

AC 2010-1230: RECRUITING ENGINEERING STUDENTS INTO K-12 TEACHING

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Recruiting Engineering Students into K-12 Teaching

Abstract

The Georgia Institute of Technology, a Research-Extensive institution located in the center of Atlanta, has a historic mission to create new knowledge and to train students in technological fields. Regulations put forth by the Board of Regents of the University System of Georgia, specifically prohibit Georgia Tech from having a College of Education, so there is no unit on campus with the mission of teaching students about pedagogy, or preparing them for a career in education. Further, there has been a historic institutional paradigm that equates success with placement of Georgia Tech graduates in technical or research positions. However Georgia is in dire need of more well-trained STEM teachers to better prepare students to matriculate into college science and engineering programs, or to enroll in the state's technical and community colleges. There is a strategic imperative for Georgia Tech to promote teaching as a valued career goal and to support those STEM majors who wish to pursue a career in teaching in the K-12 arena. As part of a new, campus-wide initiative, supported by the NSF, Georgia Tech has implemented a series of activities to promote careers in K-12 teaching, and has set up the infrastructure to track and evaluate these initiatives. This paper will describe the initiatives implemented so far, the types of road blocks encountered, and the numbers of students entering teaching from various engineering fields. Our goal is to change the perceptions among students, faculty and administrators at Georgia Tech; to promote K-12 teaching as a career option for all students, including entering freshmen; and ultimately to help produce 30-50 high school science and math teachers per year. This would make Georgia Tech one of the largest producers of high school STEM teachers in the state.

Introduction

“I’m sold! Now that I’ve done my second engineering internship I know I want to be a high school science teacher.” Lydia, a junior majoring in Civil Engineering, had been secretly considering teaching for some time, but had felt torn since she was at Georgia Tech—an “engineering school”—and had worked hard to earn her 3.8 GPA. Everyone—her professors, parents, and peers—expected her to be an engineer. She had done well in her engineering internships and knew she could land a good engineering job, but she confided concern that an engineering job might not be the best fit for her interests and career goals. Teaching was something she had always considered when she was younger since she enjoyed studying math and science, and had positive role models in her own high school teachers. She liked working with teenagers and imagined herself coaching a high school softball team. Previous generations of Georgia Tech students would have found themselves with no institutional infrastructure to support and encourage these new career goals. Thanks to a new initiative, Tech to Teaching, students like Lydia have somewhere to turn.

Since 2004, Georgia Tech has been steadily developing a program to advise, mentor, encourage and provide academic programming for students interested in K-12 teaching. Because the Institute is bound by University System of Georgia Board of Regents regulations that specifically prohibit Georgia Tech from developing state-approved K-12 teacher certification programs,

these pre-teaching initiatives necessarily serve to funnel talented STEM graduates into existing post-baccalaureate certification programs, either at other universities with colleges of education, or to alternative certification programs administered through school systems or regional educational service agencies. This pathway has always been open to Georgia Tech students, and anecdotally it is very clear that many Georgia Tech students have found their own way into teaching over the years. However because this career goal was not previously recognized by Georgia Tech as one worthy of tracking, there is no data available about how many Georgia Tech alumni have historically entered the teaching workforce.

Beginning in 2009, the National Science Foundation awarded Georgia Tech an Innovation through Institutional Integration (I³) grant, entitled Tech to Teaching, to specifically foster career paths in K-12 STEM education and to promote teaching skills for graduate students entering the professoriate. This program includes various initiatives to draw more science and engineering students into K-12 STEM education, including partnerships with other institutions, educational courses, advising, educational and outreach events, scholarships, and networking. The goal is not to discourage students from working as engineers or scientists, but to promote teaching as a valued career goal and to provide support for STEM majors who are interested in pursuing teaching. Tech to Teaching also includes a robust evaluation plan that will allow a more thorough analysis in the future of which initiatives are effective at promoting teaching careers, and that will enable tracking of these students. This current study provides an analysis of the baseline data, and details the initiatives that make up the Tech to Teaching program.

