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Engineering Technology Undergraduate Students: A Survey of Demographics and Mentoring

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Engineering Technology Undergraduate Students: A Survey of Demographics and Mentoring

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Abstract

A report published by a group of engineering technology practitioners and others interested in engineering technology called "Engineering Technology Education in the United States" was released in early 2017. The report provided recommendations of areas for further study related to engineering technology students to increase our understanding of the population. These specifically suggested focusing on the students in comparison to other students in similar and different fields of study.

Following these recommendations, a team of engineering technology education researchers has been collaborating to gather information in these areas. The team obtained institutional approval and distributed two surveys throughout the United States. The first survey was directed towards undergraduate students and the other towards those who have already completed their undergraduate degrees. This paper is focused on a high-level review of the results of the undergraduate survey, with future, in-depth publications focused on the issues identified by the report.

The survey was designed to address the issues described in the report focused on matriculation, retention, and graduation from engineering technology. In this case, we are examining the demographics of undergraduate engineering technology students, mentoring, and other issues that participants self-reported, as related to their peers in other STEAM (Science, Technology, Engineering, Arts and Mathematics) majors. Later work will focus more on program (2-year vs 4-year) comparisons, socioeconomic issues, and level of preparation for the various majors categorized as STEAM. This paper is not intended to provide responses to the recommendations of the National Academy of Engineering (NAE) report, but rather provide an overview of the responses to the inquiry focused on addressing this topic.

The undergraduate engineering technology student subset of the STEAM survey respondents is about 68% male and 30% female. This is as expected, recognizing that engineering technology and related disciplines tend to be male dominated. The reporting students most frequently identified as white, followed by Asian and Hispanic. Most students attended a suburban, public high school and about 47% of students reported receiving no support as they prepared to attend college.

Key Words: Undergraduate students, matriculation, retention, graduation, engineering technology

Introduction

The work offered in this paper was intended to address recommendations 3 and 4 from a report published by the National Academy of Engineering (NAE) [1]. This recommendation suggests that researchers focus on understanding the population of ET (Engineering Technology) students through understanding why they choose ET, socioeconomic issues, and the mentoring and peer support they receive [1]. This paper aims to provide some understanding of these topics through a survey of STEAM student populations distributed across the United States focusing on these areas.

Literature Review

The relationship of engineering technology students to others in STEM is often neglected or ignored. When neglected it is either considered engineering or at times is not included in studies because the authors are not sure of an appropriate treatment. The following provides insight into the evolution of the terms STEM and STEAM while also examining the engineering technology major, and other related topics.

History of STEM & STEAM

The use of the acronym STEM (Science, Engineering, Technology, and Mathematics) was developed by the NSF (National Science Foundation), beginning as SMET and settling as STEM in 2001 [2]. The disciplines were grouped because it was recognized that they all emphasize problem solving and critical thinking skills [3]. STEM has been recognized in educational reports since the 1980's [2]. Though each discipline within STEM stands apart, they are also intertwined-for example, physics and chemistry play a role in engineering and ET, and math is studied in all disciplines [4]. STEM does not include the arts in this grouping.

STEAM (Science, Engineering, Technology, Arts, and Mathematics) is an acronym developed at the Arts-National Policy Roundtable in 2007 [5]. The acronym adds a "A" to STEM to emphasize the importance of arts education for improvement of creativity and innovation in students[5]. There is some ambiguity when considering which disciplines make up the "A" component, with dissention over whether it represents visual arts, performing arts, liberal arts and humanities, or a combination of these [5]. The researchers considered all the disciplines to gather as broad a base for comparison and because there is no established precedence. Overall, STEAM education aims to produce well-rounded individuals by incorporating arts into STEM education [5].

Engineering Technology Students

As evidenced by the recommendations from NAE, limited literature focused specifically on engineering technology (ET) students exists. The survey discussed in this paper addresses recommendations promoting research into this population of students. Existing work reports that ET students are concrete and logical in their thinking and rely on intuition when making decisions [6]. When compared with their peers in engineering, ET students demonstrate a preference for working individually, taking risks, and utilizing trial and error to solve problems while engineering students work better in teams and prefer formal documentation and calculation to solve problems [7].

