AC 2011-2544: A DEMOGRAPHIC ANALYSIS OF ENGINEERING MAJORS WITH AN INTEREST IN TEACHING

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A Demographic Analysis of Engineering Majors with an Interest in Teaching

Abstract

This work describes a demographic analysis of student participation in teaching related professional development programming at a research extensive university. This programming is offered through *Tech to Teaching,* an initiative at Georgia Tech designed to illuminate pathways towards K-12 and higher education teaching careers for students seeking out such careers. Nationally sponsored efforts to increase the STEM workforce in the United States have gained recent prominence through such programs as the Race to the Top. Therefore, it is vital that we understand the characteristics of students who wish to help the nation meet its goals as educators who will help students at all levels become part of the STEM workforce.

In this work, we present the most prevalent demographic characteristics for engineering majors displaying an interest in teaching as a potential career. We identify this group of students by virtue of their participation in specific programming designed to highlight the teaching pathway as a potential career option. This work builds on previous published work in two ways: first, demographic data beyond gender and major are presented and now include ethnicity, GPA, age, class standing, transfer status, co-op status, and full or part-time status; second, both graduate student and undergraduate student data is presented rather than undergraduate student data only. This study was approved by the Institutional Review Board.

The context for this study is a series of professional development activities for students about teaching and learning. Activities include advising, coursework, a la carte workshops, mentoring, and practicum experiences. Student participation in these activities has been tracked longitudinally for two years with over 700 students in the database. Demographic data about these students has been collected and analyzed for trends such that a profile of typical participants has been drawn out.

Results from prior analysis of data collected at our institution have shown a disproportionate number of female students and students majoring in biomedical, chemical and bio-molecular, and industrial and systems engineering choosing to participate in programming for teaching careers. Here we expand this analysis to additional demographic characteristics and present data on longitudinal participation trends for this population. We also offer interpretations of what this data might mean when planning recruitment strategies to bring engineering students into teaching careers. Results show that the typical *Tech to Teaching* engineering participant is female, white (or international if a graduate student), majoring in industrial, civil, or mechanical engineering, and is close to graduation. Also, this student will have a GPA comparable to the average for all Georgia Tech engineering majors (contrary to what many faculty and advisors at the institution might think). Finally, this student most likely will come to a single event in one semester.

Outline

1. Introduction

Georgia Tech is prohibited from having a College of Education or offering degrees in education, but there exists a nontrivial segment of the Georgia Tech population whose primary career interests involve K-12 or higher education teaching. In past years these students would have been in the dark as they attempted to navigate such a career path while at Georgia Tech. Beginning in 2009, several units at Georgia Tech undertook an NSF project funded through the I^3 initiative whose goals are to illuminate and validate the pathway to a career in K-12 or higher education teaching. A major component of this program is a series of coursework, programming, advising, and teaching opportunities offered to Georgia Tech students who are interested in preparing themselves for a teaching-focused career but who, by virtue of being at Georgia Tech, cannot major in education.

1.1 Motivation for the *Tech to Teaching* program based on national need

Aside from providing this subset of Georgia Tech students with much-needed guidance and training, this project also serves a broader societal need by striving to increase the pool of STEM educators. The benefits of having K-12 teachers with specialized knowledge in a STEM field are numerous, but unfortunately the availability of such teachers is not currently keeping pace with the growing need. Additionally, the program strives to improve the quantity and quality of training that graduate students receive on topics related to teaching and learning, with an end goal of producing students who will contribute to the K-12 or college teaching workforce. *Tech to Teaching* strives to serve both the individual needs of students whose career goals involve teaching and the national need for teachers with sound technical backgrounds in STEM fields.

1.1.1 Research questions

In order for engineering majors with interests in teaching to be served effectively, it is critical for us to know something about them. This paper will use detailed demographic data collected on all *Tech to Teaching* participants to date in an effort to answer the following primary research questions, with a specific focus on undergraduate and graduate engineering students:

- What is the level of interest in STEM teaching careers among engineering students?
- What is the most prevalent set of demographics, or “profile” among those interested in STEM teaching careers?

1.1.2 Preview of what’s in the paper

The primary output of our analysis will be a preliminary "profile" of the demographic trends present among students who express an interest in teaching-focused careers. We also present comparisons among demographic groups (e.g., undergraduate students vs. graduate students, engineering students vs. non-engineering students, etc.) to investigate the presence of differential participation rates among such groups. We recognize that participation in the program is due to multiple factors. Factors that potentially influence participation include where we advertise our programs, who is on our advisory board, and who gets preference in programs where seating is limited. For example, workshops, which represent a considerable portion of the total activities available for students to participate in, are primarily targeted toward graduate students; in general, graduate students have a larger number of opportunities to participate than do undergraduate students. And in the case of some courses where there are more students interested in the class than there are seats available, preference is given to STEM students and those supported by other NSF projects, resulting in increased opportunity for participation by STEM majors relative to non-STEM majors. Although some of these factors cannot be quantified, general analyses comparing the participation rates of various groups should provide useful results about which groups of students are more or less likely to participate in *Tech to Teaching*.

We have considered participation in *Tech to Teaching* in two main ways: who participates and how they participate. In terms of who participates, the following demographic characteristics will be reviewed:

- Class standing
- Gender
- Ethnicity
- Major
- Co-op status

We will next describe several patterns of *Tech to Teaching* participation present among these various demographic groups:

- Counts of activities
- Number of semesters of participation
- Preferences for different activity types

Finally, GPAs of *Tech to Teaching* participants are compared with those of all Georgia Tech students in an effort to assess the prevailing popular opinion at Georgia Tech that teaching-focused careers are a last resort for those unqualified to continue pursuing engineering careers.[1]

2. Program overview with background literature and findings

2.1 Program Overview

The *Tech to Teaching* program, which began in 2009, is funded by NSF through the I^3 initiative. Its programming and activities are designed to facilitate the following goals: "(1) Create a pathway to middle and high school STEM teaching by providing students with appropriate advising, and courses in educational pedagogy; (2) Provide opportunities for mentoring by K-12 teachers during summer research internship programs, immersion experiences in the form of school-based internships under the guidance of master K-12 teachers, and induction support through annual teacher retreats; (3) Create a pathway to collegiate teaching that provides graduate students with appropriate advising, courses and workshops in educational pedagogy, and (4) Provide academic job and career mentoring by faculty, and in-depth teaching experiences through teaching practicum positions and immersion experiences teaching undergraduate courses at Georgia Tech and other local colleges. Furthermore, there is an overarching goal to change the culture at Georgia Tech so that these teaching careers are seen as viable and successful career goals" [2].

Participation in the *Tech to Teaching* program is dependent on many factors. For example, graduate and undergraduate students participate for different reasons. Undergraduate students often participate because they are considering a career in K-12 teaching, which is not a mainstream career path at Georgia Tech. Graduate students typically participate because they are teaching assistants, or because they are interested in faculty jobs, which is a very mainstream career path at Georgia Tech. Other factors affecting participation included specific faculty with external funding that need to utilize *Tech to Teaching* programming to build certain skills for the students who work with them, or faculty and/or advisors who proactively provide information about *Tech to Teaching* programming to the students they see.

Opportunities for student participation include semester-long courses (at the undergraduate and graduate levels), 1-2 hour workshops (technically open to both undergraduate and graduate students, but targeted towards graduate students), one-on-one advising (at the undergraduate and graduate levels), and mentoring and immersion experiences (at the undergraduate and graduate levels). Students are notified of opportunities for participation through e-mails (typically sent out by school-level advisors), handouts (distributed at graduate orientation and other campus-wide events), and posts on the program's website. Students have embraced the program, participating at rates commensurate with the expectations of program personnel and providing relatively high ratings for courses and workshops[3-4]. It is anticipated that providing information about the characteristics of those students who are, and are not, participating in the program will assist program personnel in both providing desired programming content and strategically targeting advertising efforts. More detailed program information is available through the program website (http://www.techtoteach.gatech.edu) and in a prior publication on the graduate programming component of Tech to Teaching.[5]

2.2 Background lit and findings

2.2.1 K-12 STEM teacher production and job availability

2.2.1.1 K-12 STEM educators

An important anticipated outcome of the *Tech to Teaching* program is to produce high-quality K-12 teachers with strong content knowledge in STEM fields. Numerous sources emphasize the shortage of such teachers, especially in high-poverty, high-needs schools [6-11]. As a result of this shortage, many students are taught math and science by teachers lacking the appropriate content knowledge to do so; for example, over half of U.S. middle school math teachers and 40% of middle school science teachers lack a major or minor in their respective subjects. These figures improve for high school math and science teachers, of whom only 14.5% and 11.2% lack a math or science major, respectively[7]. Administrators are often in need of science and math teachers, unable to fill vacancies in these positions. Per the U.S. Department of Education, as of 2004 66% of public schools with teacher vacancies in STEM fields reported problems in recruiting teachers to fill these vacancies, compared to 41% of schools reporting similar problems with English/Language Arts positions[9]. The teacher shortage is in part an issue of distribution, with shortages being more severe in some contexts than in others – urban and rural areas, and subjects such as math, science, English as a second language, and special education are particularly prone to shortages. Turnover of teachers is higher in math and science than in other fields; reasons for turnover include personal reasons, dissatisfaction with one’s job/seeking a better job, low salaries, student discipline problems, low levels of new teacher support, and low faculty input into school decision making[11]. Programs for STEM teacher training and recruiting efforts will hopefully help the U.S. avoid the fate of Norway, where there is such a severe teacher shortage that secondary schools are unable to offer science classes, “creating a downward spiral of suitable qualified STEM professionals- including teachers”[12].

