

# Encouraging the Diversity of Graduate Students in Technology

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**Abstract**— Diversity in technology programs is as confounding to technology programs as it is to any other STEM fields. Some believe that strengthening the basic skill sets of students in math [1] will raise awareness of Science, Technology, Engineering, and Mathematics (STEM) in the United States. While others find other issues such as debt cause a large influence in lack of persistence in STEM programs, both graduate and undergraduate.[2, 3]

A review of the data available on engineering technology and other technology graduate students provides clarity to the diversity issue. While the authors found some students progress onto graduate school, nearly 60% were enrolled in the 3/2 programs. These are programs where students complete a bachelor and master degree in 5 years. Our study also showed students, primarily those that are a minority by race or gender, do not continue their education through graduate school. These findings raise some questions about these students and what steps will encourage their persistence or return to graduate study. Therefore, further examination of available data, future interviews with current students and graduates will provide a better understanding of the lack of diversification and persistence in technology graduate programs.

Utilization of data gathered in the large institutional database provides a means to understand how the perception of students influences their decision to persist, continue, and complete further study. Increased understanding as it relates to students decisions to persist allows institutions to develop strategies to change student perceptions and decisions to persist. Administration will then have the information needed to support the development of programs that will encourage persistence and greater diversification of the graduate student population in technology.

**Keywords**— Technology, STEM, graduate student, diversity, persistence

## I. INTRODUCTION

Increased globalization requires graduate STEM students to develop not just technical competencies in their specific disciplines but also key soft skills that are critical for job-readiness and career success [4]. Effective soft skills in STEM fields requires professionals to demonstrate leadership competencies and organizational awareness so that they can coordinate, collaborate, and communicate with other employees from different cultural backgrounds both locally and across the globe [5]. Developing soft skills results in increased empathy, curiosity, and openness, leading to improved understandings of other worldviews [6] and the ability to manage thoughts, emotions, change, and ambiguity in order to effectively build bridges across diverse cultures [7]. One key challenge of helping graduate STEM students develop these skills is the perceived high impact of shifting focus away from building their technical and research skills. Perhaps even more difficult is finding a balance between economic and logistical constraints and evidence-based best practices such as experiential education, safe learning environments, and individualized feedback on student progress.

## II. LITERATURE REVIEW

This paper is focused on the study of existing graduate students in technology. Self-reported data is examined and reviewed establishing an understanding of these students and the overall population demographics. It provides a basis for further study of this often-ignored graduate student population to encourage matriculation, and persistence in technology graduate programs. Recognizing that underrepresented students are impacted by much more than the limited ability to be influenced by academia [8].

Few studies focused on the population of technology graduate students have been completed to date [9]. The information gathered in this recent study provides an understanding that many of the undergraduate program graduates did not understand what a graduate program gains

them. Further consideration of demographics of undergraduate students in STEM as noted in a recent publication [10] utilizing data gathered from the southeastern part of the United States, shows that ethnic diversity in STEM majors is heavily skewed toward white students. To encourage diversity of graduate students, the study population needs to be further investigated and understood.

Diversity has been an ongoing issue in education, particularly in STEM fields [11]. STEM Outreach programs often target female and minority populations with the intent of encouraging students to pursue further education in fields that are traditionally all one gender or ethnic background [12, 13]. Often ignored is the fact that many of these students will be first generation college students.

Upon examination of the data, it became evident that the students were often first generation students representing both gender and racial demographics. These students usually have a lower GPA than their counterparts [14], they are less likely to live on campus as compared to their classmates, nearly 16% of matriculating undergraduates were first generation, go to school part time as finances are of great importance as many of these students have dependents and no other source of income. More of these students tend to be low income, do not have family support based on personal college experience, overall researchers find these students unique and difficult to categorize [15-19].

### III. RESEARCH QUESTIONS

Many questions can be asked regarding diversity of graduate students in technology. However, there is little research on technology programs, and even less completed that focus on the graduate student population. To begin work on diversity and where to encourage participation in technology fields, it is critical that we understand who these students are, and what they study. Therefore, the research question is:

*Who are technology graduate students?*

### IV. FINDINGS

Graduate student data was extracted from information provided by the Purdue Polytechnic Institute Graduate School, some of which was self-reported by the students. The authors summarized the data into various demographic aspects, providing a clear vision of diversity issues in the college. In a comparison to data found in the earlier noted publication [10], examining a longitudinal dataset of undergraduate students with data gathered from the SE United States, similarities exist in all of the areas examined in this study.

This examination includes masters' students as well as those pursuing Ph.Ds. Purdue's Center for University

Professional Studies provides online and weekend masters programs, which appeal to nontraditional students. Data associated with these programs are included in the findings and noted when appropriate. Further, the data represents the most recent semester, as there have been changes in the number of students over the semesters. The most recent semester is presented as it best represents the current student population.