Tech to Teaching Strands

The Tech to Teaching program focuses on five different infrastructural elements to support prospective teachers: advising, academic courses, mentoring, immersion experiences, and transition or induction support. The program also seeks to change the prevalent sentiment voiced by peers, parents and professors that K-12 teaching is not a career that talented Georgia Tech students should pursue, and that a high powered Tech education is somehow wasted if an alumnus moves into a high school classroom.

Strand 1: Advising

In the fall of 2007 Georgia Tech created a new position—the Pre-Teaching Advisor—to assist students in navigating the often confusing maze of different teacher certification routes, advise on academic course choices, provide general support, and to help connect students with likely employers. Any student can self-schedule a 1-hour appointment, which typically first includes a discussion of the student's interests in teaching and a determination of which teaching field(s) best fit the student's academic background. Most engineering majors enter the appointment wanting to teach math, but have often never considered that they could also teach one of the sciences, computer science, or technology. Students also receive information on various volunteer and paid tutoring and mentoring positions, scholarship programs, and summer research opportunities. Sessions also often include conversations related to the student's reservations about teaching and the advisor might recommend readings or experiences that can provide the student with information on topics ranging from current issues in education to classroom management to philosophies of teaching. The purpose of the advising session is to not only educate students about teaching careers and how to prepare for them, but also to ensure the student knows that she/he has a supportive staff member to provide assistance at all stages of the

process. Students return for help with choosing certification programs and for applying to graduate school or for jobs. Some students make multiple appointments just because they need someone to be a supportive sounding board while they talk about their career interests. Graduate students who make appointments will often do so without the knowledge of their graduate faculty advisors, as their general feeling is that the faculty advisors will not approve.

Since the fall of 2007, a total of 304 individual students participated in pre-teaching advising appointments (Table 1). Of these, 33% (n=100) were engineering majors and 63% (n=190) were women. Campus-wide, 58% of students are engineering majors, and 30% are women.

Table 1. Pre-teaching Advising by College Fall 2007-Fall 2009

College	Students Enrolled			Students Advised	
	# of students enrolled	% of total student body	% female	# advised	% of total advisees
Engineering	7507	58%	23%	100	33%
Sciences	1153	9%	54%	88	29%
Computing	894	7%	12%	10	3%
Other	3419	26%	43%	106	35%

Clearly the teaching option appeals disproportionately to women students, and attracts a higher percentage of students from the College of Sciences and other majors (e.g. the liberal arts and management) than from the College of Engineering. Within engineering, the departments most highly represented are Industrial and Systems Engineering (ISyE) (n=23) and Mechanical Engineering (n=21). However if the size of the department is taken into account, the engineering departments most represented are those that are chemistry-based (Chemical & Biomolecular Engineering (ChBE), Material Science and Engineering (MSE), and Polymer, Textile and Fiber Engineering (PTFE)), and the math-heavy ISyE. ChBE and ISyE are also majors with a fairly large representation of women (Table 2).

Table 2. Pre-teaching Advising by Engineering Major

Major	# of advisees,	Enrollment	Advising Frequency*	% female in major
Aerospace	7	720	0.97%	14.4%
Biomedical	7	923	0.76%	38.8%
Chemical & Biomolecular	13	567	2.29%	37.0%
Civil & Environmental	12	782	1.53%	26.5%
Electrical and Computer	7	1140	0.61%	8.7%
Industrial & Systems	23	1092	2.11%	32.8%
Materials Science	3	117	2.56%	23.1%
Mechanical	21	1443	1.46%	11.2%
Nuclear and Radiological	2	152	1.32%	16.4%
Polymer, Textile and Fiber	5	139	3.60%	42.4%

* Calculated as the percent of enrolled students who are participating in advising.

The departments least represented are Electrical and Computer Engineering (ECE), and Biomedical Engineering (BME). The reasons for this are not yet well established, but in the case of BME (and Biology), the low representation may be because a large percentage of the majors are pre-medical students. ECE is more complicated, and will be looked at more closely over time. There is very little participation by this department in the network of academic advisors, so information about teaching career opportunities is more difficult to disseminate. In addition, the number of female students in ECE is very low and given the lower rate of participation by men in general, that is likely part of the explanation.

