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Parental Support and Acceptance Determines Women's Choice of Engineering as a Major

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Abstract

The goal of this research was to explore what are the critical factors that may influence and motivate women to major in engineering. Guided by Social Cognitive Career Theory, we examined a broad list of factors from personal characteristics and abilities and confidence level, to abilities and professional orientation of parents and friends and the potential influence of these social groups on the choice of a major. We conducted a survey of 806 freshmen and sophomore students at a public university, enrolled in biology, engineering and business classes, and asked them a series of questions about their choice of a major. Approximately 50 percent of the participants were women and about 36 percent of them were engineering majors. Our findings demonstrate that confidence in abilities, intrinsic interest in major and potential to make a difference were significant factors for individuals to choose a major but there were no significant differences among majors or gender on how these factors played a role. Interestingly, parents and friends played a significant role in the selection of engineering as a major for women. They were not a significant influence for male students. The result did not depend on the profession or qualification of the parents. We argue that these findings demonstrates that women still need more support and acceptance than men to choose engineering as a career and they need this in addition to their own intrinsic interest in the field. Implications of these findings for practice will be discussed.

Introduction

Despite the preponderance of women in bioscience, chemistry and medicine, engineering is stagnant or losing ground in the proportion of women majors.[1] According to the NSF, Bachelor's degrees awarded by sex and field were flat at approximately 50% women for all of science & engineering from 2002-2012 but declined slightly in Engineering from 20.9% in 2002 to 19.2% in 2012.[2] In 2014, incoming freshmen across all baccalaureate institutions nationwide were 55% women: for this cohort, intended majors were 63% women in all bioscience fields, 42% women in all business-related fields, yet just 27% women in all engineering fields.[3]

Trends in women majors within engineering indicate that life-science related engineering fields including biological/agricultural engineering, environmental engineering and biomedical engineering have the highest fraction of women among freshmen majors (each with over 50% women, see Table 1).[3] In terms of the distribution of women engineers across different engineering majors, the most common majors for women are biomedical and chemical engineering, with 21 and 14%, respectively, of all female freshmen intended engineering majors. By contrast, the most common majors for male freshmen intended engineering majors are mechanical and computer engineering, with 29 and 13%, respectively, of male freshmen intended engineering majors. The rationale behind these trends by engineering major may be linked to altruistic values.[4] Girls may not perceive certain fields as advancing communal goals such as helping other people,[5] and therefore may not be strongly drawn into certain fields. In recruiting, inspirational messages like "engineering is essential to our health, happiness, and safety," may especially appeal to women.[6]

Table 1. Gender split by major and distribution of women and men among engineering majors (adapted from Ref. 3, Eagan et al., 2014, a nationwide survey of intended majors).

Intended Major	Gender split by Major		Distribution among Majors	
	Women	Men	Women	Men
Biological/Agricultural Engineering	55%	45%	3%	1%
Environmental/Environmental Health Engineering	55%	45%	5%	2%
Biomedical Engineering	51%	49%	21%	7%
Chemical Engineering	38%	62%	14%	8%
Other Engineering	33%	67%	7%	5%
Industrial/Manufacturing Engineering	31%	69%	5%	4%
Engineering Science/Engineering Physics	29%	71%	2%	2%
Materials Engineering	29%	71%	2%	2%
Civil Engineering	28%	72%	9%	8%
Aerospace/Aeronautical/Astronautical Engineering	20%	80%	5%	8%
Electrical/Electronic Communications Engineering	19%	81%	7%	11%
Computer Engineering	17%	83%	7%	13%
Mechanical Engineering	15%	85%	14%	29%
		Total	**100%**	**100%**

The goal of our study was to better understand the factors that motivate women versus men to select engineering as their intended major through administration of a survey instrument guided by Social Cognitive Career Theory. Substantial research has long been conducted into possible explanations for widespread disparity in engineering, and more generally in STEM disciplines, in terms of gender and also diversity. Our work builds on studies that have identified several key contributors, including early emerging preferences among genders, the importance of STEM enrichment during adolescence, intrinsic or autonomous versus external rewards, and others, briefly reviewed below.

During the 60's and 70's, a deviance hypothesis found some support in studies of work values. Career oriented women "stressed intrinsic features of the work including the kind of people in a given occupation, the high prestige of the occupation, the opportunity to use special abilities, and whether the work left enough time to spend with family."[7] By comparison, non-career oriented women preferred "more feminine values including working with people rather than things, living up to their parents' ideas of success, a stable secure future, and helping others."[8]

Other research at the time, however, showed limited support for a 'deviance hypothesis'. In a four year longitudinal study of 110 college women (a private, expensive, co-ed, professionally oriented college in Texas), females who chose then-male-dominated occupations were essentially no different from their peers in terms of work values, relationships with parents, dating, or extra-curricular activities. Instead, an 'enrichment hypothesis' was supported, whereby career choices were linked to enriching experiences especially coupled to occupational role models, the mothers' work history, and the students' own work experience.[8] "Career-oriented women had been more influenced by teachers, professors, and people in the occupation; these role models who embodied occupation-related values led the women to identify closely with an occupation. Non-career oriented women more often named peers, family members and relatives as significant influences; their more diffuse values led the students to identify with the traditional role of housewife."[7] Similar studies supported the importance of prior work experience for high school and college age girls, both their own, and their mothers'.[8]

