

Engineering Graduates: The New Wave of Teachers

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BACKGROUND: A PROBLEM OF THE “MISSING MASS”

Seen through the glasses of professional policy makers and educational reformers, K-12 math, science and technology education are scenes of fundamental and sweeping change. Broad national standards are establishing both the need for new pedagogies and strategies for implementing them. In all three fields, there is a consensus among experts that education should be relevant to problems in the real world and inquiry- or design-based. According to these documents, both science and math education should emphasize applications to problems of technology, and technology education should be centered around analysis and problem-solving.¹

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In most of the discussions of curriculum reform, however, there is an odd neglect of a critical problem. The vast majority of teachers currently in the system have been narrowly trained in ways often diametrically opposed to the new calls for contextual, interdisciplinary learning. Math teachers have been largely prepared to drill students in algorithms and facts; science teachers are generally the products of a descriptive approach which emphasizes vocabulary and memorization rather than experimentation and concept development. Technology teachers tend to fall into two camps: the former Industrial Arts or “shop” teachers, whose focus is on use of tools to make products; and computer teachers who instruct students primarily in the use of software. Neither group is well-prepared to deal with the new standards.

So the “missing mass” problem in Math, Science and Technology Education can be stated simply: *where will the teachers come from who are knowledgeable about real-world applications of math and science and experienced in problem-solving and design?* A simple solution is emerging: recruit engineering students to become teachers.^{4 5 6} They have strong backgrounds in math and science, awareness of their applications in analyzing and solving technological problems, and typically a penchant for “hands-on” activity. The authors of this paper have been part of a program to motivate engineering students to consider careers in teaching.⁷

How feasible is this idea? Experiences from the City College program and others suggest that under favorable circumstances, many engineering students might be attracted to teaching careers. Unfortunately, all of this data is anecdotal. To our knowledge, no systematic research has been done to explore the potential role of engineering graduates in K-12 education. This paper reports on what we believe to be the first such study.

RESEARCH GOALS AND METHODS

The study was conducted by an engineering faculty member and five engineering students. Its purposes are threefold:

1. to determine the level of interest in teaching careers among engineering students;
2. to explore the reasons why some engineering students would consider teaching as a career; and
3. to identify the barriers which would discourage engineering students from pursuing teaching careers, and possible means of addressing them.

We are interested in knowing the level of interest in teaching careers to assess the feasibility of moving significant numbers of students into education. An understanding of the incentives and impediments students perceive will make it easier to design programs which could motivate engineering students to consider teaching as a career. Thus, the results of this study should have direct bearing on programs intended to tap into this large pool of potential teachers.

The research design has three major components:

1. a broad-scale written survey of several hundred engineering students, most of whom attend the City College of New York;
2. in-depth structured interviews with nine engineering students who have expressed a strong interest in pursuing teaching careers after graduation, and in some cases, also after a few years in industry or graduate school; and
3. similar interviews with nine recent engineering graduates who are currently working as K-12 teachers.

The survey was administered to 288 engineering students, including 276 from City College and twelve from other schools. The City College respondents were asked to complete the questionnaire forms by students at the end of regular engineering classes. The questionnaires contained two questions about the student's plans after graduation, with "Teach" as one of the options. Those who did not select this option were asked to answer five additional questions about circumstances which might make them more likely to consider teaching. Following these were some basic demographic questions. The questionnaire concluded with this request: "Please share with us any comments you'd like to about teaching. If we can quote you, please print your name."

The survey respondents were broadly representative of the student population in the City College Engineering School: approximately 29% are Black, and an equal number are Hispanic. Another 19% are Asian or Pacific Islander; 13% are White and the remaining 10% describe themselves as "Other". Of the cohort, 23% are female, a somewhat larger percentage than in the Engineering School as a whole.

The interviews were conducted by two engineering students. The eighteen interviewees, including nine engineering students who have decided to become teachers, and nine teachers who have recently graduated from engineering school, were identified through personal contacts. The interview protocols for the two groups were similar. Each consisted of about ten questions designed to elicit the reasons for the respondents' career choices. In particular, we wanted to know both their *positive* reasons for wanting to become teachers as well as their *negative*

reasons for not wanting to be engineers. The following interview questions illustrate this attempt to get at both positive and negative attitudes towards both fields:

2. Which factors made you consider teaching as a career rather than engineering?
4. To what extent do you think this society values education?
5. What aspects of engineering made you decide not to become an engineer?
7. What are the disadvantages of becoming a teacher?