The importance of having STEM teachers with solid backgrounds in STEM content knowledge is illustrated by a set of findings from a study on determinants of student performance. In general, significant positive relationships were found between the number of undergraduate math and science courses a teacher had taken and the amount of improvement in high school students’ respective math or science performance (controlling for students’ ability upon entry into the class). Pedagogical training courses also had positive associations with pupil learning, and in some cases the size of these effects was larger than was the case with the content courses. Conversely, teacher degree level and years of experience had virtually no association with pupil learning[13]. So there is empirical evidence for a link between teachers’ level of relevant background training and their students’ subject-specific performance.

What are the reasons for the low supply of qualified STEM teachers? This problem is driven in part by the fact that approximately 17% of postsecondary degrees awarded in the U.S. are in STEM fields, and the U.S. is 20th among all nations in a count of 24-year olds who earn degrees in natural science or engineering[7]. Compounding the problem, the relatively small pool of STEM majors typically has multiple and attractive career options. To combat these other attractive career options, science teachers may need a relatively more expensive compensation package compared to, say, an English teacher[11]. Compensation is a major issue in STEM teacher recruitment and retention. Economic labor market theory of supply and demand can be applied in the following way to teacher labor markets: “the number of people willing to work as teachers is directly and positively related to the desirability of the teaching profession as compared to alternative available professions”[10]. Results of a study in which undergraduate STEM majors were questions about their career plans revealed that an annual starting salary for K-12 teaching that is 45% above the local average K-12 teacher starting salary would make 48% of sophomores and 37% of juniors “seriously consider” a career in K-12 teaching. These students were also asked to report the importance of various factors in their decision to consider or not consider a K-12 teaching career if the salary were equal to what they expected to get from their first job; the three factors with the highest average rated importance were “whether I would like working with children”, “whether I would be good at teaching” and “need to give up current career plan”[14].

Despite the low salaries and attractive competing career options, STEM majors do become teachers, typically because they find it personally rewarding, enjoy making a difference in students’ lives, and enjoy learning new things. In a study of undergraduate STEM majors engaging in a tutoring program for high school students, three general factors played a role in tutors’ reports that they felt favorably towards considering a teaching career: positive perception of the value of the tutoring work, positive perception of tutors’ aptitude for teaching, and perception of teaching as a complex endeavor[10].

2.2.1.2 K-12 Engineering specific educators

Efforts to increase the number of STEM majors and thus the number of potential STEM professionals, including teachers, have in some cases focused on introducing engineering principles to the K-12 curriculum. This is good news for *Tech to Teaching* participants, and may drive some of the *Tech to Teaching* participation for K-12 relevant activities.

One source of engineering specific K-12 educator demand is Project Lead the Way, a pre-college engineering curriculum program, which has been adopted by over 10% of high school and is used in all 50 states[15]. The goal of this program is to integrate STEM content into the program of study for middle and high school students. Seven courses are offered through this program at the high school level, some of which can be used to earn college credit. Teachers of PLTW courses must go through professional development and training in project-based and problem-based instruction. In a study comparing the beliefs of PLTW teachers with regular math and science teachers, PLTW teachers were more likely to identify support for engineering in their schools, were less likely to believe that a successful engineer must be a high achiever in math, science, and technology, and were more likely to state that the science and math content taught in their classes was integrated with engineering content[15].

Further, a number of states are now developing K-12 engineering curriculum standards. Massachusetts is one example, where standards were introduced in 2001[16]. A number of other states have initiated similar activity[17].

2.2.2 Need for better training of Higher Ed faculty in teaching and learning

Higher education faculty, for the most part, read very little about education research[18], or about teaching and learning in general. This has led to very slow progress in changing the way teaching and learning occur at the university level. This pace of change has been slow despite many calls for reform in education, and despite the fact that, during recent decades, researchers have uncovered vast knowledge about how people learn, and in particular how people learn in STEM fields[19]. We agree with Carnegie Senior Scholar on Educational Assessment Lloyd Bond's support for the notion that teaching does indeed have "deep structure" which teachers can be trained to tap into[20]. We believe that a critical mass of advanced knowledge about teaching and learning, and specifically within the field of engineering education (see (Lord and Camach[21]; Turns, and Eliot et al.[22]) for just two examples), does exist and that this knowledge should be applied as a widespread effort.

As outlined in Utschig and Schaefer[23], much of the work in recent years about teaching and learning was articulated in the seminal work by Barr and Tagg describing a paradigm shift from teaching to learning[24]. Prince & Felder have published a number of articles which draw upon a variety of studies both within and outside of engineering contexts demonstrating the effectiveness of active and inductive teaching and learning techniques[25-27]. Specifically, collaborative learning, cooperative learning, problem-based learning, project-based learning, inquiry learning, just-in-time teaching, case-based learning, and discovery learning are shown to have the potential for significant positive effects on achieving student learning outcomes when facilitated effectively. Smith et al provide additional support for the techniques outlined by Prince and Felder, but with a particular emphasis on how student engagement is a key aspect to success in these techniques[28]. They focus on two techniques in particular, collaborative learning and problem-based learning, as representative of pedagogies of engagement, and outline the impact they can have on elevating student learning. Finally, Froyd has begun to comprehensively assess how major research studies support the efficacy of specific types of teaching and learning[29-30]. He looks at both the evidence for how well these techniques work, and at level of effort required by faculty to implement the techniques.

The need for better training to help faculty more effectively utilize various techniques such as those described above is evidenced by the existence of many programs around the world designed specifically to help faculty develop their knowledge and skills related to teaching and learning. Utschig and Schaefer offer a thorough exploration of these programs worldwide[31]. These authors also point to many small scale programs in the United States such as Preparing

Future Faculty, STEMES, and others. Finally, Visco et al outline common elements present in many of these training program that form a basic set of competencies[19].

Georgia Tech, having built a program at an institution without a college of education, is a natural fit for this model where many elements across the university must be tied together to improve teaching and learning. *Tech to Teaching* ties together STEM education-interested students with STEM education-interested faculty through professionals and resources in the Center for the Enhancement of Teaching and Learning.

3. Methods of data collection

3.1 Description of database

A database is currently under development which includes a large set of demographic data for students who have participated in one or more teaching-related activities via the *Tech to Teaching* program; this database is the source of the data analyzed in this paper. Demographic variables tracked include name, gender, ethnicity, major, GPA, age/date of birth, date of entry to Georgia Tech, graduate or undergraduate student, class standing (freshman, sophomore, junior, senior, MS, or PhD), institutional transfer information, whether the student co-ops, and whether the student is full or part-time. Teaching-related activities tracked include enrollment in full-semester courses, participation in individual 1.5-hour workshops, one-on-one advising appointments, and mentored practicum experiences where students help teach a class or teach a class on their own under the guidance of an experienced educator. A list of student participants is prepared each semester and demographic data from that specific semester are requested from the Office of Institutional Research & Planning (IRP). This process runs a semester behind, such that the FA09 data was actually requested and compiled during SP10. The reason for this is that activities can run to the very end of the semester, so the lists are compiled in the subsequent semester to ensure that all participants are included.

3.2 Overview of data & analyses

All of the demographic data is representative of that student *during* the target semester when they participated in a *Tech to Teaching* programming event. Thus, all the demographic data are the students' data as of one semester prior to the target semester; for example, for a FA09 participant, the GPA recorded would be his/her cumulative GPA upon completion of the SP09 semester and his/her major would be the major recorded at the end of the SP09 semester.

Even if students participating in a given semester have also participated in prior semesters (and thus had their demographic data provided before), their demographic data is requested for each semester in which they participate. This longitudinal data is collected because of the expectation that some demographic variables (e.g., GPA, major, co-op status) are likely to change over time. For the purposes of this paper we are not tracking changes over time in these variables.

In this paper, two types of analyses will be presented. In "snapshot" type analyses, data from a given semester is analyzed for that semester only, for students participating in that semester only. For analyses where all participants are included at once (aggregate-level analyses), some participants, by virtue of having participated in more than one semester, will have more than one data point. In these cases, the most recent data point is used (e.g., most recent GPA or major).

Semesters included in this paper are spring 2009, summer 2009, fall 2009, spring 2010 and summer 2010. A total of 708 unique students, comprised of 349 engineering students and 359 non-engineering students, participated in one or more teaching-related activities over this 5-semester time period and had demographic data available. Approximately 87 participants did not have available demographic data; in most cases the reason for this is that the student was not enrolled during the semester prior to the target semester, thus no demographic data was available. The cumulative number of unique engineering student participants is shown below.

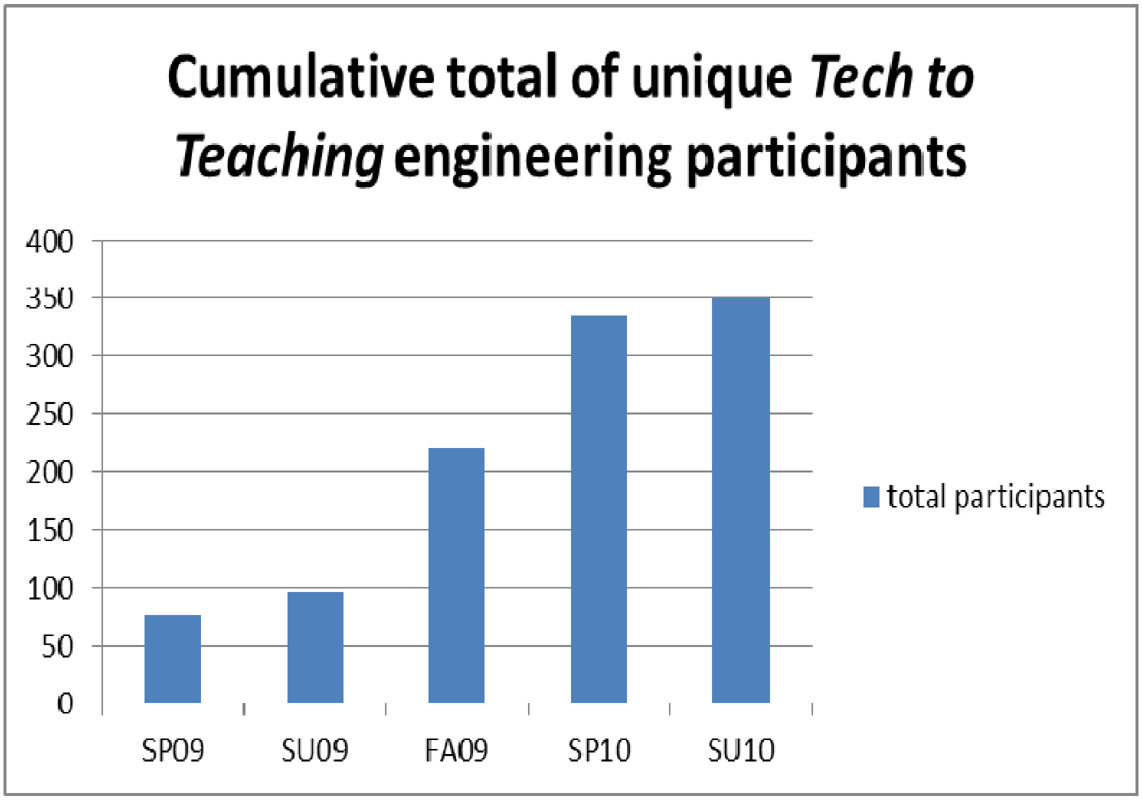

Figure 1. Cumulative total of unique *Tech to Teaching* engineering participants.