#### A. Age

While comparing ages of masters and PhD students, a distribution of data is expected for the traditional student that goes straight through school with no gaps or time off. While this data shows the expected distribution, the number of students in both levels of graduate school that are 36 years old is significant. These students represent non-traditional students and in research [20] are referred to as "returners." This population of student usually, after obtaining their undergraduate degree, practice in their field for 5 years or more before returning to school for a graduate degree. Based on the data shown below in Figure 1, well over 60% of the masters' students meet the returner criteria, while well over half of the doctoral students are returners.

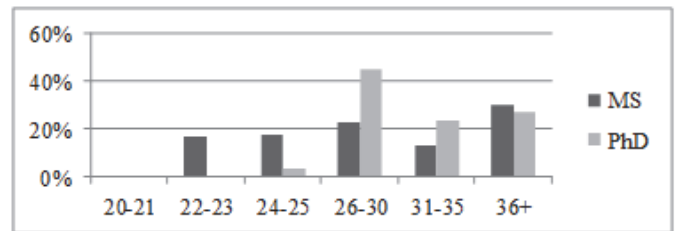


Fig. 1. Age Distribution of Masters and Doctoral Students

#### B. Ethnicity

Figure 2 shows the ethnic diversity in the college. The distribution between white and international students as contrasted against all other racial groups is stark. This figure shows that the majority of the students in these programs are either white or international. Other diversity in these programs is very small. Research on engineering technology programs [10], shows the undergraduate distribution with a higher percentage of white students and a population of black students that is higher than what was found in this data. Regardless, there is a noteworthy lack of diversity in these programs.

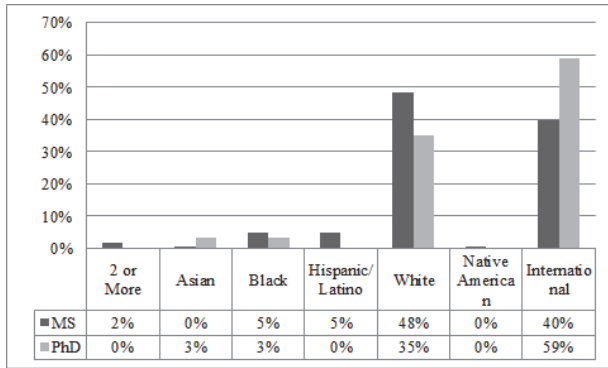


Fig. 2. Racial Distribution of Masters and Doctoral Students

### C. Residency

Residency data shows that the number of in-state students is higher than those from out of state for both masters and doctoral students. International students are slightly fewer than the instate students pursuing a master's degree, while they are significantly higher than in-state students pursuing a doctoral degree. The percentage of out of state students is far lower than the percentage of international and in-state students pursuing either degree. Figure 3 shows the distribution for comparison of this data.

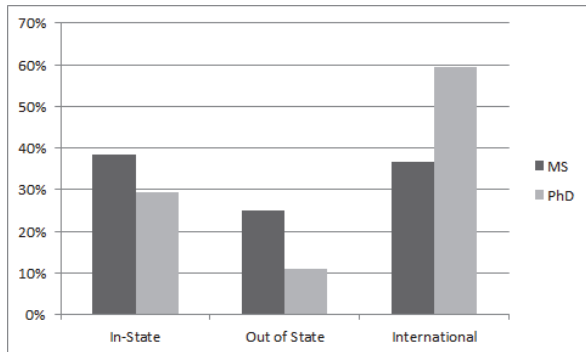


Fig. 3. Residency Distribution of Masters and Doctoral Students

When considering residency, tuition is often a factor in a student's decision of where to go to graduate school. Table 1 shows the tuition costs for in state, out of state, and international students in the graduate school. These totals do not include living expenses, and are for nine credit hours in one semester.

Table 1. Tuition Costs Based Upon Residency  
(9 credit hours, 1 semester[21])

In-State Graduate Students	\$5,287.00
Out-of-State Graduate Students	\$14,688.00
International Students	\$14,768.00

### D. Gender

Gender division within the college for masters students is nearly 1/3 female and 2/3 male. The doctoral student population has slightly more male students than the masters' student population. Comparison of this data is shown in Figure 4.

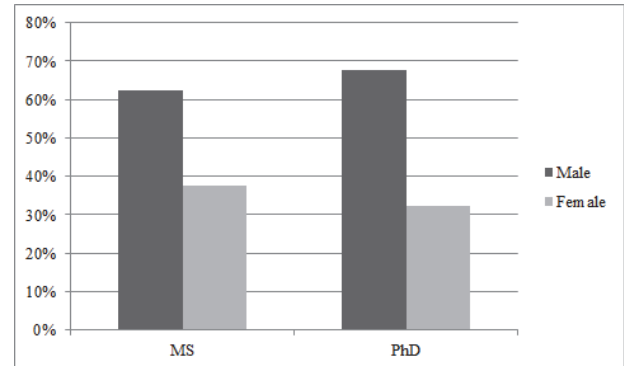


Fig. 4. Gender Distribution of Masters and Doctoral Students

### E. Degree Program/Major Distribution

Figure 5 provides a comparison of the number of students in each major of the college. The department or school represented in this figure are: AT-Aviation Technology, BCM – Building and Construction Management, CIT – Computer and Information Technology, CGT – Computer Graphics Technology, ET – Engineering Technology, and TLI – Technology Leadership and Innovation. This figure contains three bars per major, each represents an online professional development option, and the on campus MS and PhD degrees. Both the online degree offerings and the leadership major are chosen by students pursuing an advanced degree more frequently than other degrees. The professional development option includes weekend programs, and other flexible options for obtaining degrees that are often preferred by non-traditional students. Thus the importance of including this information in Figure 5.