In designing the interview protocols, we also included “probes” intended to elicit answers in case the interviewee didn’t understand the question or didn’t know how to answer, but these probes were hardly ever used in the actual interviews.

RESULTS

The questionnaire survey produced the following quantitative outcomes:

1) What are your plans after graduation?

Work in Engineering	Graduate School	Teach	Other	Total # of Respondents
174 (60 %)	102 (35 %)	37 (13 %)	25 (9 %)	288

2) (If answer to #1 was “Teach”): At what level do you plan to teach?

Elementary	Middle School	High School	College	Total number responding to this question
4 (1 %)	4 (1 %)	30 (10 %)	34 (12 %)	72 (25 %)

3) through 7) (If answer to #1 was other than “Teach”)

	YES	NO	TOTAL
3) If teaching jobs were readily available would you teach?	154 (53 %)	108 (38 %)	262 (91 %)
4) If you received financial support for becoming a teacher would you consider teaching?	186 (65 %)	80 (28 %)	266 (92 %)
5) If you had difficulty getting a job in engineering would you consider teaching?	201 (70 %)	56 (19 %)	257 (89 %)

6) After a couple of years in engineering would you consider becoming a teacher? 164 (57 %) 39 (14 %) 203 (70 %)

7) If becoming a teacher required additional education coursework, would you take it? 145 (50 %) 102 (35 %) 247 (86 %)

Notes to survey results:

1. All percentages are expressed as a fraction of the total number of respondents (288).
2. In question #1, some respondents selected more than one option
3. In spite of the instructions, some who expressed the intention to teach also answered questions 3 - 7.

Of the 288 students surveyed, about 40 offered written comments in the space provided. About half of these were signed. Many of these comments provided little if any explanation about the student's career choices. Examples include the following:

1. I wouldn't mind teaching the engineering disciplines at a high school level.
2. Teaching is a good way to go over what you've learned.
3. I'll consider teaching after having some experience in engineering.

Others offered more insight, and many of these were similar in content to the responses to the interviews. These will be discussed in the following paragraphs.

Both the interviews and many of the written comments on the questionnaires suggested a variety of positive and negative attitudes towards careers in engineering and education. For many of the engineering students who are leaning towards teaching careers, a major factor is the desire to help others. In some cases these feelings focus on a racial or ethnic group, or even on the respondent's own children, while in other cases it is less specific. Some typical responses in this category - ordered from the least to the most specific - are the following:

1. The future of our nation depends on education.
2. I think one of the best things in the world is helping others and by choosing teaching as a profession I will contribute to this so ignored topic of helping society improve day by day.
3. I would like to offer some service to my Black community and to unfortunate kids.
4. I feel as a parent, that the only way to help alleviate the problem of (1) not enough teachers and (2) not enough caring teachers, is to personally contribute to the number of available good teachers.

A second set of responses, not always easily distinguishable from the first, focused on personal satisfaction as a motivation for teaching. Often these comments reflected students' feelings of gratification from prior experiences in teaching or tutoring. One student, for example, explained that he is working as a doorman in a luxury building to put himself through college. Many of the high school students in the building ask him to help them with computer problems. As a result of these informal tutoring experiences, he has come to realize that he really loves teaching and has decided to become a teacher. Some other answers in this category were as follows:

1. I love to teach. I love the idea of passing on my experience, both practical and theoretical.
2. Teaching would be great not only to help others but also to keep your own knowledge fresh in your head.
3. I have always liked helping others by teaching (math especially).

An unexpected set of responses came from a third group, who expressed dissatisfaction with their own educational experiences, and the feeling that they could do better than the teachers they had had. This sentiment was most often expressed by the practicing teachers who were engineering graduates. One teacher commented that he felt "frustrated that constantly [in his own education] an equation is put up on the board and you are expected to get some physical sense out of it." He added, "you can't, unless you are able to really play around with it." At some point, he decided that he would like to teach physics and be able to say to his students "this is what this stuff is really used for."

Another teacher, who has just completed her Ph.D. in Education after obtaining a degree in Electrical Engineering, explained that as an engineering student she often hesitated to ask questions in class. She felt she was always running the risk of "visibly annoying" the professor when she interrupted to ask for clarification. She feels that a classroom at any level should be more open and available to students. With her own students, it is understood that asking questions is an integral part of the lesson.