Employers frequently misunderstand engineering technology, with ET graduates noting that they often must explain their training to potential employers [8]. Employers may interpret ET degrees as associate's or technical degrees and may have the perception that ET degrees are inferior to engineering degrees [9]. Therefore, the "loose coupling" of degree and employment noted by the NAE is significant in ET education, potentially contributing to issues with student retention. While the work noted above is ET specific, no literature exists specifically covering the demographics of ET students, the mentoring they receive, or the socioeconomic factors that affect them, an area of study which this paper aims to address.

Socioeconomic Factors

A variety of socioeconomic issues influence the decision to attend college and pursue a major in STEAM. Foremost is the financial ability for a student to attend college, as college represents a form of social mobility [10]. There is a significant gap between rich and poor students in their relative enrollment in college [10]. When students from disadvantaged backgrounds apply to college, they may be further disadvantaged by admissions policies that favor children of alumni, relatives of donors, or students able to pay full tuition and their high school preparation[10].

Considering attending college, socioeconomic status and the education of the parents play a role in the decision of attending college, choice of major, and sometimes choice of career [11]. Self-belief in academic ability influences the choice of major, connected to socioeconomic issues as grade school preparation influences confidence [11]. Financially preparing for college is tied to socioeconomic status, with those socioeconomically advantaged saving early for their children's educations, before the child enters grade school [12]. This practice benefits upper-class and upper-middle class families, as they have the income to save, leading to a continuing cycle of college attendance and social mobility [12].

Pre-College Education

The education and opportunities provided to students while in high school play a significant role in their confidence and success in college as well as their selection of major [13, 14]. Hands-on work such as laboratory experience, FIRST Robotics, Project Lead the Way (PLTW) and other programs encourage development of STEM skills before students enter college. The coursework in the PLTW program features hands-on projects for high school and middle school students that aim to teach critical thinking and problem solving, skills recognized as important in STEM [15]. It has been suggested that involvement in PLTW among underrepresented and underprepared populations can encourage higher enrollment rates among these groups and better prepare them for college coursework verses non-PLTW students [15]. Participation in PLTW encourages more students to enroll in STEM majors [16].

FIRST Robotics programs impact students in a similar way. The program has been shown to improve confidence and self-esteem in students while showing them how to apply their classroom knowledge to real-world situations [17]. Work has been proposed to track students who have participated in these types of programs as they progress through college to gauge the impact of these programs on college success [15]. However, a specific study on ET students and the impact of these programs is lacking in the literature.

Community Support and Mentoring

The mentoring and community support a student receives in their pre-secondary years can influence the decisions the student makes when deciding to attend college and in selecting a major. For students of low socioeconomic status in districts with low budgets, low-cost programs like text-messaging and peer mentor outreach can encourage students to enroll in college by providing financial aid information and professional assistance [18]. Support from the community can come in the form of affinity groups, religious institutions, and other organizations designed to support members of the community as they encounter a variety of life's issues. The lack of these programs as well as the presence of such programs may influence student academic performance [19]. Previous work on this data set and comparison with other available information found that disadvantaged school districts in New York are less likely to provide guidance counselors which may result in a lack of support as students make life decisions [20].

Support in College

When considering switching majors, the support students receive from academic advisors can affect the decision. It has been suggested that academic advisors often do not provide enough support to students when deciding which major to select; a significant finding as it is generally

recognized that relationships with faculty members impact student success [21]. Further, student retention in their major is impacted by the quality of academic advising received [22]. The disconnect between degree and employment for ET students perceive a lower career availability for these students, causing them to switch majors, a suggestion backed up by a study showing that career availability is closely linked to student retention [23].