Majors were separated into engineering and non-engineering based on institutional classification schemes. For multidisciplinary majors (i.e., majors housed in multiple schools), these majors were retained in the data set if 50% or more of the schools listed for that major were engineering schools.

4. Results and Discussion

4.1 General Findings & Profile

Providing a set of characteristics of students interested in teaching careers will help inform the appropriate recruitment strategies and contents of programming intended to serve this audience. Specific analyses supporting each piece of the profile are provided below, but the general findings about typical characteristics of participants in these teaching-related programs are provided in Table 1. Use of the word "significantly" in this table implies statistical significance (at the $p < .05$ level or better, with exact p-values for $p > .05$ not being obtained); supporting analyses for these statements regarding statistical significance are presented later in the paper.

Table 1. Summary of *Tech to Teaching* participant "profile" characteristics.

Variable	**General Finding**
Engineering participation rates	Among undergraduate students, *Tech to Teaching* participants are significantly more likely to be non-engineers than engineers; among graduate students, *Tech to Teaching* participants are equally likely to be non-engineers or engineers.
Gender	Among all groups, *Tech to Teaching* participants are significantly more likely to be female.
Ethinicity	For undergraduate *Tech to Teaching* students, the ethnic breakdown of engineers does not appear to differ from than of non-engineers. For graduate *Tech to Teaching* students, the ethnic breakdown of engineers does appear to differ from that of non-engineers, with asian and international students appearing to be slightly over-represented, and white students appearing to be slightly under-represented, among engineering students.
Class Standing	*Tech to Teaching* engineering participants are more likely to be graduate students than undergraduate students (this is unsurprising given the larger number of opportunities within the program for graduate students).
Engineering	Among undergraduate engineering students, the major distribution of *Tech to Teaching* participants matches that of all Georgia Tech undergraduate

Majors	engineering students; among graduate engineering students, some majors (industrial and mechanical engineering) are overrepresented while others are underrepresented.
Co-op participation	The level of co-op participation among all *Tech to Teaching* participants is very low (less than one half of the institutional co-op participation rate). Of the seven total co-op participants, six were male, five were mechanical engineering majors, and 4 were undergraduate students.
Tech to Teaching participation: # activities	Engineering and non-engineering students do differ on the number of activities they participate in, with the 1 activity group having non-engineeering students in the majority and the 2+ activity group having engineering students in the majority. Students doing 1 activity are more likely to be undergraduate students while those doing 2 or more activities are more likely to be graduate students (this is consistent with the larger number of participation opportunities for graduate students).
Tech to Teaching participation: # semesters	Engineering students do not differ on the number of semesters in which they participate from other participants; undergraduate students and graduate students do not differ on the number of semesters in which they participate. To date, the majority of *Tech to Teaching* engineering participants have participated during only 1 semester.
GPA	GPAs are roughly comparable between undergraduate engineering participants and all Georgia Tech undergraduate engineering students; GPAs are roughly comparable between graduate engineering participants and all Georgia Tech graduate engineering students.
Tech to Teaching participation: activity type	Workshops are the most popular *Tech to Teaching* activity for engineering graduates while advising and courses are the most popular *Tech to Teaching* activities for engineering undergraduate students. Engineers and non-engineers show similar general trends, except that non-engineering graduate students participate in advising at nearly twice the rate of engineering graduate students.

4.2 Specific Analyses & Findings

4.2.1 Engineering vs. Non-engineering

We analyzed the distribution of students enrolled in engineering majors as opposed to non-engineering majors within the *Tech to Teaching* program, and compared this distribution to the general Georgia Tech population. These analyses were run separately for undergraduate and graduate students as their major distributions are expected to differ.

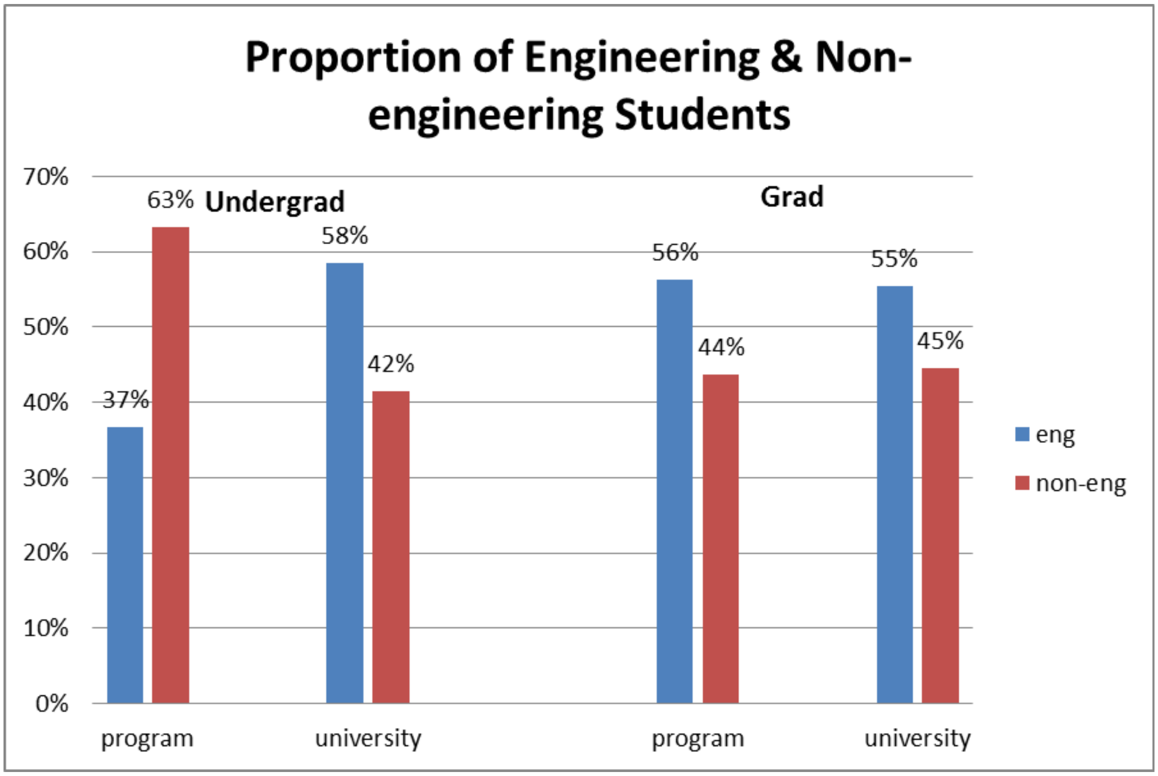

Figure 2. Proportion of engineering & non-engineering students participating in *Tech to Teaching*.

The breakdown of engineering vs. non-engineering students in the graduate Tech *to Teaching* participant group mirrors that in the overall Georgia Tech graduate student population closely. The results of a Chi-square goodness of fit test reveal that the mix of engineering and non-engineering graduate students in *Tech to Teaching* is not significantly different from that of the general graduate student Georgia Tech population, X^2 (1, N = 455) = .04, p > .05. So graduate engineering students participate in *Tech to Teaching* at a rate that matches their representation in the general Georgia Tech population.

For the undergraduate students, engineers are quite underrepresented (& non-engineers are over-represented) relative to their respective standings in the Georgia Tech undergraduate student population. A Chi-square goodness of fit test reveals that, among undergraduate students, the proportion of engineering and non-engineering students in *Tech to Teaching* differs significantly from the general Georgia Tech population, X^2 (1, N = 253) = 18.10, p < .001. So undergraduate engineering students are less likely to participate in *Tech to Teaching* than would be expected given their representation in the general Georgia Tech population.

4.2.2 Gender

We analyzed the gender of *Tech to Teaching* engineering participants as compared to the gender of all Georgia Tech students, separately for the undergraduate and graduate student populations. The goal of this analysis was to see if one gender is overrepresented among *Tech to Teaching* engineering participants relative to the general Georgia Tech population.

