied to another program/major directly from high school and was admitted to my current major.
 - (Major applied to: _____)
 - At my institution majors are declared after the freshman year. I applied to this program/major and was admitted to my current major for my sophomore year.
 - At my institution majors are declared after the freshman year. I applied to another program/major and was admitted to my current major for my sophomore year.
 - (Major applied to: _____)
 - I transferred from another program/major at the same university.
 - (Previous major/program: _____)
 - I transferred to this major after some community college but before receiving an associate's degree.
 - (Community college major: _____)
 - I transferred from community college after receiving an associate's degree
 - (Associate's degree major: _____)
 - I transferred from another four year program at another institution
 - (Previous major/program: _____)
 - I applied to this program/major after working in industry and was admitted to my current major
 - I applied to another program/major after working in industry and was admitted to my current major (Major applied to: _____)
- Why did you choose your current major?
 - I am a hands-on person and this major allows me to work with my hands more than others I was considering.
 - There is a high demand for graduates with degrees in my major.
 - I do not want to work in a cubicle all day.
 - I wanted a curriculum with more hands-on courses and less calculus and theory.
 - Other _____

Engineering Technology and Engineering Program
Comparison of Underrepresented Students in the Same Institution

Appendix A (con't)

Engineering Technology Student Survey – Questions Used In This Paper

- How did you first hear about engineering technology in general and your current major in particular?
 - High school counselor
 - High school teacher
 - I know an engineering technologist
 - An academic advisor, success coach, or other college staff member
 - An engineering professor
 - An engineering technology professor
 - When I was admitted to the program
 - A student in the program
 - Other _____