Peer mentoring has been shown to increase both retention and self-esteem among college students [24]. Campus mentors provide students with helpful information that can equip students with skills to deal with academic challenges and can help students make decisions, as shown in a study of first-generation college students [25]. Thus, in general, the support students receive from their peers and faculty can impact decisions regarding major and the decision to remain in college. Querying undergraduates about the support they have received thus far can help identify areas of improvement, with changes resulting in the potential for increased retention.

Research Questions

An overview of the data gathered for this project intended to learn more about engineering technology undergraduates focused on demographics, their influences, and choices is provided by answering the following

Who are engineering technology undergraduate students?

Methodology

To address these and other research questions, the team developed a Qualtrics survey. The survey was aimed at STEAM undergraduate students and gathered information concerning demographics, presecondary education and support prior to college and confidence in students' preparedness for their major. The survey also queried students about whether they switched majors and how happy they were in their current major. The questions were a mix of selected choice questions and free answer questions. Only the results of a few of the selected choice answer questions are presented here. After survey development, the team received Institutional Review Board (IRB) approval and distributed the survey through a variety of venues including personal networks, social media, professional educator networks and other methods to distribute the survey to STEAM undergraduate students across the United States. Additionally, the link to the survey was sent to academic advisors in STEAM departments at universities across the United States. A similar survey was distributed to STEAM graduates.

At the close of the survey, the anonymous and voluntary survey data was compiled and those respondents indicating engineering technology as their major were sorted out for further analysis.

Questions relevant to the topics in this paper were analyzed using Microsoft Excel. After the responses to the questions were counted, graphics were created and formatted for inclusion.

Findings

The findings presented in this paper represent responses from those survey participants listing engineering technology as their major (27 participants). Though the STEAM survey was distributed to STEAM undergraduate students and repeatedly sent out, the number of engineering technology students responding was low. For this paper, the results of their responses are shared and previous survey's where the participation rate was much higher consulted. Due to the lower sample size, but higher response rate by female and minority students, the authors are sharing the results to open the conversation for future work, not strong conclusions. The comparison between ET and other STEAM majors will be the subject of future work. For this findings section, the ET participants addressed will be referred to as survey participants or respondents without the distinction of ET.

Demographics

Figure 1 presents the gender and race identification of the survey respondents while Figure 2 presents the age distribution. These figures suggest that the survey respondents were mostly white males in their late teens and early twenties.

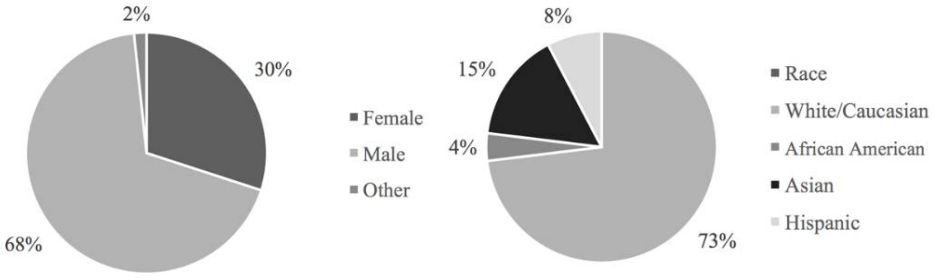

Figure 1. Gender and Race Distribution of Survey Respondents

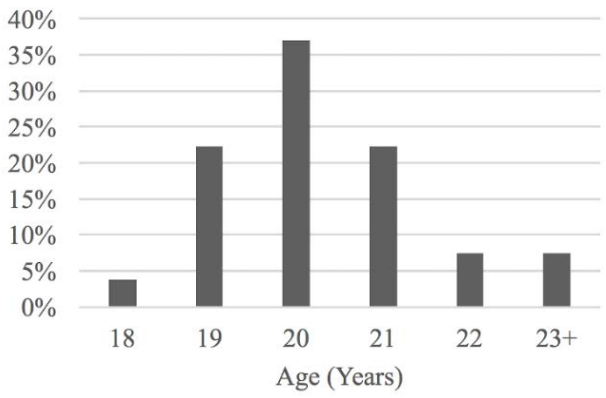

Figure 2. Age Distribution of Survey Respondents

As a discipline, ET (and STEM by extension) tends to consist of primarily white males [20, 26-28]. The age distribution in Figure 2 suggests that most respondents started college immediately after finishing high school, indicating that most likely this degree is their first. A small number of participants reported ages over 22 years.