These views were echoed by some students who are still in engineering school. Some typical comments were:

1. I feel that I could explain the material better than some of my professors. Give back to the community.
2. I would like to teach since unfortunately there are many teachers or professors who make stuff difficult for students and/or do not know how to teach. I hope to make a difference.
3. Some professors teach quite well while others don't. I think that the more someone cares about teaching, the more effective that teacher will be. I would care about making the student learn.

What obstacles do engineering students or graduates see turning them away from careers in education? There were a variety of answers to this question. Comments on the questionnaire alluded to the low pay, lack of "prestige and respect" and physical danger experienced by

teachers. Some saw their own inadequacies as a barrier: “I would want to know if I had good teaching skills before I would consider teaching.” Another was even more sweeping: “To be a teacher, you have to have your life in order before taking on the responsibility of teaching others.” These and similar comments indicate that some students believe that teachers have to meet a very high standard, and are not certain whether they can qualify.

Some of the interviewees who are currently teaching have also had to deal with negative feelings about teaching. One teacher confessed that he had not told his parents about his plans, fearing the negative reaction he felt he would receive. “It was difficult to get a lot of support for [teaching] when I was in college.” Another reported that in the view of their peers, to teach after receiving an engineering degree is “a waste”.

One teacher commented, “I know that teaching is seen as a ‘lower profession’, but I feel like the only response to those comments is: “Do you have kids? Well, who do you want teaching them, me, or someone who may not understand the material as well?” As one math teacher told me, “If you are going to make this choice, you have to have enough self-confidence to say, ‘Yes, I am making this choice.’ It may not be a popular one, but I have to go forth and do what I want to do.”

While some may express some reservations about education as a field, they may also have negative feelings about engineering, which can influence them to consider teaching. These kinds of sentiments were expressed most clearly by a science teacher who had worked briefly as an engineer. “In a lot of companies, you are so separated, working on one small piece of something. Ultimately, you are so disconnected from the whole that you couldn't even describe to others what you are doing.” In this situation, it was hard to feel that “you, personally, are important”. By way of contrast, “... in teaching you can't just know the material, the actual person is important and you are required to put in some of your own style.” After 2 years in industry he decided to come back to his own high school in Harlem to teach Math and Physics.

Negative views about engineering were rarely cited by engineering students as reasons to become teachers. One student, however, did make the following comment: “A lot of engineering students are so competitive and to themselves that they don't really do a lot of team work. I think in education you have to be willing to put yourself with other people, especially students.”

IMPLICATIONS

We were surprised and pleased by the relatively large number of students who say they have decided to become teachers. Approximately 13% of engineering students surveyed intend to teach upon graduation. Very few of this group have been involved in any program designed to motivate them towards teaching. A majority (53 %) say they would teach if jobs were readily available and accessible. An even larger group, 65 %, would make the same decision if financial support were available. Teaching would be an option for 70% if students found difficulty obtaining an engineering job. These results suggest that teaching might be a far more attractive option to engineering students than is usually imagined. However, it is important to recognize that City College is not typical of engineering schools, in its student demographics, nor its location in New York City. It would be important to do similar studies elsewhere.

The adage, “Teachers teach the way they have been taught” may have to be turned around. A useful conclusion from this study is that students are strongly influenced by the way they have been taught, but sometimes in the opposite direction. Clearly, some students are motivated to become teachers precisely because they *don't* want future students to suffer in the way that they have. This insight can be very useful in designing programs to motivate engineering students to become teachers. It is important to use the students' own experiences in education as both positive and negative examples from which to analyze and understand pedagogy.

Students' prior experiences in education are also important in another way. Many engineering students *have already* been engaged in teaching, and see these experiences as far more gratifying than their engineering studies. Therefore, programs to engage them in teaching careers should refer to their own prior experiences in teaching, tutoring, helping younger siblings, being team leader in a class, etc. These experiences can serve as valuable reference points both for seeing the satisfaction that can be derived from teaching, and for evaluating pedagogical practices.

Finally, and perhaps most important, this study offers a valuable lesson in not jumping to conclusions about how students think about themselves and their futures. We were delighted by the breadth and depth of opinion that was expressed in this study. Their responses confirm our belief that many engineering students have the maturity and sense of responsibility to make positive contributions as teachers.

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