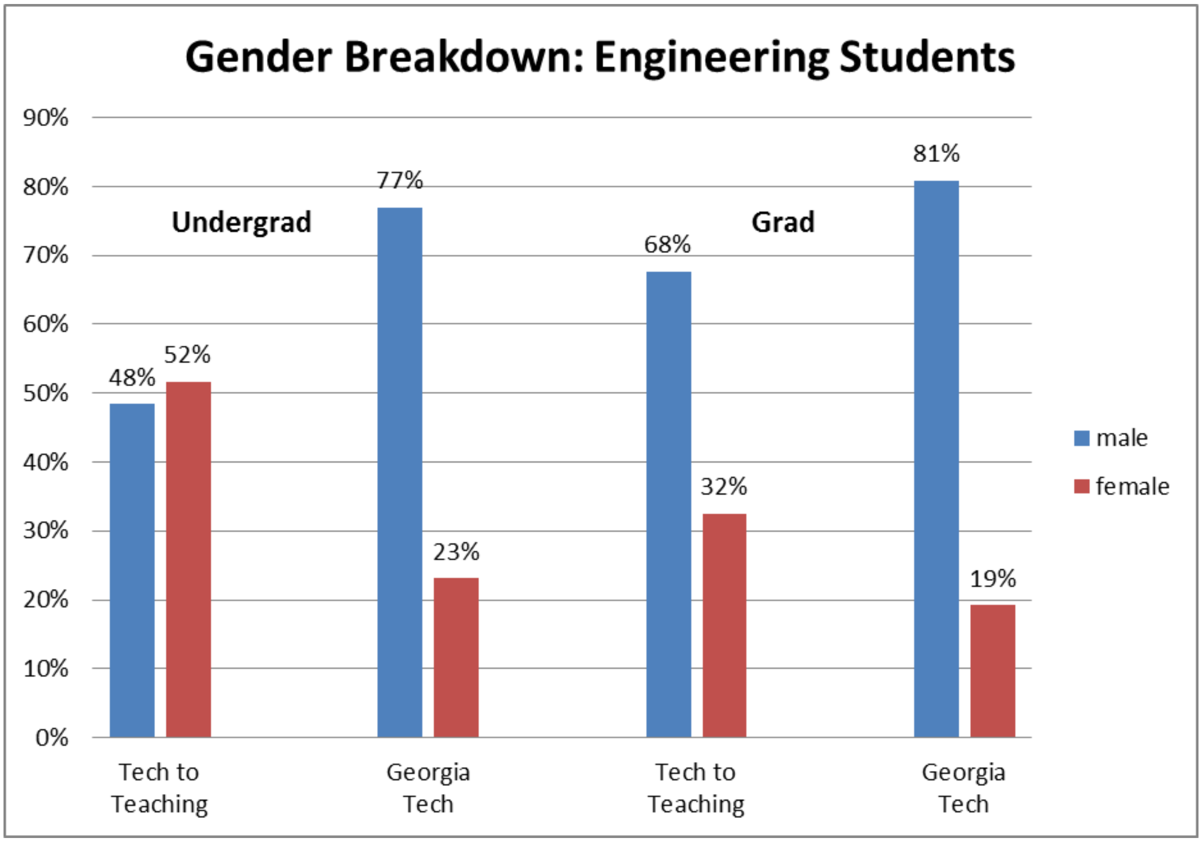

Figure 3. Gender breakdown of engineering students participating in *Tech to Teaching.*

Compared to the Georgia Tech population, females are over-represented in both graduate and undergraduate student *Tech to Teaching* groups. The extent of overrepresentation by females is larger among undergraduate students than among graduate students. A chi-square goodness of fit test reveals that the gender distribution of both groups differs significanlty from the gender breakdown for each of these groups in the larger Georgia Tech population: undergraduate engineering students, X^2 (1, N = 93) = 47.49, p < .001, graduate engineering students, X^2 (1, N = 256) = 10.98, p < .001. So in general, *Tech to Teaching* engineering participants are more likely to be female.

4.2.3 Ethnicity

The ethnicity of *Tech to Teaching* engineering and non-engineering participants was compared, separately for undergraduate students and graduate students. The goal of this analysis was to investigate whether the ethnicity of *Tech to Teaching* participants differed from the general engineering population. We would have preferred to compare the ethnic breakdown of *Tech to Teaching* engineering participants directly with that of the full Georgia Tech engineering population, but that comparison was not feasible due to differences in the coding of ethnic background groups between our *Tech to Teaching* data set and available demographic information for the general Georgia Tech population.

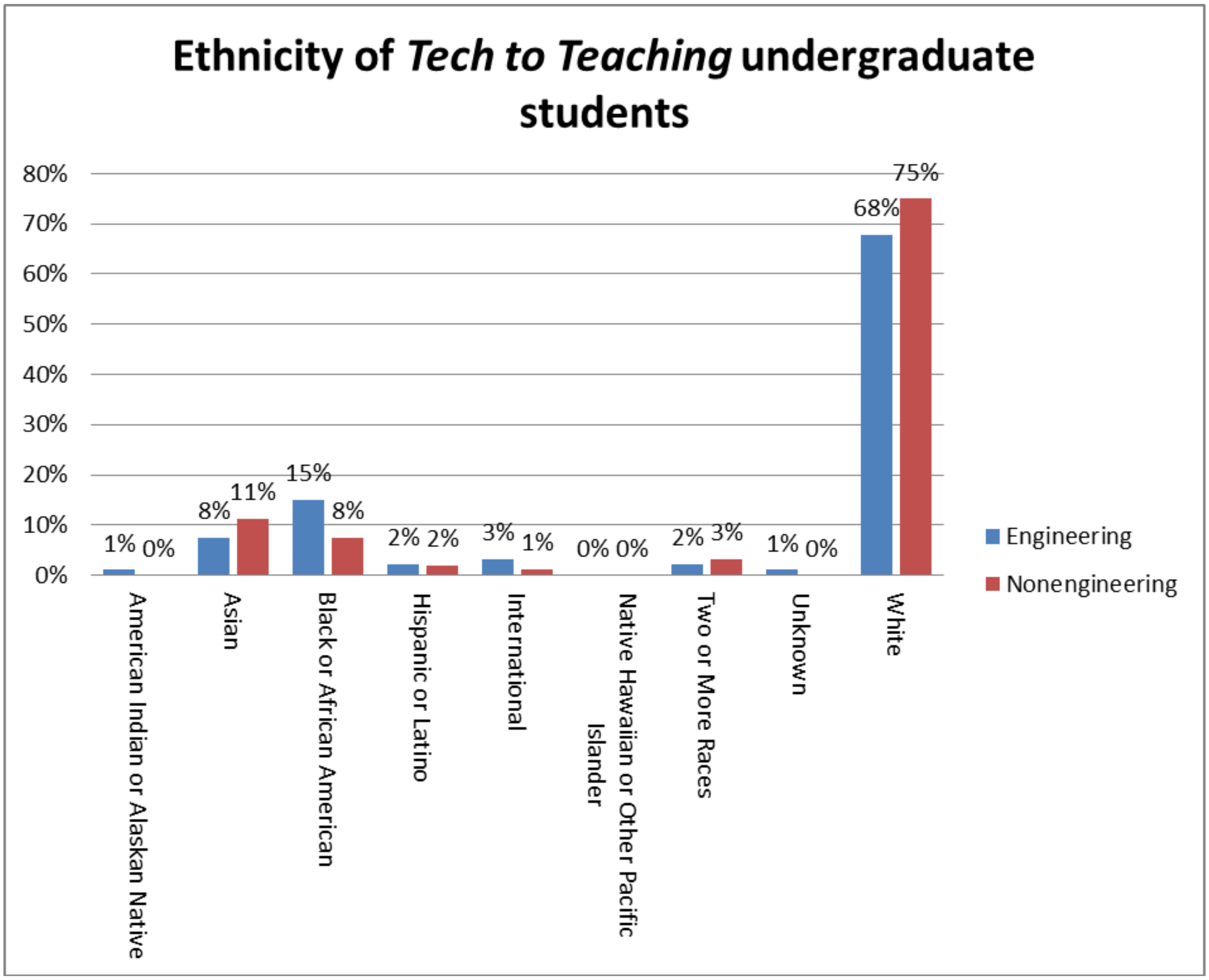

Figure 4. Ethnicity of undergraduate student participants in *Tech to Teaching*.

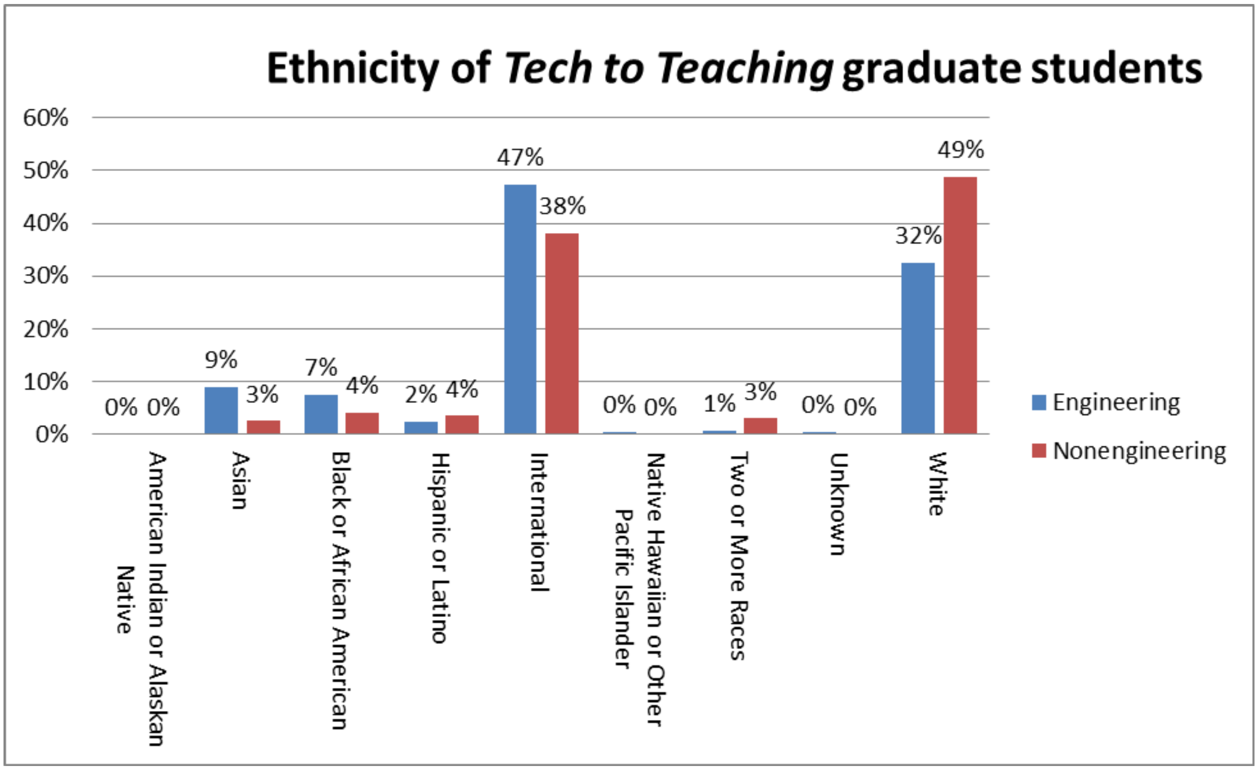

Figure 5. Ethnicity of graduate student participants in *Tech to Teaching*.