Respondents were then asked to indicate where they lived before beginning their first degree. The cities listed by participants were sorted into generally accepted regions within the United States and are shown in Figure 3.

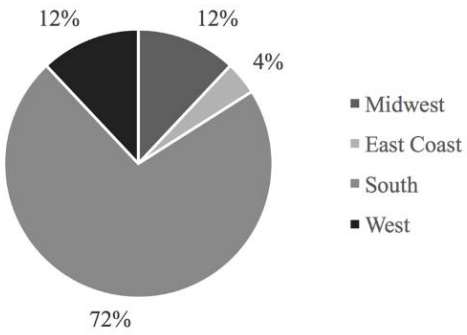

Figure 3. Regional Origins of Survey Participants

Most participants reported living in the South, with the smallest number of participants reporting their location on the East Coast. This dispersion of data does not represent the engineering technology population and should only be used for developing future studies, rather than making conclusions about any of the populations.

Grade School Influences

Respondents were next asked to indicate the type of elementary and high school they attended. Figure 4 shows survey participants' responses when asked to describe their elementary school.

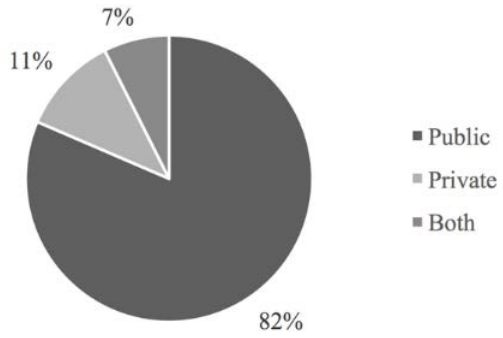

Figure 4. Responses to Type of Grade School Attended

Survey participants were asked to choose whether they attended a public or private elementary school (or both), and the results show that most students attended a public school at this level. Figure 5 shows responses to two questions asking participants to describe their high school in terms of public or private and location or type.

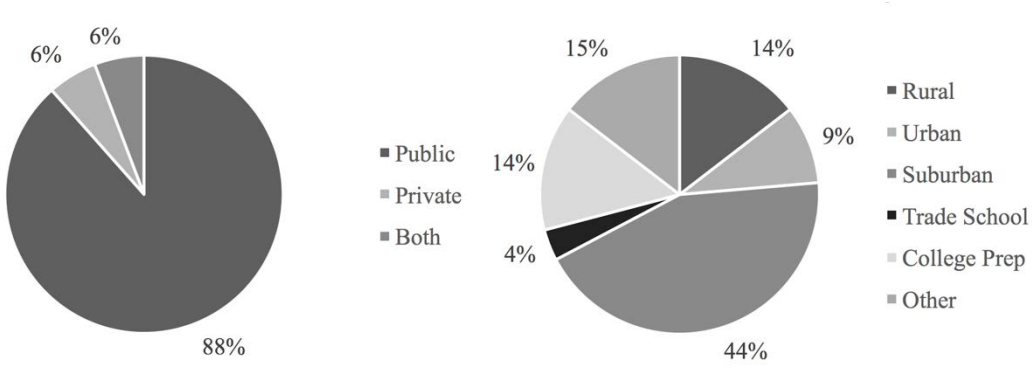

Figure 5. Responses to Type and Location of High School Attended

On the left, students were asked to select whether they attended a public or private high school (or both). The percentage of survey participants attending a private high school is about 6%, which is less than the National Center for Education (NCE) data. Private school graduates tend to choose degrees outside of ET, while far more public-school graduates choose ET, as reported by NCE supplied information. When asked to select a description of their high school, about 44% of survey respondents described their high school as suburban and public. Very few respondents went to trade school, and the distribution for the other options are within 6% of each other. The same number of survey respondents came from a rural high school as from an urban high school.

