Engineering Technology Students - How do They Compare to Other STEM Students?

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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.

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For many years, students interested in Science, Technology, Engineering, and Mathematics (STEM) majors were easily identified. However, since the realization that the US has a low number of students enrolled in STEM programs, great effort has been expended to encourage youth to pursue careers in these areas. Because of these broad-based efforts, the demographics of students moving into STEM are different from those in the past. There is a noted lack of diversity in students majoring in engineering technology; this is not as prevalent in other STEM fields.

Engineering technology students belong to a unique group. They are formally trained engineers with a high level of applied knowledge. This is a contrast to their counterparts in traditional engineering and other STEM fields and leads to the question of - How do engineering technology students compare to those in other STEM fields?

For this study, data is being extracted from the Multiple-Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD) dataset. This dataset consists of over one million unique undergraduate, degree-seeking students in 11 institutions. This is a large dataset that provides sufficient data for descriptive statistics to begin a comparison of the students in all of the STEM fields as represented by this dataset. Descriptive statistics are used to summarize data extracted from MIDFIELD, and the results of this study provide evidence of the uniqueness of engineering technology students. While engineering technology students are generally white male, approximately 25% of the population is a diverse combination of other ethnic groups and females. Male students matriculate between the ages of 15 and 35, while the majority of females begin their studies between ages 18 and 21.

Introduction

Scholars with a focus on engineering technology education are currently developing a foundation of research for this population[1]. Too often research on engineering technology students is included in the larger population of traditional engineering students[2,3]. This essentially removes the ability to differentiate between traditional engineering students and engineering technology students in STEM, making it difficult to learn about the distinct differences in these students. Further, while there is research in other STEM fields, they are often distinct from traditional engineering, making this population in engineering technology relatively unknown.

This study uses the MIDFIELD[4] database to separate the engineering technology students from traditional engineering students, enabling the distinction of these two groups of students.

Literature Review

Historically STEM majors were easily identified by gender and by particular habits and characteristics. Studies and reports have agreed that there is a shortage of individuals with STEM degrees. Furthering that assertion, research also states that there will be a shortage of STEM graduates of nearly one million by 2022.[5] The predictor of this shortfall suggests that this lack of STEM graduates can be increased by improving retention of these students.[6] Graham[6] suggests that supporting literature uses three interventions to improve retention of STEM students: early college research opportunities, incorporating active learning into introductory courses, and participation in learning communities of like STEM majors.

Diversity. Students majoring in STEM fields, while increasing in diversity, need to represent diversity in the same numbers as what is represented in the national population.[7-9] The challenge has been taken on by various groups and organizations[10-12], without understanding the effect of their efforts. Often a true demographic of these students is not understood, leaving organizers with generalizations based upon activities and interactions in the informal setting. Many successes have been recorded and discussed at length[11,13], without a great deal of differentiation of students based on gender, age, or ethnicities. All of them have been proven to influence choice of major and extracurricular interests.

Demographics. Some assert that the demographics of different STEM groups have changed due to these efforts inside and outside of the formal school setting. However, the demographics have not changed in ways that reflect current demographics of the population at large[14]. It is unclear if this is due to targeted or convenient venues for outreach or if it is due to some other reason.

Discipline Specific. Lent , Lopez, Lopez, and Sheu[15] suggest that it is convenient to aggregate STEM fields, however it is useful to disaggregate them into specific disciplines for purposes of discipline specific research. This research is focused on engineering technology as a specific discipline. It is a smaller field as compared to traditional engineering, the sciences, and mathematics. It is a field that has experienced a lack of diversity as evidenced by those working with these students. To support these observations, this study will utilize the MIDFIELD database[4] to extract demographic data for students majoring in engineering technology.

Population Comparison. This data is explored to determine how this population compares to others that are usually aggregated in the STEM disciplines. It is the intent of the authors to contribute to the foundational research in engineering technology, ultimately affecting changes in recruitment and retention of the study population.

Research Question

Comparing the demographics of the various STEM disciplines leads to the research question for this study.

- *How do engineering technology students compare to those in other STEM fields?*

The answer to this question contributes to the body of knowledge of engineering technology and STEM.

Methodology

Work on a longitudinal database is done using different methods. In this particular situation where comparisons of raw data are made to answer a basic questions, descriptive statistics is used. The reporting institutions supplied information for the data in MIDFIELD. The data was examined and summarized to determine how much of the data represented continuing students, transfer students, and those that matriculated. Based on the amount of data and verification, the data represents what is found in all of MIDFIELD for the various majors and STEM groups indicated in the database.

Results

When comparing engineering technology student data to traditional engineering, Figure 1 shows the total number of engineering technology students as compared to all traditional engineering students in MIDFIELD.