The relatively low participation rate by the engineering students, compared to other majors on campus, does not mean that actively promoting K-12 teaching within the college is a wasted endeavor. If even 30 engineering students per year choose to pursue high school science or math teaching, this would have a positive impact on K-12 education in Georgia, particularly since engineers are one of Georgia Tech's best sources of likely physics teachers. In addition, engineering departments such as Mechanical Engineering, which historically have struggled to attract and keep female majors, might be able to recruit and retain more women if those students know that high school teaching is a very viable (and supported) option for them at some point in their career.

Information Sessions

Another advising-related initiative is to bring local school district human resource staff and Masters of Arts in Teaching (MAT) faculty to campus. The Pre-Teaching office hosts regular Information Sessions that are open to the broader college community (including alumni). Local school districts jump at the chance to recruit Georgia Tech students into teaching—especially those who want to teach math and science (particularly physics). In the spring of 2008 Georgia Tech hosted a “From Tech to Teaching Open House” which functioned much like a job fair. Approximately 100 students attended the Open House and several students made contacts which led to job offers.

Certification Routes and Joint Programs

Because Georgia Tech students must complete teacher certification elsewhere, we have actively developed partnerships with nearby universities that offer MAT programs. Two of these partnerships have been the basis for three successful NSF Robert Noyce Teacher Scholarship Program grant proposals that provide scholarships to students from either Georgia Tech or the partner school who are interested in becoming high school math or science teachers. Each partnership is negotiated separately, and is dependent upon the partner's particular programs and opportunities. For example, in order to recruit more Georgia Tech students into its MAT program, one partner institution will accept Georgia Tech's undergraduate education courses for graduate credit if the student passes a content exam from the partner school. Another partner university has begun working with Georgia Tech to develop a new BS/MAT option in which students will be able to earn their bachelors degree at Georgia Tech and then seamlessly transition into the MAT program at the partner school, applying up to 6 hours of course credits to both degrees. This option is modeled on the popular BS/MS programs that exist for most of Georgia Tech's engineering and science majors. Students must have a high GPA (3.5) at the time of application, and must maintain a minimum of a 3.0 to remain in the option. The BS/MS

option is therefore considered to be prestigious, and the hope is that by offering the BS/MAT option, K-12 teaching's profile will also be raised on campus.

Georgia Tech students have several attractive non-MAT certification options open to them, primarily through the Georgia Teacher Academy for Preparation and Pedagogy (GA TAPP) alternative certification program¹. This program, administered by individual school systems and the regional educational service agencies (RESAs), allows participants to take pedagogy courses required for certification while working full time as a classroom teacher. Whether this is a successful route for the average Georgia Tech student remains to be determined.²

Robert Noyce Teacher Scholarship Programs

There is an ongoing policy debate about whether offering scholarship money to undergraduate students is an effective means of recruiting them into teaching^{3,4}. Georgia Tech is currently a partner on three NSF Robert F. Noyce scholarship programs with two partner institutions—Kennesaw State University (KSU), and Georgia State University (GSU). The KSU/GT programs are in Chemistry/Physics and in mathematics, and the GSU/GT one is in broad-field science, and both require that the student enroll in the partner school's MAT program. These Noyce Scholarship programs provide students with scholarships of \$10,000 per year for up to two years, and students are required to make a commitment to teach in a high needs school system for two years for every year of scholarship they received. While these scholarships will not allay concerns that students might have about pursuing a teaching career, they do help pay for the educational expenses incurred while enrolled in an MAT program. Our hypothesis is that this will increase the likelihood that students will enroll in a MAT program instead of attempting to enter teaching through the GA TAPP program.⁵ The KSU/GT Chemistry and Physics program is now in its third year and has been a successful recruiting tool for the KSU's MAT program: In the first two years 11 Georgia Tech students were awarded and accepted Noyce scholarships (8 in Physics; 3 in Chemistry). The prospective physics teachers have come from a variety of majors: Physics (3), Civil Engineering (2), Mechanical Engineering (2), and Electrical Engineering (1). The other two programs are new, and the first applicants will be recruited in the spring of 2010. Several students have turned the scholarship down because they were not willing to make the required teaching commitment. This trend will be tracked over time.