College Prep Support

Survey participants were then asked a series of yes or no questions to gauge whether they received support from community groups, religious groups, or other groups in their preparation for college. The responses are summarized in Figure 6.

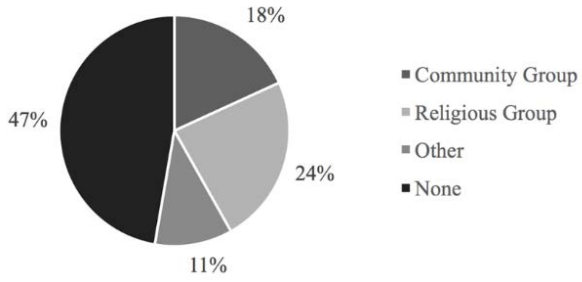

Figure 6. Support in College Preparation from Community Groups

Although more than half of students reported receiving some sort of support (and 16% received support from more than one group), it is difficult to ignore the large percent who reported receiving no support at all from the community.

Next, the support first-generation survey participants received for college was compared to the support received by non-first-generation survey participants. Figure 7 illustrates the percentage from both groups who feel they had adequate support.

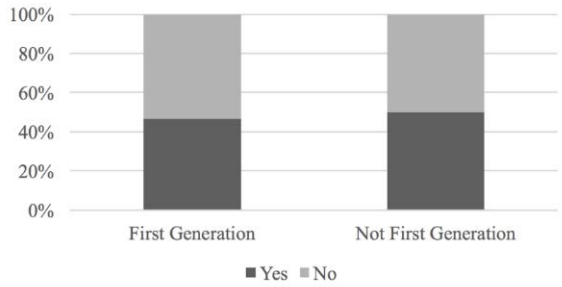

Figure 7. First-generation and Non-First-Generation Students' College Preparation Support

First-generation survey respondents reported feeling as though they had the proper guidance 47% of the time, while non-first-generation survey respondents expressed the same sentiment exactly half of the time.

Switching Majors

Survey participants were next asked to indicate if they had switched majors and if so, how many times. Of the students who responded to the survey, 40% said they had switched majors at least once since starting college.

Survey participants were then asked if they understood all aspects of their major when they began college. Their responses are presented in Figure 8. Of the survey participants selecting yes, only 10% of them switched majors. Of survey participants who did not understand their major when they started, that number jumps to 53%. Those who did not understand all aspects of their first choice of major were more likely to switch.

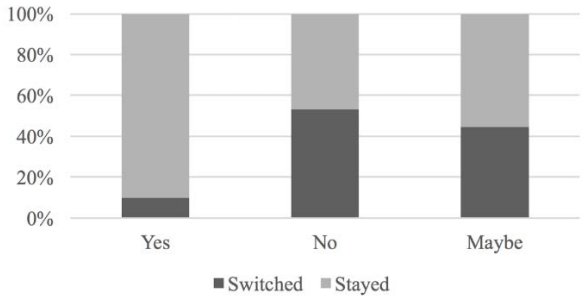

Figure 8. Survey Participants' Understanding of Major when Entering College

Next, the survey participants were asked if they were happy with their current choice of major. Figure 9 presents the results of this question, organized into two categories: those who switched majors and those who stayed with their major.

Figure 9. Happiness with Current Major

Survey participants who switched reported being happier than survey participants who stayed, but only by a slim margin.