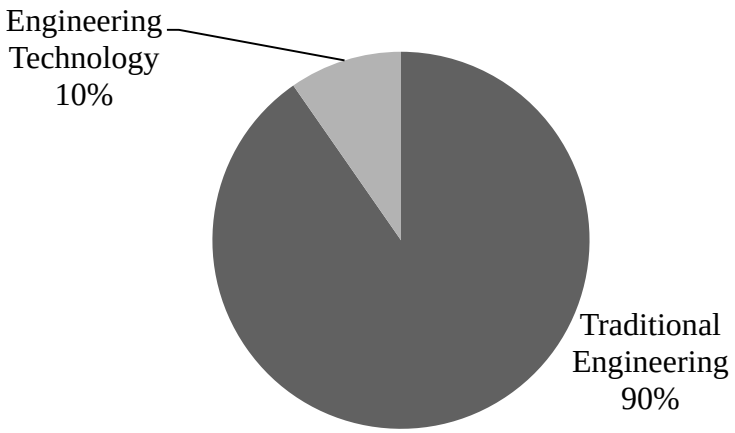
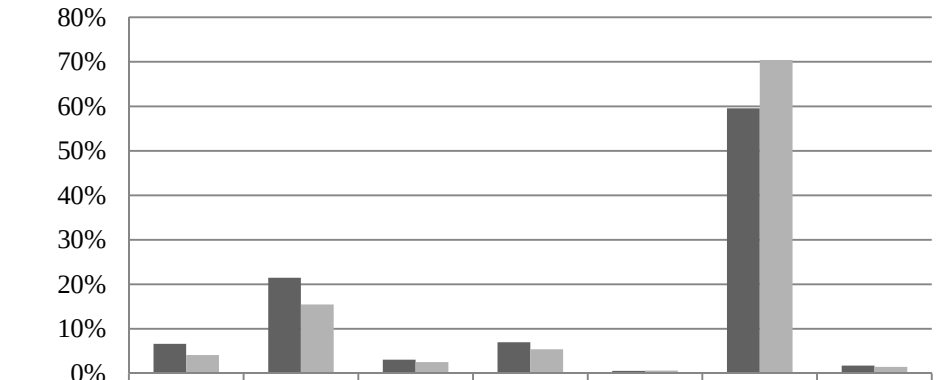


Figure 1. Engineering Technology vs. Traditional Engineering Majors

Ethnic data when extracted for engineering technology students is shown in Figure 2.This figure illustrates the findings, representing engineering technology extracted from all STEM data in MIDFIELD. This graph provides a clear indication that the majority of students in engineering

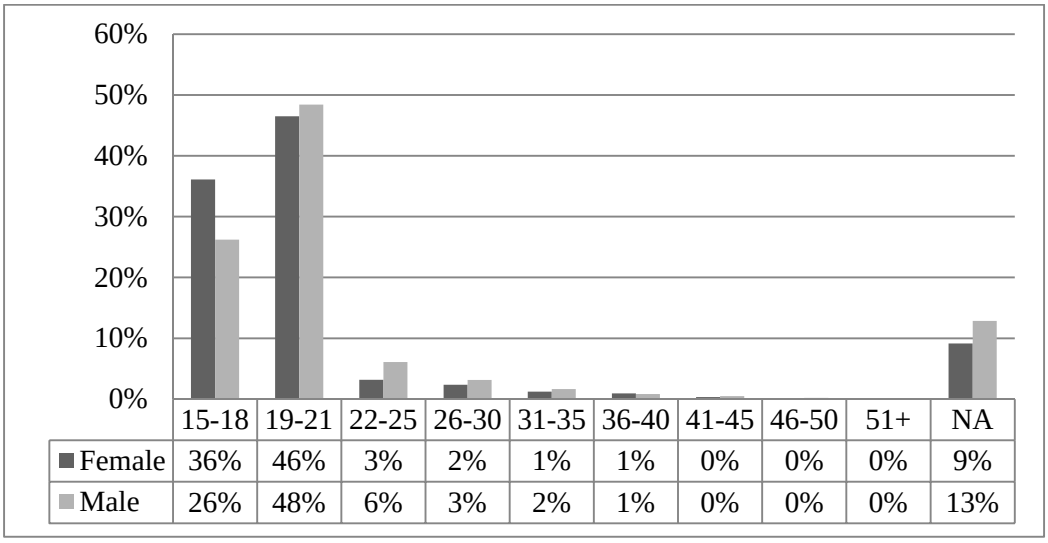
technology are white, with African-American and students identified as other ethnicities following at a distance. Within this distribution, the following figure represents engineering technology students, which is 6% of the study population.