Chi-square analyses were not conducted for the ethnicity data due to a very low number (i.e., less than 5) of individuals in several categories, a situation which is problematic for a chi-square test. Trends in the ethnicity data were instead examined. For *Tech to Teching* undergraduate students, the ethinic distribution of engineering students and non-engineering students appears similar. Among *Tech to Teaching* graduate students, Asian and International students appear to be slightly over-represented among engineers whereas White students appear to be slighlty over-represented among nonengineers. In general, graduate student *Tech to Teaching* engineering participants tend to be international or white, with little representation from other ethnic groups. Undergraduate student *Tech to Teaching* engineering participants tend to be white, and possibly black/African American or Asian.

4.2.4 Class Standing

We analyzed the class breakdown (graduate vs. undergraduate students) of *Tech to Teaching* participants as compared to the full Georgia Tech population, separately for engineering and non-engineering students. The goal of this analysis was to see if one class was over-represented among *Tech to Teaching* participants, relative to the general Georgia Tech population.

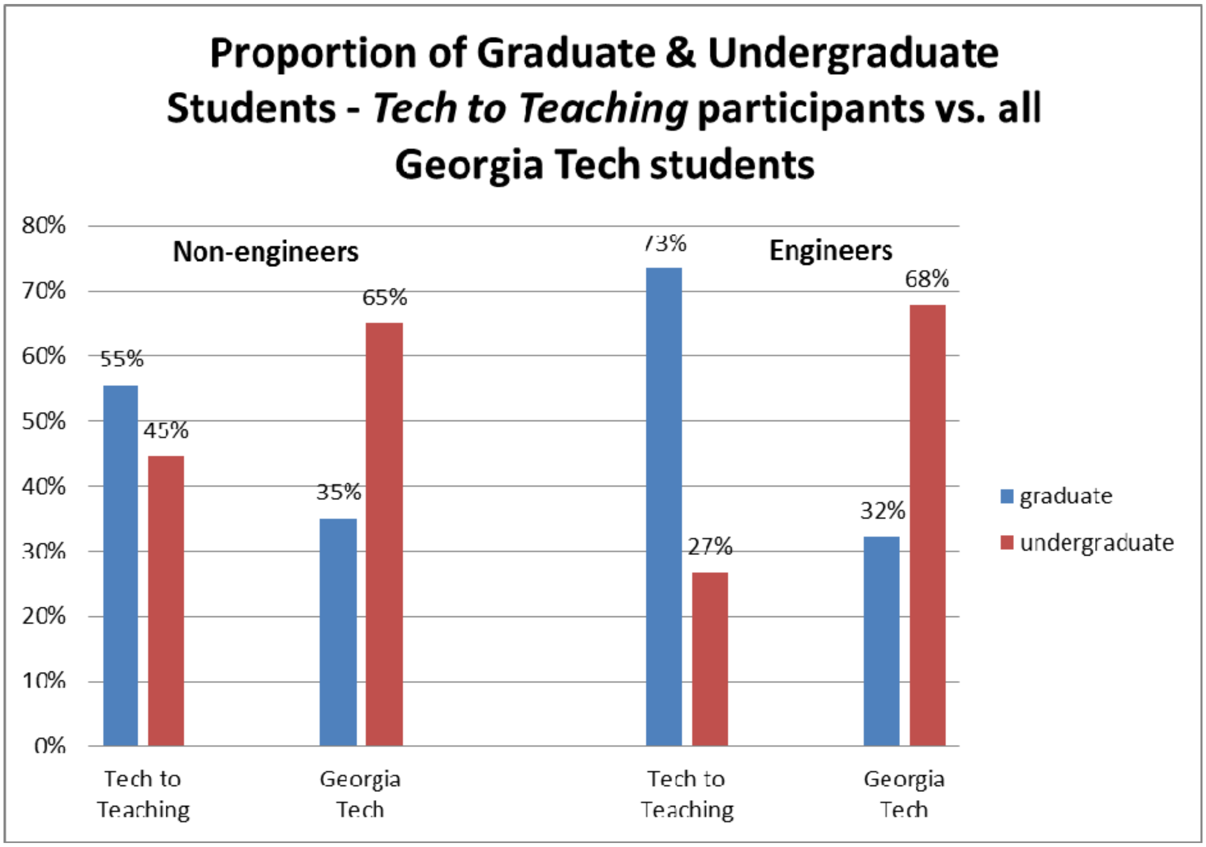

Figure 6. Proportion of undergraduate students and graduate students among non-engineering and engineering participants in *Tech to Teaching*.

Graduate students are over-represented relative to the general population at Georgia Tech in both the engineering and non-engineering *Tech to Teaching* participant groups. The extent of this overrepresentation is larger among engineers than among non-engineers. The graduate student vs. undergraduate student distribution among both *Tech to Teaching* engineering students, X^2 (1, N =349) =142.95, $p < .001$ and *Tech to Teaching* non-engineering students, X^2 (1, N =359) =17.58, $p < .001$ differs significantly from the respective graduate student vs. undergraduate student distribution of engineers and non-engineers in the larger Georgia Tech population. So in general, *Tech to Teaching* participants are more likley to be graduate students.

The detailed breakdown of engineering *Tech to Teaching* participant class standing is shown below.

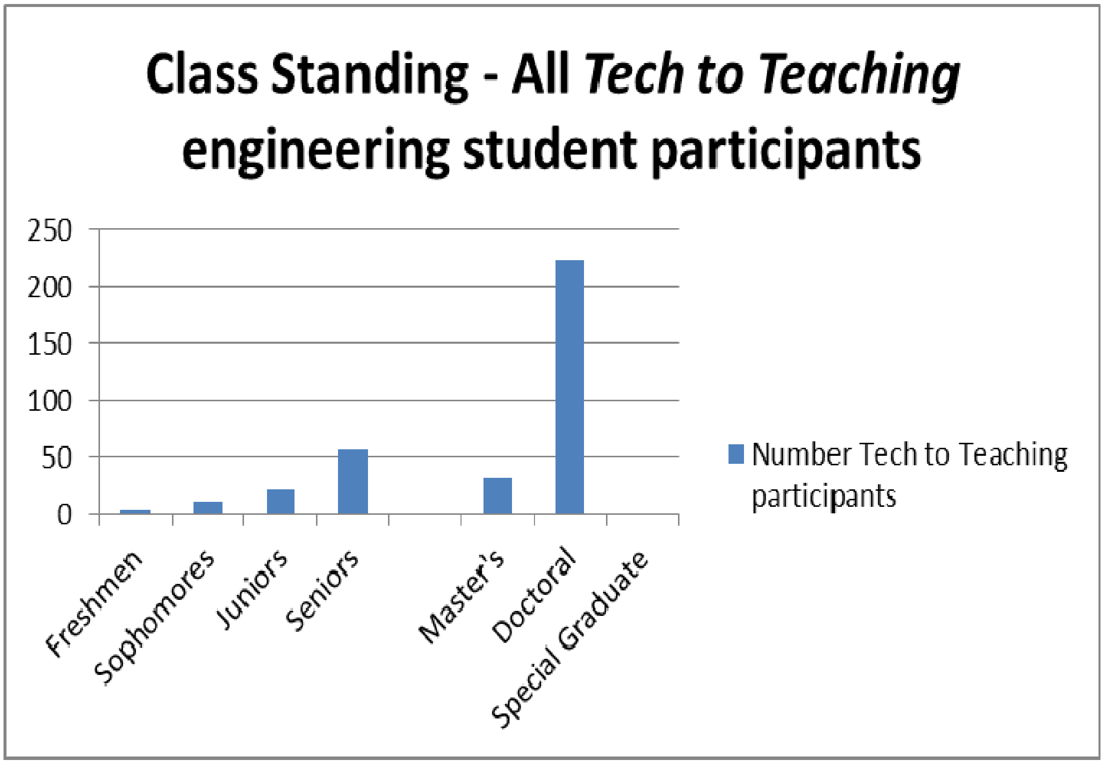

Figure 7: *Tech to Teaching* engineering participation breakdown by class standing

4.2.5 Engineering Majors

We compared the distribution of engineering majors among *Tech to Teaching* participants to that of the general Georgia Tech engineering population, separately for undergraduate and graduate students. The aim of this analysis was to see if any engineering majors are over-represented among *Tech to Teaching* participants, relative to the general Georgia Tech population, for either undergraduate or graduate students.

