



## Discovering How to Get Engineering on the Radar of Community College Students

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# Discovering How to Get Engineering and Computer Science on the Radar of Community College Students

## Abstract

It is well-known that community colleges (CCs) are a largely unexploited resource for more engineers and computer scientists in the United States. It is also well-known that many of these students do not have engineering as a career on their radar because they know little or nothing about engineering.

In Fall 2014 on a visit to a nonmetropolitan CC, two engineering professors visited nine classrooms and talked with over 165 students. At the beginning of the presentation the students were surveyed for their opinions on engineering including their interest, their knowledge of engineering, and their myths about engineering. This paper shows the results of the survey and, in particular, examines the results by whether or not a student is interested in engineering or computer science as a career. An emphasis in our work has been to encourage females and underrepresented minority students to consider engineering. The CC we visited has a high Hispanic population. By analyzing these results, we will be better able to focus future presentations to these populations of students.

## I. Introduction

It is well-known that the US needs more engineers and computer scientists. It is also well-known that community colleges (CCs) are a largely unexploited resource for more engineers (this term shall include computer science in this paper). In addition, many female and underrepresented minority students attend CCs. Many of them are first-generation and low-income students without strong self confidence that they can succeed at a university, let alone succeed in engineering. It is also well-known, and we have shown in our studies, that many of these students do not have engineering on their radar because they know little or nothing about engineering. Further, our research has shown that although students know little about engineering, many have concluded that it is not interesting and has nothing to do with their lives.

Research<sup>1</sup> has shown that the conversation with potential engineering and CS students must change if we are to get their attention. The purpose of our study and survey is to better understand the myths and lack of understanding about engineering by CC students in order to better communicate with them and to interest them in engineering.

As part of an NSF STEP grant (#0856834), visits were made to rural CCs to try to get engineering on the radar screen for CC students to consider as a possible career. We have learned that a captive audience is the best way to do this, so we visit CC mathematics, science, and engineering classes to inform or encourage students to study engineering. At the same time we give them advice on transferring to a university, no matter what their major.

On a trip in Fall 2014 to a rural CC, nine classrooms were visited and conversations were held with over 165 students. The class appointments had been set up by a liaison at the CC with the

permission of the individual instructors. At the beginning of a presentation by two engineering professors, a short survey was conducted. In addition to basic demographic data, the students were asked for their opinions on engineering including their interest, their knowledge of engineering, and their possible myths about engineering.

The survey was developed using grounded theory. The results of the survey were analyzed by whether or not the student is interested in engineering or computer science as a career.

## II. Literature Review

According to Ogilvie<sup>2</sup>, who did a recent review of literature on transfer students' pathways to engineering degrees, too little research has been done on transfer students. Most of this research has been done by those in the CC and little has been done from the engineering point of view. The transfer student research that has been done covers a variety of areas.

The transfer research<sup>3,4,5,6</sup> has included summer bridge programs for transfer students, as well as summer research internships<sup>7</sup> and new student orientation<sup>8</sup>. Other topics address by research on transfer students include mentoring/tutoring, faculty-student connections, study groups, dealing with failure, and transfer shock. These topics are primarily about making sure that transfer students succeed in the four-year college or university setting. Another category of transfer student research is on the topic of what CCs need to do to help their students to succeed and to be able to transfer well.<sup>9,10,11</sup> Other related topics on CC students include programs of university to CC outreach programs.<sup>12</sup> This last paper described a two week summer program to interest high school and CC students in engineering, science, or math. A major factor was to get students who were interested enough to apply. The authors found that it took personal outreach and encouragement.

Related to the topic of this paper is a work in progress paper of how to communicate unique messages about engineering to first generation students.<sup>13</sup> This paper uses Social Cognitive Career Theory developed by Lent, Brown, and Hackett.<sup>14</sup> According to this theory the factors that directly influence or moderate the career choice process are environmental variables as financial resources and access to role models and social supports; cognitive person variables such as outcome expectations, self-efficacy, and goals; and other person factors such as gender and ethnicity. These are factors with which we take advantage. For example, we noted that the rural areas of the nonmetropolitan CCs were deeply affected by the recent recession. Due to this factor students were interested in hearing about the high employment rate of engineers and their excellent salaries, about available scholarships, and the role models and social support that would be provided through a special transfer center at the university, and a focus on females and underrepresented minority students so they would also be supported in these areas.