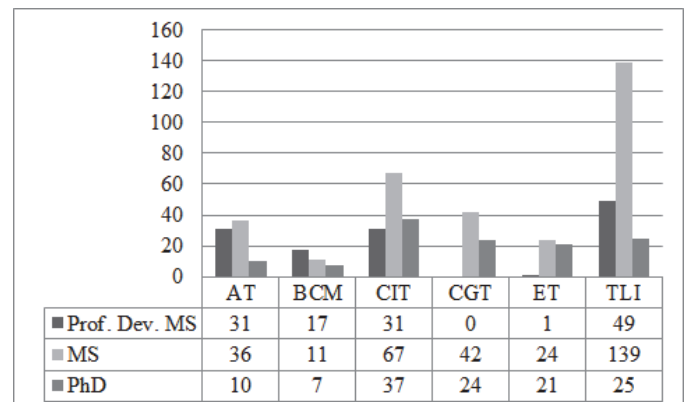


Fig. 5. Major Program Distribution of Masters and Doctoral Students

## V. DISCUSSION

Using the demographics presented in this paper, it is evident that graduate students matriculate later than expected of a traditional student. Reasons for the delay may be attributed to a late start as an undergraduate[10], that they are part of a subpopulation of students that are first generation college students[17, 19], or they are simply a “returner”[20] with professional experience. Some college graduates may not matriculate into a graduate program, despite a desire to do so.

A multitude of reasons for lack of matriculation, as well as completion of graduate degrees exist, they include lack of ethnic and gender diversity, and the cost of education. Previous research state that many minority students are first generation [14]. Success as a college student, regardless of status as an undergraduate or graduate student relies heavily on family support. If the family doesn’t have the understanding and the mentoring of someone that does fail, dropping out and never matriculating is the result [15, 16].

### A. *Lack of Ethnic and Gender Diversity*

Review of the presented data also shows that the majority of students in the graduate program are white or international. This trend is also evident in studies of undergraduate students[10, 22] where black students are in the minority, but significantly higher than what is found in graduate school. Figure 2 provides evidence that there are some Hispanic/Latino students pursuing an MS, but none a PhD. The gender comparison shows there is no parity in either masters or doctoral students. It is clear that female students are underrepresented in these graduate student populations.

### B. *Cost of Education*

As noted earlier, first generation students usually do not move far from home. The university being studied is a state university with preferential tuition rates for students residing in state. This may drive the higher number of instate students as opposed to out of state students. Graduate education is often pursued at the loss of time worked, and continued focus on academic pursuits. Graduate education usually translates to less time allotted for work, and continued focus on academic pursuits. This drives first generation and minority students away from graduate studies [16].

In the review of this data, it is evident that technology graduate students generally come from families with low income or a lack of expectations and goals for graduate degree completion. They are generally successful, with a significant amount of mentoring and support within degree programs. Experience with the current student population shows that students who best acclimate to their environment, are supported by family members, and engage with faculty and

peers are most successful. Since the population of students is so skewed toward one race and one gender, current research [15] generates questions regarding the potential success of students that continue to have impediments such as financial, emotional, and other support throughout their studies.

## VI. CONCLUSION

Finally, something must be done as diversity in technology is seriously lacking as compared to other STEM fields. To encourage diversity in graduate school, in particular, the one studied, a number of things must be present. Potential students must see the value in the investment of time, energy, and self. If they have no role models, this is difficult. If they do not have additional resources that are evident, this too makes this transition difficult, if not impossible.

Further, the age data establishes that a significant number of the graduate population in this college is returning students. This poses a separate set of issues for those used to dealing with traditional students, moving from high school, to undergraduate academics and then later graduate studies. These older students are experienced in the workplace, they have some of the soft skills employers seek, and they understand what they will be going to when they complete their studies. Students such as these are more demanding, suggesting that they are very focused on the end goal.

## VII. FUTURE RESEARCH

To develop a sound understanding of student motivation and to encourage them to pursue graduate degrees interviews and other techniques to understand the student perceptions must take place. Research exists that allows a synthesis of findings, such as those made in this paper. However, direct contact with potential and new students must be made to solidify understanding of how to increase the diversity within the technology graduate student population. Once programs are developed and implemented to increase the diversity of graduate students, the programs must be assessed and this research repeated to determine the program’s effectiveness.

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