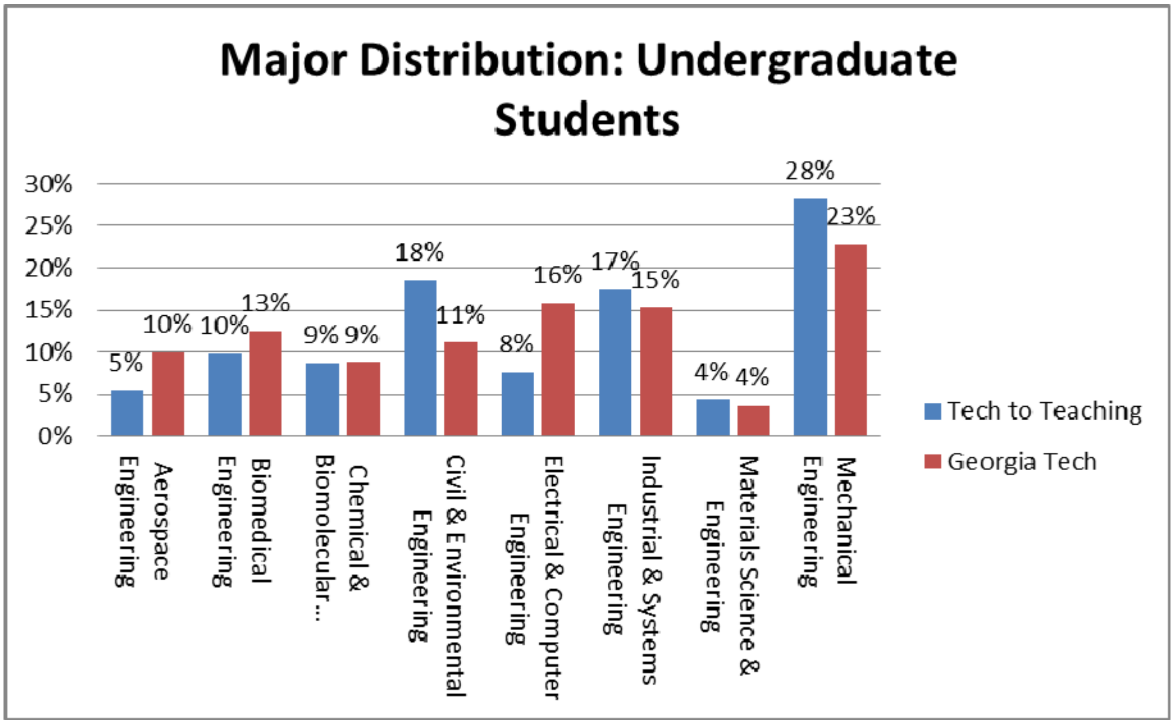

Figure 8. Distribution of majors among undergraduate student engineering participants in *Tech to Teaching*

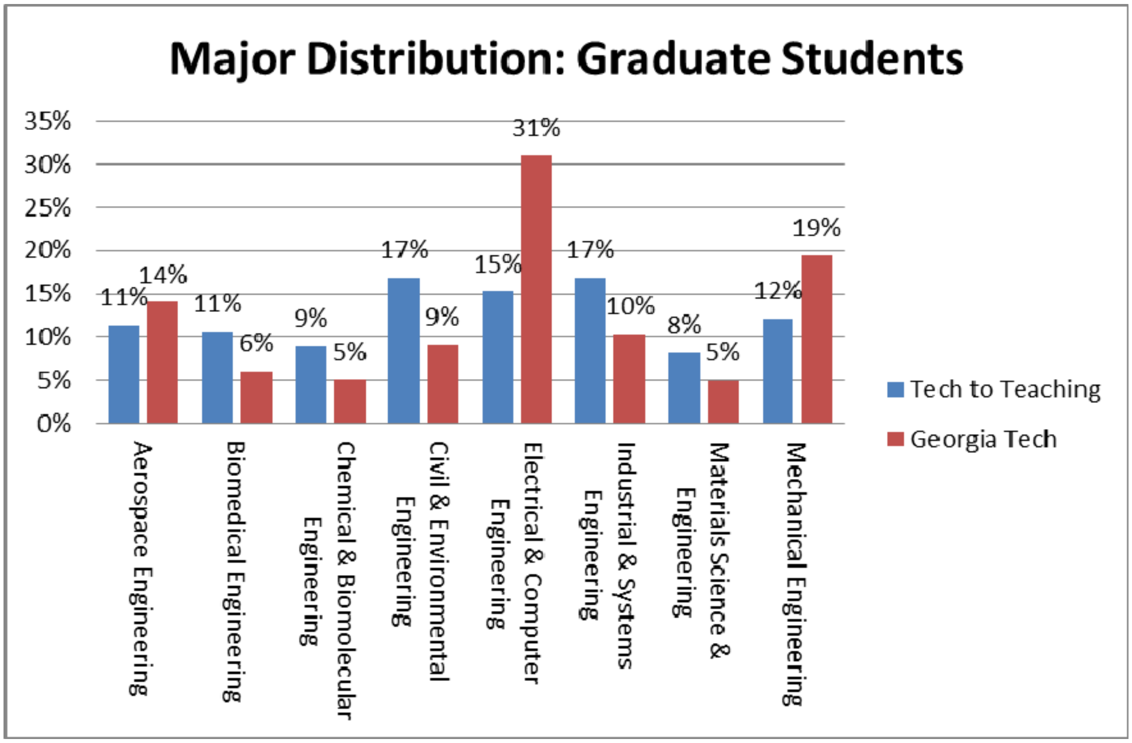

Figure 9. Distribution of majors among graduate student engineering participants in *Tech to Teaching*.

A chi-square goodness of fit test reveals that for undergraduate engineering students, the distribution of majors among *Tech to Teaching* participants *does not* differ from that of the Georgia Tech undergraduate engineering student population, X^2 (7, N =93) =13.00, $p > .05$. For the graduate engineering students, the distribution of majors among *Tech to Teaching* participants *does* differ significantly from that of the Georgia Tech graduate engineering student population, X^2 (1, N =256) =142.95, $p < .001$. While this analysis is not intended to assess the significance of differences at the level of individual majors, we can observe the following trends in the data: it appears that, for the graduate students, Civil & Environmental Engineering and Industrial & Systems Engineering are over-represented relative to the Georgia Tech population while Electrical & Computer Engineering and Mechanical Engineering are under-represented. Data for the representation by major of undergraduate students participating in the advising portion of Tech to Teaching is available from Spencer et al[33].

4.2.6 Co-op Participation

There is a very low level of co-op participation among *Tech to Teaching* engineering participants (10 total, of which seven were engineers). Less than 4% of *Tech to Teaching* participants co-oped in any one semester, compared to approximately 10% of engineering students who co-oped institution-wide. This is not surprising, as most co-op participants are participating in the co-op program as a means of introducing themselves to the type of job they would ideally like to pursue in their post-Georgia Tech careers. As such, it makes sense that there is little overlap between *Tech to Teaching* participants and co-op participants.

Of the seven total engineering co-op participants, six were male and one was female; five were mechanical engineering majors, one was electrical and computer engineering and one was industrial engineering; four were undergraduate students and three were graduate students; and one was black or African American, one was Hispanic or Latino, three were white, and two were international.

4.2.7 Level of Participation (Activity & Semester Counts)

The number of semesters in which *Tech to Teaching* students participated in *Tech to Teaching* programming, as well as the total count of activities they participated in, were compared between engineers and non-engineers in an effort to investigate whether engineering and non-engineering students show differential rates of participation in *Tech to Teaching*. This count of semesters in which students participated reflects a count of any semesters in which they participated in one or more *Tech to Teaching* activities. The activity count is a count of the total number of distinct *Tech to Teaching* activities in which they participated.

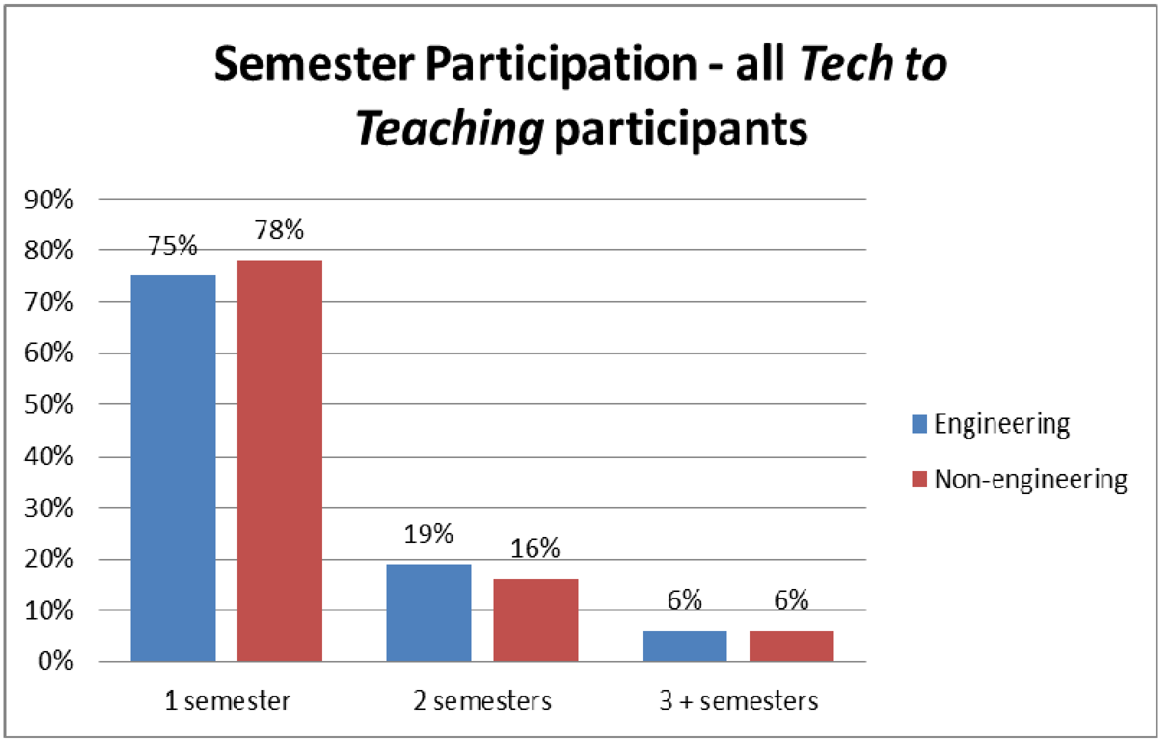

Figure 10. Count of semesters in which students participated – all *Tech to Teaching* students