Strand 2: Academic Courses

In the fall of 2004, Georgia Tech introduced its first-ever undergraduate education-type courses: Principals of Learning and Teaching, I and II. These introductory courses, which are standard fare in other types of universities but were new to Georgia Tech, serve to familiarize students with basic educational psychology and pedagogical theories, and to provide them with some first-hand practical experience in the field of K-12 education. In the spring of 2010, over 50 students were enrolled in the undergraduate education courses.

Strand 3: Mentoring Experiences

Career counselors regularly recommend that college students interview professionals in their prospective fields in order to learn about a career. Therefore one initiative implemented as part of Tech to Teaching is a Summer Undergraduate Research Experience (Teaching-SURE) program that places Pre-Teaching students and experienced high school STEM teachers together into research labs to engage in summer research projects. The goal of this pairing is to allow the

undergraduate students to work with, and be mentored by, seasoned professional teachers, and to give them the opportunity to work with the teachers to develop classroom activities based on the research experience. Students are encouraged to maintain their relationships with the teachers and, when appropriate, to participate in the teachers' classroom activities throughout the academic year. For Summer, '09 there were 30 student applications for 9 positions. Of the 8 students who replied to the exit survey,

- 8/8 survey respondents agreed or strongly agreed with "After the Teaching SURE experience I believe I will be a better teacher."
- 7/8 survey respondents agreed or strongly agreed with "I feel that the Teaching SURE program improved my likelihood of success as I move along the pathway towards a teaching career in science or math."
- The students felt they had acquired skills related to teaching as a result of their participation in this program. These skills included patience, knowledge of strategies for helping high school students learn, and knowledge of logistical aspects of teaching such as becoming certified and making lesson plans.

Strand 4: Immersion Experiences

The Pre-Teaching program encourages all students considering teaching to get exposure to the field so that their expectations for teaching will be realistic and they will remain in the field for the long run. Georgia Tech has many structured ways students can participate in K-12 education, including paid tutoring and mentoring opportunities through the university's K-12 educational outreach center; the required classroom observations and practicum experiences in the Pre-Teaching courses; and partnerships with nearby schools and school districts. In all of these immersion experiences students can attend teachers' pre-planning sessions, where they are familiarized with planning, curriculum design, and assessment, and they can also formally observe teachers and plan to teach some of their own lessons under the teacher's supervision.

Strand 5: Transition or Induction Support

Tech to Teaching, in collaboration with the Robert Noyce Scholarship programs, will implement teacher institutes where alumni who have become in-service teachers are provided with support and a professional learning community.⁶ The first institute is planned for the summer of 2010.

Raising Awareness Across Campus

A final, broad, and ongoing initiative is to raise general awareness, both on campus and in the community, of K-12 teaching as a career option for Georgia Tech students. High school seniors planning on entering teaching careers have historically not enrolled at Georgia Tech as freshmen. For the past two years, only one incoming freshman has indicated that he or she should be coded "Pre-Teaching", whereas approximately 300 per year have asked to be coded "Pre-Health" and over 100 have chosen to be "Pre-Law."

In contrast, exit surveys from the past three years indicate that by graduation, surprisingly large numbers of students plan to enter teacher certification programs. Research indicates that it is not unusual for prospective teachers to begin considering teaching during their college years and that many academically talented students delay deciding to teach.⁷ The 2008-2009 student exit survey of engineering students had a response rate of approximately 48%. In that group, 45 of

the 1,245 students who responded were planning to pursue teaching as a career. That is an overall rate of 4%. As with the advisees, it was skewed towards the women, with 7% of the female graduating engineering majors self-reporting that they planned to pursue teaching. The most highly represented of majors were mechanical engineering (n=11) and industrial engineering (n=9).