Discussion

While previous work in engineering technology undergraduate students has been published in the last few years [8, 20, 28, 29], a comparison of the STEAM study findings to those findings is of interest to the researchers and others in the engineering technology field, if only for the possibility of learning more about this relatively unknown student population. The data from this study shows a higher percentage of female students as compared to male students, and significantly higher than the general engineering technology student population [28, 30]. This is also true when comparing race distribution as noted in Figure 1. Other studies show a much smaller minority population than what is found in this study [26, 27]. This is due to the low sample size as compared to reported demographics provided by other universities with engineering technology programs [31] as well as former studies noted in this paragraph and other work [30]. The data provided by this study will be utilized in future studies focused on gender and minorities, providing an insight into these rarely studied subsets of engineering technology.

Most of the students responding to this survey are 20 years old with a typical bell curve representing students younger and older. This provides an indication that most of the responding students are traditional students that begin their post-secondary education either immediately after high school graduation or within a year or so.

Students responding to this survey were primarily from the United States. Locations were examined and grouped into regions with most of the students originally coming from the South. Most of these students attended public school, with slightly over 10% attending private, and the balance reporting attending both. It may be important to consider the type of grade school attended as the learning environment differs between public and private education. Considering the beginning of a student's education may be one factor in identifying why students make certain choices concerning educational paths later in their career. Future work comparing other survey questions to type of school attended may illuminate some connection between school attended and future success. This provides another lens to consider these post-secondary respondents, their progress, and potential for growth in their academics.

In Fall of 2018, the National Center for Education Statistics (NCES) reported that 10.2% of students in the U.S. attended private schools, which disagrees with the data gathered from this survey [32]. Again, this may be attributed to the small sample size. There are not an abnormal number of survey respondents coming from private grade schools. There appears to be some differentiation from the NCES statistic, as respondents reply to the type of high school they attended. Most of the responding students reported attending public high schools in suburban or urban areas.

Studies focused on medical programs often report the impact community and social environment has on that career choice. The researchers asked questions about community support to assess the impact these groups/individuals have on students choosing STEM or engineering technology as a career. Most of the responding students indicated that they had no support from the community concerning their preparation for college or support prior to that time. Slightly over half reported getting support from community, religious, or “other” sources at this time.

Researchers reviewed the data to determine if first generation students received support while preparing for college and considering their academic major. The results of this question were nearly the same. This was somewhat of a surprise as many of the studies focused on first generation students indicate there are far more issues in that student group than those that are not first generation [33, 34].

Students were asked if they knew what their major was at matriculation. Most indicated that they did not, with nearly 40% of those students switching majors at least once prior to responding to the survey. The results from this question suggests that students that understand their major are less likely to change majors, while that did not were far more likely to switch.

Finally, the last question asked students if they were happy with their major and if they had changed majors. Those that did not switch majors were ambivalent, while those that switched indicate far more happiness from the switch.

Conclusion

Overall the undergraduate engineering technology students responding to the survey represent a higher population of female and minority students than what is reported by universities. Based on their response to age, indications are that respondents are primarily traditional students matriculating right after or within a short time of high school graduation. Most of these students are from the southern part of the United States with the South and Midwest representing nearly 85% of these students. They also indicated that in even greater numbers than most went to public high schools in urban and suburban areas. When comparing these numbers to NCES reported statistics, it was noted that most engineering technology students are from public schools in suburban areas. Responses to student support from community groups provides engineering technology administration information to support future work with community groups, and religious organizations to encourage student exposure and support to develop an interest in and ultimately choose engineering technology as a major. Further insight into the amount of college prep and other related support regardless of first-generation status, will provide this group with additional information for recruitment efforts. Finally, while students many not understand their major, they do find pleasure after making a switch after matriculation.

Future Work

The findings, regardless of the smaller sample size suggest that work in this area is warranted. A study that targets the engineering technology community should be used with adjustments in the wording of questions and interviews to probe into student's experiences and backgrounds. A focus on female and minority students would provide data on students that are often misunderstood, while the generalized survey would provide more information on this unique body of students in engineering technology. Work on developing more materials to share with community groups regardless of make up should provide information to students considering the pursuit of a college degree and give them more clarity on engineering technology as a career choice.

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