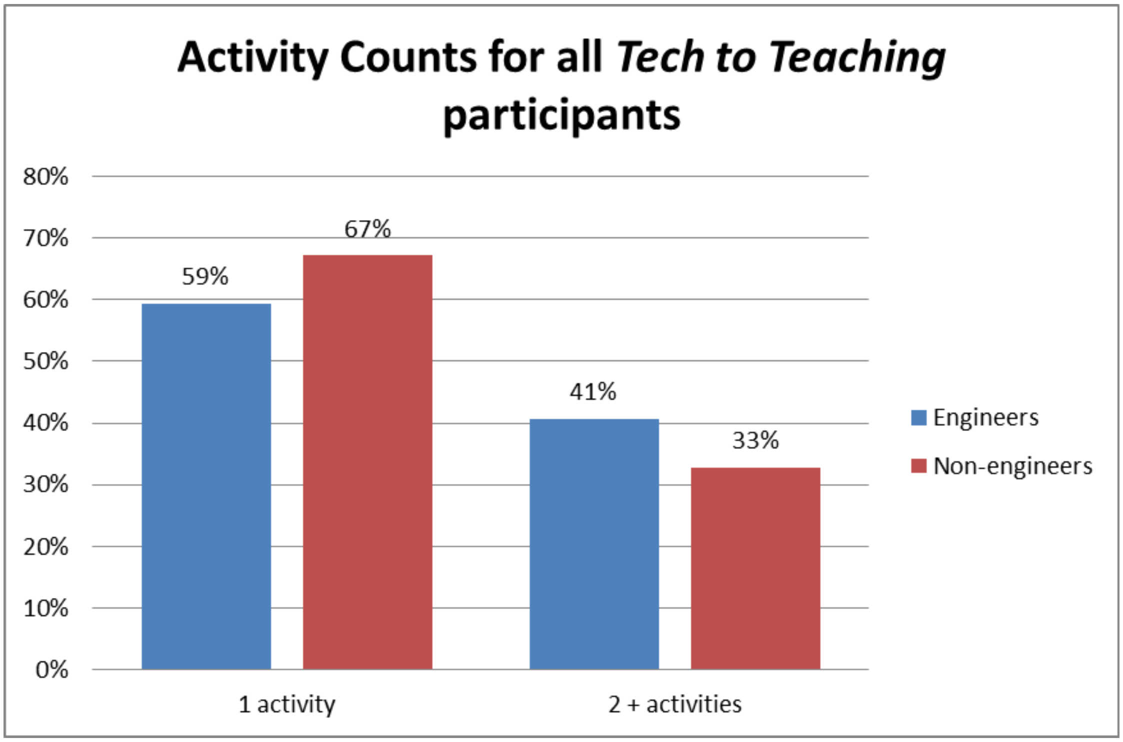

Figure 11. Activity counts for all *Tech to Teaching* participants.

A Pearson's Chi-square test reveals that engineers and non-engineers do not differ significantly in the number of semesters in which they participate in *Tech to Teaching*. Engineers and non-engineers do differ significantly in their activity counts, X^2 (1, N =708) =4.66, $p < .05$, with members of both groups being more likely to do one activity as opposed to 2 or more activities, but with non-engineering students dominating the 1 activity group and engineering students dominating the 2+ activity group. So individuals doing 1 activity only are more likely to be non-engineering students, while individuals doing 2+ activities are more likely to be engineering students.

Comparisons were also made on the demographics of engineering students participating in 1 vs. 2 or more program activities in order to determine if these groups differ in meaningful ways. The gender breakdown of the 1 activity group compared to the 2 activity group is fairly similar, with the 1 activity group being 60% male and 40% female and the 2 or more activity group being 65% male and 35% female. The class standing of these two groups is different, with the 1 activity group being 67% graduate students and 33% undergraduate students while the 2 or more activities group is 83% graduate students and 17% undergraduate students. So those participants doing 2 or more activities are unlikely to be undergraduate students. This is not surprising, as the type of activity most amenable to repeat participation is the workshops, which are primarily targeted toward graduate students.

More specifically in terms of class standing, nearly 80% of those doing 2 or more activities are doctoral students, while doctoral students comprise about 55% of the 1 activity group, and seniors make up over 20% of the 1 activity group.

The average GPA for students in the 1 activity group is comparable to that of students in the 2+ activity group. Lastly, the ethnic breakdown of the 1 activity group differs slightly from that of the 2+ activities group; White students comprise the largest portion of the 1 activity group (46%), while International students make up the largest portion of the 2+ activities group (40%). This difference in ethnic breakdown is largely due to the fact that graduate students dominate the 2+ activities group, and a substantial portion of the graduate students are International students.

Analyses on the total activity counts and semesters of participation of *Tech to Teaching* participants were then run separately for graduate and undergraduate students to investigate whether graduate and undergraduate students show differential rates of participation in *Tech to Teaching*.

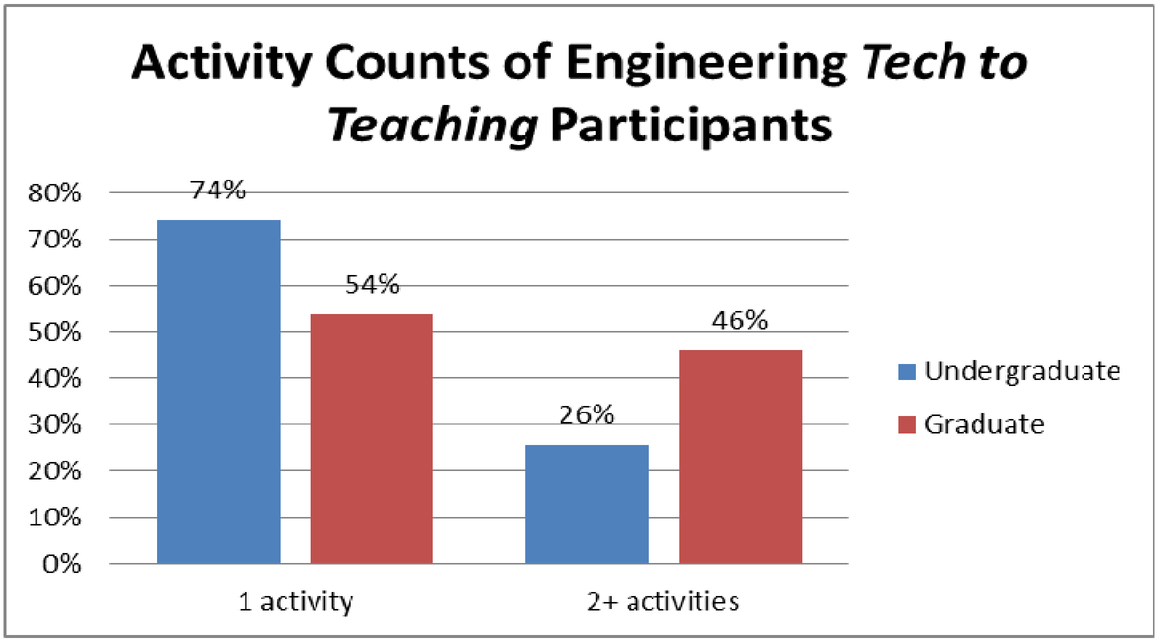

Figure 12. Activity counts for *Tech to Teaching* engineering participants.

Chi-square tests for independence reveal that among engineering students, X^2 (1, N =349) =11.63, p < .001, undergraduate and graduate students differ significantly in their activity counts. It appears that undergraduate students are much more likely to do 1 activity as compared to 2 or more activities. This trend exists among graduate students as well but to a significantly lesser extent.

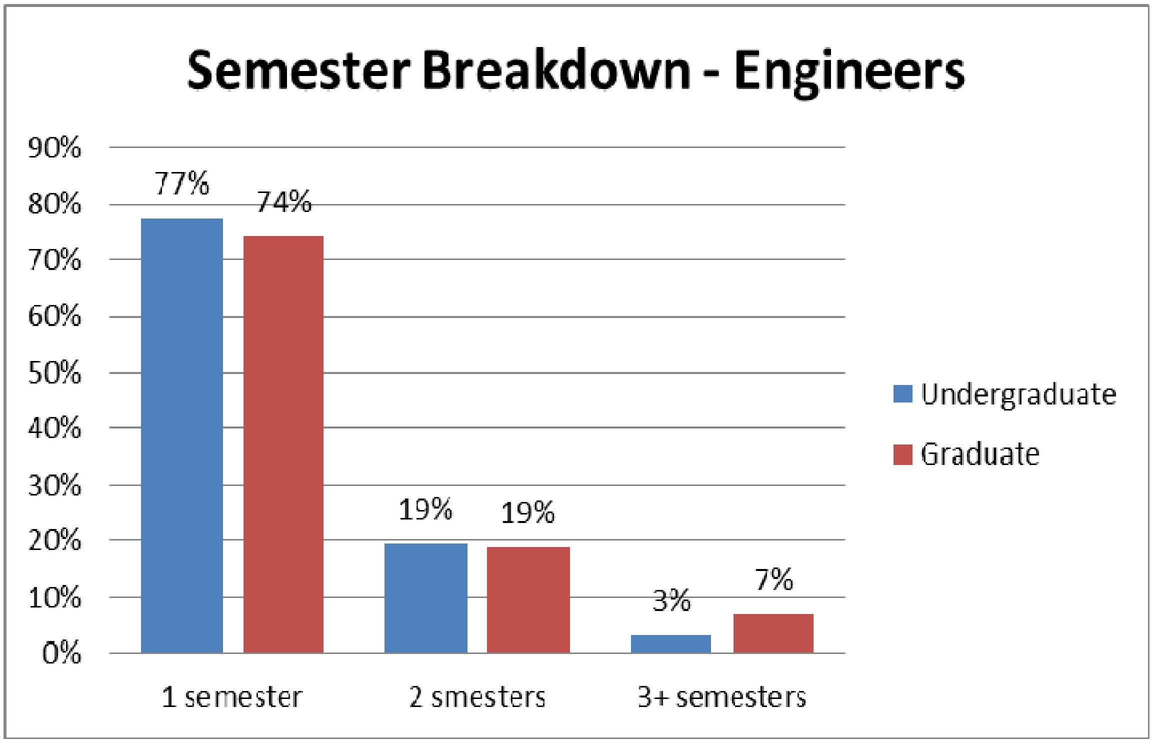

Figure 13. Count of semesters in which students participated – *Tech to Teaching* engineering students

Among *Tech to Teaching* engineering participants, graduate students and undergraduate students do not differ significantly in the number of semesters in which they participate, X^2 (2, N =349) =1.75, $p > .05$ for the engineers, graduate students vs. undergraduate students.