	Asian	Black	Hispa.	Inter.	Native Amer.	White	Other
Female	7%	21%	3%	7%	1%	60%	2%
Male	4%	15%	3%	5%	1%	70%	1%

Figure 2. Ethnic Diversity Within Engineering Technology

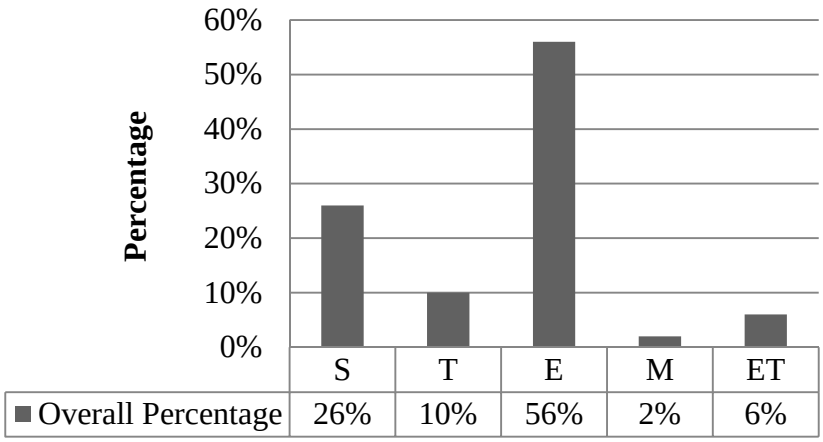
Diversity by age is shown in Figure 3, with the majority of students in the age group noted for traditional college students majoring in engineering technology. There are a few non-traditional students[16]; there are so few relative to the traditional college age they are difficult to see in this figure. Of particular note are the differences in gender. Slightly more than a third of the female students matriculate early while most matriculate between the ages of 19 and 21. While the figure shows that male students generally matriculate throughout a broader span of ages between 15 and 35.



	15-18	19-21	22-25	26-30	31-35	36-40	41-45	46-50	51+	NA
Female	36%	46%	3%	2%	1%	1%	0%	0%	0%	9%
Male	26%	48%	6%	3%	2%	1%	0%	0%	0%	13%

Figure 3. Age Diversity Within Engineering Technology (Age at Matriculation)

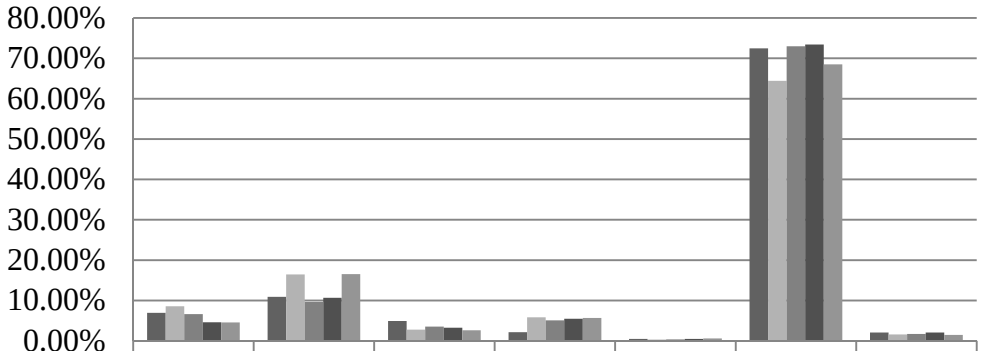
Comparing data between engineering technology and other STEM fields, the following graphs, provide comparison data. Figure 4 shows the comparison of STEM majors with the engineering technology data in its own category. ET or engineering technology depicts the size of that population relative to the other STEM fields.



	S	T	E	M	ET
Overall Percentage	26%	10%	56%	2%	6%

Figure 4. Engineering Technology Majors vs. STEM Majors

Figure 5 shows the ethnic diversity within STEM majors, noting overall percentages within each STEM category. Relative to one another, white students are most prevalent in STEM with a slightly higher percentage of black students in Technology as compared to the other STEM majors.



	Asian	Black	Hispanic	Internat.	Native Amer.	White	Other
S	6.96%	10.92%	4.94%	2.15%	0.49%	72.46%	2.08%
T	8.56%	16.46%	2.80%	5.84%	0.32%	64.44%	1.59%
E	6.65%	9.65%	3.52%	5.09%	0.37%	73.00%	1.73%
M	4.62%	10.67%	3.25%	5.50%	0.48%	73.42%	2.08%
ET	4.56%	16.54%	2.61%	5.67%	0.62%	68.49%	1.50%

Figure 5. Ethnic Diversity Among STEM Majors

Finally comparing the matriculation age of each group of students within STEM majors, Figure 6 shows that engineering technology majors are later to start their program and traditional engineering majors are the earliest. Math and technology majors overall are close to one another in age at matriculation, with science slightly earlier.