Many other research papers are centered on university/CC programs and partnerships, S-STEM Scholarship Programs for transfer students, and smoothing the transfer process. Other research focuses on the characteristics of transfer students, modelling of their characteristics, and comparisons of transfer and native students. While all of this research is about transfer students, it still does not help shape the message for engineering to reach those students in the CC who do not ordinarily or naturally choose engineering, but might if they knew more about it. One paper

that does shed some light on our problem is a paper about whether engineering attracts or repels female students who passionately want to help people.<sup>15</sup>

We have written several papers on attracting more CC students to engineering.<sup>16-21</sup> One of our early lessons was that of the impact of role models or face-to-face contact. We were the first engineering professors to ever come to five non-metropolitan CCs and talk to the students about engineering. Some students were confronted with engineering as a career choice for the first time. Others who had their myths and reasons for having dismissed engineering as a career choice, were challenged for the first time. Others had faintly thought of engineering, but not acted on this thought due to lack of encouragement. During the past several years we have been trying to better understand what would get a CC student to think seriously about engineering.

In Fall 11, we administered a short questionnaire to over 116 students during one day at a non-metropolitan CC.<sup>18</sup> The questionnaire was given at the beginning of 20-60 minutes presentations in classrooms and in one case to several classes at one time who met in a large room.

Refreshments were offered to the students in the large meeting. We used three speakers for the classes: a male Hispanic electrical engineering professor, a Caucasian female industrial engineering professor, and a briefly retired Caucasian female engineer. The classes ranged from trigonometry and pre-calculus classes to calculus III, a chemistry class, and an Intro to Engineering class. Several insights came from that survey:

- Students were more certain of earning a Bachelor's degree than an Associate's degree.
- Females were more certain than males that they would earn a Bachelor's degree.
- Caucasians were only slightly more positive of earning a Bachelor's degree than Hispanic/Latino students.
- About 90% of the student had families who were supportive or very supportive of them earning a Bachelor's degree.
- There seemed to be no difference in family support by gender, ethnicity, or age of the student.
- Males were more likely ( $p=.001$ ) to choose engineering as their major than females, which would be expected.
- Hispanic/Latino, as an ethnic group, were the most certain of choosing engineering or CS as a major (79% were very certain or certain).
- Males were also more likely ( $p=.153$ ) to transfer to ASU than females.

The students were asked to rank several areas for which they wanted more information. The areas in order of rank were:

1. Financing a Bachelor's degree
2. Learn more about engineering
3. Where engineering jobs are located
4. Know more about the engineering majors

In Fall 2012, we designed a survey for CC students to answer the question: "What about engineering attracts or does not attract you?"<sup>19</sup> We asked students in the classes of all five of our

partner CCs to complete the survey. After asking for demographic data, we asked the students if they were interested in engineering as a career or if they were not. If they were interested in engineering, they were asked to check all of the reasons why from a list, to list any additional reasons, and to indicate their top three reasons. If they were not interested in engineering, they were asked to check all of the reason why from another list, to list any additional reasons, and to identify their top three reasons. The survey was given to 295 students.

The top three reasons for females for choosing engineering were, in order: money, like math/science, and the career is challenging. The top three reasons for males, in order were: money, many job opportunities, and they like math/science. The top six reasons that CC students were not interested in engineering were: does not sound interesting, not good enough at math, think engineering is simply too hard, do not like math, not aware of many engineering job opportunities, and want to work outside, not in an office. In addition, females did not like physics. The overwhelming reason for disinterest in engineering was that it did not sound interesting.