4.2.8 GPA

GPAs were compared between *Tech to Teaching* participants and the full Georgia Tech population, separately for the following four groups: undergraduate engineering students, graduate engineering students, undergraduate non-engineering students, and graduate non-engineering students. Due to a lack of standard deviations on GPA data for the full Georgia Tech population, statistical comparisons between these average GPA values could not be conducted.

Table 2. GPA comparisons for *Tech to Teaching* participants and all Georgia Tech students.

Term	*Tech to Teaching* **avg. GPA**	Georgia Tech **avg. GPA**	**Difference (***Tech to Teaching* **- Georgia Tech)**
Undergraduate Engineering Students			
SP09	3.18	3.02	0.16
SU09	2.84	3.01	-0.17
FA09	3.20	3.02	0.18
SP10	2.98	3.03	-0.05
SU10	2.94	3.02	-0.08
Graduate Engineering Students			
SP09	3.63	3.60	0.03
SU09	3.55	3.62	-0.07
FA09	3.67	3.66	0.01
SP10	3.66	3.60	0.06
SU10	3.67	3.62	0.05

While not investigated statistically (please see note immediately prior to Table 2 about reasons for lack of statistical analysis), GPA data do show trends of slightly higher GPAs among *Tech to Teaching* participants as compared to all Georgia Tech. This provides evidence against the prevailing popular opinion that students resort to teaching when they can’t cut it in their engineering or other, presumably more difficult, majors.

4.2.8 Activity Type

The types of activities in which *Tech to Teaching* engineering participants elected to participate were compared between undergraduate and graduate students. The goal of this analysis was to assess the activity preferences of different sub-groups of *Tech to Teaching* participants and see if these differed.

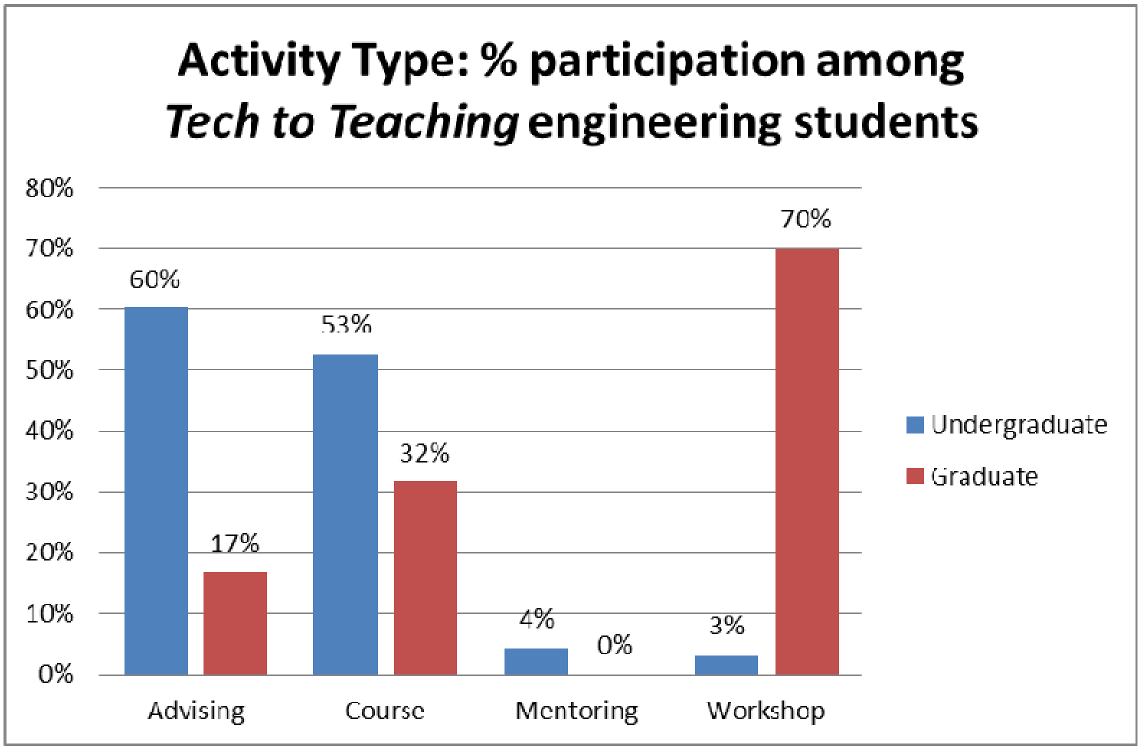

Figure 14. Activity type participation by class standing for *Tech to Teaching* engineering students

Among engineering students, workshops are the most popular activity for graduate students while advising and courses are the most popular activities for undergraduate students. Very few undergraduate students participate in workshops, which make sense because these workshops are primarily intended for, and marketed to, graduate students. Though not shown above, it is interesting to note that non-engineering graduate students are almost twice as likely to participate in advising as engineering graduate students.

5. Conclusions and Implications

5.1 Who is the likely engineering participant in *Tech to Teaching*?

Results show that the typical *Tech to Teaching* engineering participant is female, white (or international if a graduate student), majoring in industrial, civil, or mechanical engineering, and is close to graduation. Also, this student will have a typical GPA for an engineering major (contrary to what many faculty and advisors at the institution might think). Finally, this student most likely will come to a single event in one semester.

5.2 Is there a part of the population at Georgia Tech that just isn't participating, and if so how can we reach them?

Undergraduate engineering students, especially male undergraduate engineering students, have a relatively low likelihood of participating in *Tech to Teaching*. It would be erroneous to imply that this is, in of itself, a problem. The limited number of positions teaching engineering content in high school, coupled with the multiple attractive and lucrative career paths likely to be open to engineering majors, contributes to a reasonable expectation that a relatively low portion of the undergraduate engineering population would pursue a K-12 teaching career. The gender difference is unsurprising in light of the reported statistic that the public K-12 teaching force in the 2007-2008 school year was 76% female[32]. While it is not part of the mission of this program to "recruit" students into teaching-oriented careers, program personnel can ensure that members of this low-participating group are at least made aware of the program and their opportunities to participate in it. If these students are not being reached by the program's advertising efforts, this may in part explain their low rate of participation. However, it could also be the case that there is simply a lower level of interest in K-12 teaching careers among this group, and it is outside the scope of the *Tech to Teaching* program to attempt to manipulate student interest in teaching careers.

As for participation by major, among graduate engineering students, electrical and computer engineering and mechanical engineering are somewhat under-represented. This is consistent with Spencer et al's findings[33] for undergraduate students in electrical and computer engineering.

5.3 What will happen as we follow these students longitudinally for a longer period? Who comes back to participate, who continues, etc.

Another notable finding of this study is that the majority of program participants are only participating in one activity, and accordingly are only participating during one semester. A sizeable portion of graduate programming is oriented towards finding a job, so it is possible that students are waiting until they near graduation to participate. However, much of the potential benefit of the program exists in the option for students to earn a teaching certificate, and the option for a teaching minor is currently in development. These options require participation over multiple semesters, so if graduate students wait until they are ready to leave Georgia Tech before they start participating, such options will be unavailable to them. Also, results of a research study on the career plans of STEM undergraduate majors suggested that juniors reported requiring a higher salary to seriously consider teaching than did sophomores, and all students ranked "need to give up current career plan" and "ability to continue work in discipline" as important factors in considering whether or not to pursue K-12 teaching, even under a scenario where it paid comparably to the job they were planning to get (Milanowski, 2002). This research suggests the possibility that, among STEM majors, the closer they are to graduating, the less consideration they would give to a K-12 teaching career. STEM students should be made aware of the program, and more broadly the notion that K-12 teaching is an option for them, early on in their undergraduate careers so they will have the time to pursue this option if they so desire, and not be motivated against doing so by a substantial investment in an alternate career path. We must also entertain the possibility that students are only participating in one activity because they do not find this activity worthwhile and are reluctant to engage further with the program. None of the evaluations that are currently being done (i.e., participant evaluations for all workshops and courses) suggest that this is the case, but evaluations should be conducted for all program activities to ensure that most students are satisfied with all activities and programs. Program personnel are currently working on developing an evaluation procedure for advising appointments.

The longitudinal nature of these data will also allow us to eventually investigate potential changes in the frequency of Georgia Tech students reporting entry into the K-12 and college teaching workforce. As we expand the scope of data collected for this project beyond the five semesters reported on in this paper, it will become useful to assess specific, concrete long-term outcomes, such as the number of GT students who join Teach for America or other programs and pursue K-12 and higher education teaching-oriented careers.

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