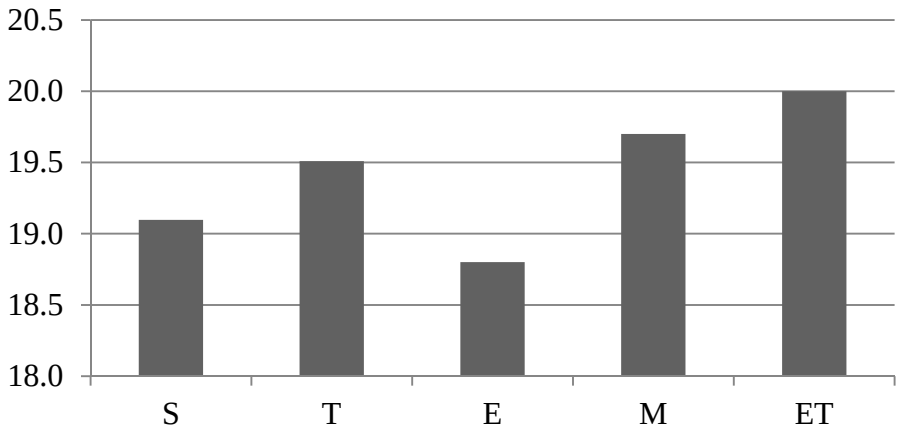


Figure 6. Age Diversity Within STEM Majors (Age at Matriculation)

Discussion

Data was obtained for students studying in STEM fields, as well as those specifically listed as engineering technology majors. Overall, when analyzed, the data shows that 6% of STEM graduates studied engineering technology, while 56% of STEM students studied traditional engineering. A comparison of the two majors relative to one another is shown in Figure 1.

Demographics – Engineering Technology. The engineering technology population is made up of nearly 70% white students, 20% African-American students, 3% Asian students, and the 7% balance all other ethnic groups. Gender disparity is also evident in age and ethnic data, supporting assertions made by observers that engineering technology is an area under represented[17] in ethnic, gender, and age. In this case, there is evidence that most of the female students are in the traditional age group of college students[18], while the males matriculate over a slightly longer span, between the ages of 15 and 35.

Demographics – STEM. The majority of students in any category as found in the MIDFIELD data are in traditional engineering, followed by science and then technology, which follow. Math majors represent the smallest percentage of the population, dwarfed by engineering technology, which is nearly three times as large as math.

While comparing ethnic data within STEM majors, it is clear that STEM students are not racially diverse despite years of efforts to diversify this student group[11]. Many sources state that the representation of racial groups other than white have increased and that it is beneficial for

STEM[19,20]. Figure 5 brings clarity to the situation by depicting that in almost all STEM fields white students are in the majority, with other ethnic groups following at a distance.

The age comparison shows that engineering technology majors start later in life than all the STEM majors, and traditional engineering students by slightly more than a year. Students majoring in science start earlier than all majors except those majoring in traditional engineering.

Conclusion

The analysis performed in this study shows that engineering technology students represent a small group of students as compared to traditional engineering. These students are predominantly white males, although literature suggests that there has been an increase in STEM diversity[17,21]. Engineering technology students generally matriculate at age 20, males and females exhibit different patterns upon their first matriculation. Female students begin at the traditional age for college students ranging from 15-21, and male students will matriculate in an even distribution between ages 15 and 35.

Based upon these findings, future work will focus on learning more about these students and graduates to further our understanding of age at matriculation and choice of major. A number of studies have provided a basis for understanding other majors and their composition. Similar work at the ages they do and what cultural influences affect their choice of major, and if they choice includes STEM and the choice of a STEM field.

A recent report "Engineering Technology Education in the United States",[1] published by the National Academy of Engineering, provides five recommendations for future study. The third recommendation suggests that learning more about why different segments of the engineering technology population graduate, and engage in program materials, can be used as a means to increase diversity in a somewhat homogenous population. Before suggesting methods to improve diversity, a large, well-defined study of the ET population, including interviews, is needed to understand the specific issues and preferences of the populations included in this study.

Such a future study needs to include consideration of why engineering technology students start their studies later in life, particularly since the overall study population appears to be somewhat traditional, beginning their studies within a short period of completing high school. It is also important to consider that while engineering technology is a relatively small part of the STEM student population, these students represent a unique group of students worthy of future study. Furthering our understanding of the age at matriculation, distribution of ages throughout engineering technology majors, and the major relative to other technology and STEM majors will provide a means to develop greater diversity, and continuity in students studying engineering technology.

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