From the information gathered in the survey just described, we designed another survey where both students interested and not interested in a career in engineering could rate the same statements and they could be compared to give further insight.<sup>21</sup> A survey of 22 statements was given to students at two CCs with 64 students taking the survey. The students were asked to rate each statement from 1 (Strongly Agree) to 5 (Strongly Disagree) on their belief that the statement was true. Some statements were positive, some negative, and items were listed in random order. From this survey, the most positive uniform responses were:

- I want to use my career to make a difference
- Engineering jobs have a lot of flexibility and variety
- I want to use my career to help people
- Engineers work outside as well as in offices
- Engineering has many job opportunities
- I could use engineering to help my community
- The US needs more engineers to stay competitive.

Several items showed a lack of information among the students including: students believing an engineer must be a “brain”, an engineer must love math, engineers have low unemployment rates, and not believing that engineer have the highest starting salaries with a Bachelor’s degree. The survey showed strong evidence that those students, who are interested in engineering, understand what an engineer does and that students, who do not understand what an engineer does, are not interested in engineering. The survey also showed that students who do not like physics tend to not be interested in engineering, students interested in engineering tend not to believe that the subject is too difficult for them compared with students who are not interested in engineering, students who are interested in engineering believe more strongly that engineering can be used to help the community than do students who are not interested in engineering.

The survey in this paper was similar to this last survey with only a few minor changes. The number of items was reduced from 22 to 21 by leaving out the statement “Engineering and CS

sound interesting” since it was only being used as a reliability check to the statement “Engineering and CS do not interest me.” The statement “I am interested in Engineering or CS” was replaced by the statement “I am interested in Engineering or Computer Science as a career” to make the statement more restricted.

### III. The Survey

This survey was based on grounded theory. Through conversations and surveys of CC students over 13 years, student interests, likes, and dislikes have been discovered and analyzed. We have particularly worked with CC students from five non-metropolitan schools in Arizona. Our research shows that about 30% of the CC students, both metropolitan and non-metropolitan, who transfer to the Ira A. Fulton Schools of Engineering only decided on an engineering major after they were at the CC. Most students at the CC do not have engineering as a career anywhere on their radar. Based on our research then, a survey was developed listing 21 items. The student is asked to rate the truth of each statement on a Likert scale of 1 = “Strongly agree” to 5= “Strongly disagree.” The statements are as follows:

#### *Interest in engineering or computer science*

1. I am interested in Engineering or Computer Science (CS) as a career
2. Engineering and CS do not interest me
3. Working with robotics would be interesting
4. I want to use my career to make a difference
5. I want to use my career to help people

#### *Lack of information*

6. I do not really understand what engineering or computer science is about
7. I understand what an engineer or computer scientist does in their career

#### *Misperceptions*

8. An engineer or computer science major must be a “brain”
9. Engineering and CS are too difficult for me
10. Engineering and CS require too much work for me
11. An engineer or CS major must love math
12. I do not like physics and therefore do not want to be an engineer or CS major
13. Engineering and CS careers are not well suited for women
14. Engineering and CS have nothing to do with my life
15. Engineers work outside as well as in offices
16. I think I would use engineering and CS to help people in my community

#### *Inadequate Information*

17. Engineering and CS have many job opportunities
18. Engineering and CS jobs have a lot of flexibility and variety
19. Engineering and CS have the highest starting salaries after a Bachelor’s degree

20. Engineering and CS have low unemployment rates

21. The US needs more engineers and computer scientists to stay competitive internationally

The survey was given to 159 individual students attending math, science, and engineering classes at a CC. There were 89 males and 70 females who took the survey. One hundred twelve (73.7%) of the students were underrepresented minorities, primarily Hispanic/Latino. The survey was given and collected at the beginning of presentations by two ASU engineering professors.

#### IV. Analysis and Results

We are looking for trends of a difference in beliefs between students interested in a career in engineering or CS and students who are not interested. Because we are looking for trends, we are not that interested in exact statistical significance. The first survey statement was used to separate the students into those who were interested in engineering or CS as a career (strongly agree or agree), those who were neutral, and those who every not interested in engineering or CS (disagree or strongly disagree). Of the 70 females, only 15 (21.4%) were interested in engineering or computer science and of the 89 males, 55 (61.8%) were interested. We looked for the largest discrepancies in statement ratings between the students who were interested in engineering and CS and those who were not.