In other research, "girls report less interest in math and science careers than boys do" from early adolescence, and "girls identified as mathematically precocious are less likely than boys to pursue STEM careers as adults."[9] Such differences have been reported to begin at a much earlier stage as well, with developmental studies revealing newborn girls preferring to look at faces while baby boys prefer mechanical stimuli.[10] Human societal pressures cannot be solely to blame, since preferences among juvenile boys to play with wheeled toys (a wagon, truck, car, construction vehicle, shopping cart, or dump truck) were paralleled by non-human male primates (11 out of 21 rhesus monkeys suitable as subjects for the study). For the female monkeys in this troop of 135 monkeys, play was more varied among the wheeled toys, as well as 7 diverse plush objects (23 out of 61 potential subject monkeys).[11]

Independent of such early divergences in interests, strong differences remain in motivators when it comes to students selecting their careers. To approach this question, Self Determination Theory ('SDT') proposes that behavior is connected to motivations on a spectrum from autonomous to controlled, i.e. based on internal versus external rewards, respectively. Those with more autonomous motivations are more likely to be more productive, creative, and to 'thrive and persist in a chosen career.' One such study explored motivations for early career choices among a small, representative group of 11 male and 11 female undergraduates.[12] Ultimately, the women and men studied were similarly motivated in their career choices, partitioned almost equally across the entire spectrum of Self Determination Theory. But, they discussed these motivations remarkably differently, with men especially interested in the technology while the women were much more focused on business- and people-related (i.e. non-technology) activities. This is an important finding and possible opportunity for future retention efforts in engineering, since in reality (based on workplace observations), the actual engineering workplace includes extensive social aspects (e.g. "communicating, coordinating, managing, and influencing people"), but these are "rarely credited by engineers themselves as being 'real' engineering work."[13]

Studies of expectancy-value perspectives draw similar conclusions. In a thorough review analyzing gender differences in STEM educational and occupational choices, it is noted that, "Women report a greater propensity toward working with people and valuing jobs that are more flexible and accommodating to their childrearing responsibilities."[14] Yet STEM careers are regularly perceived as the opposite.

Improvements in support and understanding of STEM in the home are also helpful for promoting STEM professions, regardless of gender. This includes providing role models as early as secondary school, conveying the beneficial impact on society, and, again, affirming that STEM careers inherently involve opportunities to work with people despite misunderstandings to the contrary. For women in STEM actually in the workplace, on the other hand, more flexibility to work from home, as well as leadership and advancement opportunities, are observed to be beneficial. Incentives to stay with a STEM profession need to be extended to all underrepresented populations, not simply mothers of young children as is commonly applied, since reasons to leave STEM fields vary greatly.[14]

Social Cognitive Career Theory (SCCT) is also applicable to trying to explain their career plans. The SCCT model has 4 core variables: self-efficacy beliefs, outcome expectations, interests, and goals. In a study of 579 male and female college students (sophomores) in Spain, there were "no statistically significant differences in outcome expectations or goals."[15] This was based on questions related to a students' appreciation for an engineering degree positively influencing their professional career, and on the extent of their academic plans. The students were also asked about their level of confidence in earning high marks on courses with basic requirements for engineering majors, and on their interest in engineering related activities such as solving mathematical problems. The answers indicate that women had "less self-efficacy beliefs and interest than men."[15] One key conclusion is that to increase graduate rates of female engineers, self-efficacy must therefore be promoted to overcome this disparity. Women were also more likely to perceive support from peers, family, and especially teachers, another possible avenue for future attention. A key implication is that to increase graduate rates of engineers, self-efficacy must be promoted.

Such theories relating early math and science performance with confidence, background, and life goals are commonly connected to gender imbalance in STEM. But in a compilation of 4 distinct longitudinal studies (1972, 1982, 1992, and 2004) with data from more than 40,000 students, career aspirations were considered in terms of gender, patterns in course-taking and offerings, and common pathways towards STEM careers such as medical and law school. The results suggest the structure of STEM undergraduate programs, professional training, and their links to careers in the same field are themselves partially to blame for unequal participation by women. For example, women are more likely to take and excel in more diverse classes as students, including elective courses in non-STEM fields. They also appear to prefer departments where the major can be selected later in the undergraduate career, and is less hierarchical than is common with STEM degrees. Unsurprisingly, this often translates into women pursuing traditionally female-dominated majors instead of more male-dominated STEM majors. Careers such as medicine and law, which leverage intensive post-graduate training, have also been more successful at improving gender balance. In parallel, these disciplines draw students (particularly females) with more diverse but less prescribed academic backgrounds than a STEM undergraduate diploma, again in their favor as compared to STEM career or graduate study options.[16]

More general parental involvement is also found to be important. A longitudinal study of 203 working and middle class families, consistent with social learning theory, reported that socialization experiences during childhood (10 years old) coupled with the eventual attainment of more male-typed occupations (including STEM careers).[17] For example, spending more time with fathers as children promoted more gender-typed occupations in young adulthood for boys, versus broader than usual occupation decisions (including more male-typed) for girls. Promoting greater involvement by fathers in their young daughters' lives may thus be a simple path for improving the gender imbalance within STEM disciplines.