To increase awareness of teaching as a legitimate career goal, initiatives now target both currently enrolled students as well as prospective freshmen attending on-campus recruiting events. The Pre-Teaching web site and the Teacher-Prep listserv, which has approximately 430 subscribers, are used to disseminate information and advertise programs and opportunities. In addition, because most Georgia Tech students usually do not begin to seriously think about K-12 teaching until they have already chosen a major and even completed the bulk of their undergraduate program, efforts are being made to increase departmental academic advisors' awareness of this career option. Anecdotal evidence supports the importance of these advisors, as virtually all applicants to the 2010 Teaching SURE program come from departments with academic advisors who are active in the network of advisors, and who have received information about the program through Tech to Teaching.

Tech to Teaching Evaluation

As part of Tech to Teaching, the Pre-Teaching advising and programming activities at Georgia Tech are part of a formal evaluation to monitor changes in student interest in teaching careers, the effectiveness of the various program initiatives, and changes in awareness and acceptance of K-12 teaching as a career by the Georgia Tech faculty and administrators. The evaluation will also track students longitudinally, where possible, to establish the bottom-line numbers of how many beginning teachers Georgia Tech produces and whether they successfully transition to teaching careers. Georgia Tech has never before made any formal efforts to collect data on student interest in K-12 teaching careers, nor monitored alumni career paths in teaching. This data will provide evidence for other universities about the effectiveness of recruiting engineering students into K-12 teaching as one strategy for addressing our serious shortage of high school STEM teachers.

Roadblocks and Challenges

Faculty and Parent Attitudes

Faculty members' attitudes toward K-12 teaching can be a roadblock for students who are considering teaching. This is especially true for academically talented students, as faculty members will typically encourage them to pursue MS or Ph.D. programs in STEM fields as opposed to graduate-level education programs. Pre-Teaching students often report being told by faculty that they are "too smart" to teach at the K-12 level. Graduate students who begin to lean towards K-12 teaching careers may risk losing funding from research advisors who do not support their decision. Other graduate advisors may ask why a student would choose to "waste" their graduate-level education by going into K-12 teaching. Many undergraduates report receiving the same message: that their Georgia Tech education would be "wasted" on a K-12 teaching career.

Members of the Georgia Tech community are not the only or necessarily the most important source of negative attitudes towards K-12 teaching careers. Many parents do not encourage their children to consider K-12 teaching. At recruitment sessions that include parents, it is not uncommon for parents to stop by the Pre-Teaching table to explain that while they think their child would make a good teacher, and might enjoy teaching, teacher salaries are too low. Other parents see teaching as a possible back-up plan should engineering or other careers not work out. Students often mention that their own parents—often their mothers—are K-12 teachers who tell them to “do anything but teach!” Many students either worry or know that their parents will not be happy if they go into teaching, and many feel the need to have their parents’ approval. Some students mention that their parents cannot understand why anyone with an engineering degree would go into teaching. Like some faculty members, many parents feel that a Georgia Tech education would be “wasted” in the K-12 classroom. As one student put it, parents ask “why bother to go to Georgia Tech if you’re only going to be a teacher?”

Student Attitudes

Many students considering teaching are highly conflicted. They often initiate their first Pre-Teaching advising session by explaining that they have always considered teaching but pushed it aside because they felt they should go into a career that offers higher salaries or is more prestigious. Because these students performed well academically in high school, especially in math and science, they generally chose to go to Georgia Tech and become engineers since engineering uses math and science, is prestigious, and pays well. Teacher salaries are a major concern. Certified teachers who have master’s degrees can begin teaching in the metro-Atlanta area at salaries close to \$50,000 per year, but most engineering students feel this amount is too low. Students also worry about whether they will find teaching intellectually challenging or if it will be “too boring.” Some students think they would enjoy the actual process of teaching, but wonder if they will be turned off by dealing with their future schools’ administrators, parents, classroom discipline problems, red tape and pressures to teach only to achieve standardized test scores. Some students are turned off by the low standards for entering the profession. As high achievers, these students are not sure they want to enter graduate programs that will accept combined verbal and quantitative GRE scores of only 800, for example.