We now compare the average ratings of the students interested in an engineering or CS career with those who are not interested in such a career. If we look first at the statements about interest, the largest difference between those students who were interested in engineering or CS and those who were not was in the first statement. The average response to the statement, "I am interested in Engineering or Computer Science as a career" was 1.7 for those interested and 3.75 for those not interested. This difference not only puts the students into the two categories, but also shows that those interested were stronger in their agreement with the statement than those who were not interested. The next largest difference was found with the statement, "Engineering and CS do not interest me." This question was stated in the negative to verify that the students were being consistent. The difference in ratings was not as large for this question, but it was stated a bit differently by not relating their interest to a career. Those interested in engineering were also more interested in working with robotics than those not interested in engineering. However, surprisingly, a large number of students, both female and male, thought that working with robotics would be interesting even if they were not interested in engineering as a career. We were interested in this item because often examples of engineering activities include robotics. Both students interested and not interested in engineering and CS as a career were similarly quite strong in their agreement that they wanted to use their career to help people (1.8 average rating) and even stronger in their belief that they wanted to use their career to make a difference (1.6 average rating).

In the lack of information category, those interested in engineering were in more in agreement with the statement, "I understand what an engineer or computer scientist does in their career" than those not interested in engineering or CS as a career by an average rating of about 2.2 to 3.1.

In the misconception category, the major differences between engineering career minded students and those not interested in an engineering career were in three categories: engineering interested students agreed more with the statements “engineers work outside as well as offices” and “I do not like physics and therefore do not want to be an engineer or CS major”, and engineering interested students disagreed more with the statement: “engineering and CS have nothing to do with my life”. These results all point to the conclusion that students who are interested in an engineering or CS career know more about these subjects than those who are not interested. To a smaller degree, students who were interested in an engineering or CS career also were more likely to agree with the statement: “I think I would use engineering and CS to help people in my community”.

Another observation to note is that both groups of students strongly disagreed with the statement, “engineering and CS are not well suited for women” with students interested in engineering disagreeing with the statement a little more strongly than those not interested in engineering. Both groups agreed (rating about 2.75) that an engineering or CS major must love math. To a lesser degree (rating about 2.4), but still in agreement, both groups believed that an engineering or CS major must be a “brain.” These myths need to be broken. Both groups tended to disagree with the statement, “Engineering and CS are too difficult for me” with those interested in engineering disagreeing more strongly. The ratings for engineering and CS majors requiring “too much work” were similar to the rating for “too difficult.”

Regarding the inadequate information section, there were again some differences between students interested in an engineering or CS career. The students who were interested were more likely to agree that engineering and CS jobs had a lot of flexibility, have many job opportunities, and that the US needs more engineering and computer scientists to stay competitive. The interested students also believed more strongly that engineering and CS have low unemployment rates and have the highest start salaries for a Bachelor’s degree, but the margin was quite small. Both groups were a little more likely to believe the higher starting salaries than the low unemployment rates for engineers.

## V. Conclusions and Recommendations

The results of this survey agree well with our former surveys and with what we know from the literature. In general, it shows us that students who are not interested in engineering or CS, in general, do not know that much about the majors. Knowing from an earlier survey that money is a big consideration, we suggest that the topic of money needs to be used as a way to get students’ attention. The myths that being very smart and loving mathematics are necessary for a person to be an engineer, are myths that we continually need to address.

Additional analysis of this data will include comparing the results of the minority versus non-minority students and comparing the results by gender, especially to identify significant differences.

We believe that it is very important to show the variety of types of jobs that are available for engineers and computer scientists. We also believe it is important to survey the students that are

being recruited for engineering and CS to learn what matters to them in order to design the most effective message in order to get engineering and CS on their radar.

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