Most of the students working with the Pre-Teaching advisor have maintained GPAs of 3.0 or higher. Many have participated in co-op and internship programs. Many of them have done undergraduate research. Few of these students choose K-12 teaching because they have no other options. It is good that such talented and well-rounded students choose teaching, but knowing that they have the options of going into engineering jobs or graduate programs can make it hard for these students to commit to a teaching career. It is not unusual for students to schedule their first meeting with the Pre-Teaching advisor during the last few weeks of their graduating semester. When asked why they waited so long, students explain that they needed to weigh all their options or were still talking to their parents about what to do with their lives. This timing results in students missing application deadlines for funding opportunities, MAT programs, and test dates for the state’s teacher certification exams which are generally required prior to being hired. Because these students have always done well academically, they are sometimes surprised and frustrated to learn that some planning is usually necessary to transition into a teaching career.

In contrast to these top students, other students decide to pursue teaching after they come to the realization that getting hired in their field may be difficult given their academic record. Although there are some loopholes, Georgia requires a cumulative undergraduate GPA of 2.5 or higher to enter teacher certification programs, so students who have low GPAs cannot easily enter teaching. When asked why they have not done well in school and why they are considering teaching, most of these students admit that they have not enjoyed their engineering courses but decided to finish their degree “no matter what.” These students might have benefitted from earlier proactive advising that might have led them to choose a different major. Even though they have struggled with their coursework, most of these students stress that they enjoyed math and science in high school and feel certain that they would enjoy teaching these subjects. They often explain that they realized that they were not cut out to be engineers but not until it was too late.

Ironically, even students who want to become K-12 teachers often have attitudes toward teaching that can be real roadblocks in their career path. They tend to think that because they have done well in school and know their academic content, they can begin teaching with no additional education or training. They have not considered issues such as classroom management, curriculum planning, assessment, or pedagogy. Students who would be willing to enroll in and pay for years of law or medical school are sometimes resistant to going to school to become a teacher. However many, of not most, engineering majors have no prior experience in K-12 teaching, and therefore understandably cannot convince principals that they are ready to manage classrooms without additional educational training. Therefore even academically outstanding STEM students can find it hard to get hired without an MAT degree.

Tracking Students

Tracking students as they transition to K-12 teaching is an ongoing challenge. Because it is an informal and self-selective program, students who want to go into teaching are not required to ever interact with the Pre-Teaching office or to be coded “Pre-Teaching” in any of the student information systems. Students considering teaching careers are encouraged to take the pre-teaching courses, but this is a suggestion and not a requirement. Because most engineering majors allow so few electives, engineering students often do not have time to take these courses, which would be “extras” in an already overloaded schedule. MAT and alternative certification programs do not require that undergraduates take particular courses or get specific experience, and students can decide to go into teaching at or after graduation. It is very difficult to identify or track Pre-Teaching students unless they choose to participate in advising or other program services. This is markedly different from Pre-Medicine in which students must take standard required courses, gain specific types of experiences, and apply to medical schools through common applications and nationally centralized services. Pre-Health advisors receive official reports each year informing them of their school’s applicants and their success in the admissions process. This kind of data reporting system does not exist for Pre-Teaching. Through the Tech to Teaching grant, new assessment tools are being developed, but the success of these will be dependent on students choosing to identify themselves as “Pre-Teaching.”

Conclusion

In 2007, when there were few Pre-Teaching advising appointments and few initiatives had begun, Georgia Tech’s goal of ultimately producing 30-50 math and science teachers per year

seemed unrealistically ambitious. The advent of the Tech to Teaching program and the developments over the past two years are encouraging. In the spring of 2010, undergraduate students initiated a Pre-Teaching Society. The new and expanded Noyce scholarship opportunities are providing more financial incentives for students to enroll in MAT programs. The Pre-Teaching SURE program has shown its continued popularity in its second year. Pre-Teaching advising appointments continue to increase. Based on data from the Institute's exit surveys, it is quite possible that Georgia Tech is already reaching its goal. The key will be to continue to work towards centralizing and formalizing the program so that all students with an interest in K-12 teaching careers will become involved in Tech to Teaching programs and courses, and more high school students who are talented in STEM fields will enroll in Georgia Tech with the intention of training the next generation of STEM students.

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