Naturally there are strong cultural elements to career motivators as well. As has been shown repeatedly, professional choices are generally strongly influenced by family members, and by meaningful career services at school. More broad objectives of 'finding a job' and 'being happy' are also important. But in a survey of 1163 women in Turkey, engineering branches perceived by students as more appropriate for men (mechanical, civil, electronic) are in fact favored by men, and those perceived as more appropriate for women (genetic, bioengineering, chemical, environmental, industrial) tend to be favored more by women. Although not supported in similar surveys in Europe and the US, this is most surprising since when directly asked, those same students state that "gender does not play a role in their choices".[18] This finding may suggest that the students are in denial. Or, it may be a small step in the right direction, since, "at least theoretically, the students know that their decisions should not be biased based on gender."[18] In any case, comparisons of the gender gap across nations demonstrates that, "female quantitative performance varies by societal perceptions of male/female status, equality, and stereotypes that are embedded within the larger cultural context."[14]

Important conclusions to be drawn in terms of improving diversity among STEM disciplines include: 1) breaking the perception that studying science is only useful for eventual scientists; 2) the "creation of 'third spaces' in which to engage disadvantaged urban youth with science and mathematics to support them in their performances of scientific identities and their use of science and math knowledge and skills to transform their lives, both in and out of school;"[19] and 3) the importance of equally distributing science capital throughout society, most effectively by helping family members to be comfortable and understand the benefits of science in the home.

Methods

The goal of our research is to shed some more light on the importance of some of the factors discussed above for choosing engineering as a major and to examine their differential and unique effects on the choice of women and men. With this in mind, we surveyed 806 freshmen and sophomore students at a public university, enrolled in biology, engineering and business classes, and asked them a series of questions about their choice of a major. Out of the 806 students who participated, 752 provided complete responses to all survey questions and their demographics are reflected in Table 2. This institution is a public state university classified as R1(Highest research activity) by the Carnegie classification and offers a wide range of undergraduate degrees in engineering, business, and arts and sciences. We chose classes in engineering and biology to recruit our participants to try to balance the gender distribution. We also included business students to include the choice of another professional degree, in addition to engineering, in the comparison.

Since our work is about selection of major it may be important to indicate when students typically select their major. At our institution, among students enrolled in the School of Engineering, 81% have declared a major in their Freshman year, and 94% have declared a major in their sophomore year. Major declaration rate in the School of Business is 72% for freshmen and 79% for sophomores. Overall at our institution, the proportion of students who have not declared any major in their freshman year is 25% as freshmen and 21% as sophomores.[20]

The survey was administered in person using paper surveys over two consecutive semesters, fall 2013 and spring 2014. From the students we reached who completed the survey, approximately 50 percent of the participants were women and about 36 percent of them were engineering majors (Table 2).

Survey

We administered an anonymous 10-minute survey during lectures courses in spring 2013 and fall 2014. Students were asked about the factors that affected their choice of major and choice of a career and the importance of these factors in their decision making process. We selected these factors guided by the social cognitive career theory and what has been identified previously as important influences for career choice.[21,22] Participation was voluntary, but students did not self-select to be part of the study. We targeted primarily freshmen in our selection of classes to survey (76% of the sample), but our sample did include 24% of sophomores or more senior students, especially in business. Among the engineering students surveyed, 91% were freshmen, and our sample comprised about 36% of the total engineering freshmen population at that time. Likewise, among the biosciences students surveyed, 82% were freshmen and our sample comprised 57% of the total biosciences major population at that time. Because of the nature of the business students and the classes they take, 99% of the business major participants in the sample were sophomore or above and represented about 21% of the business student population at that level at that time. [20]

Table 2. Survey respondents by sex, major, race, and ethnicity

	Male	Female
All Engineering	183 (48%)	86 (23%)
Biomedical Engineering	39 (10.3%)	47 (12.6%)
Chemical Engineering	13 (3.4%)	9 (2.4%)
Civil Engineering	11 (2.9%)	5 (1.3%)
Computer Engineering	42 (11.1%)	14 (3.7%)
Electrical Engineering	6 (1.6%)	0
Environmental Health Engineering	8 (2.1%)	3 (.8%)
Materials Engineering	3 (.8%)	2 (.5%)
Mechanical Engineering	49 (13%)	3 (.8%)
Other Engineering	12 (3.2%)	3 (.8%)
All Biosciences	49 (13%)	166 (44.4%)
All Business	38 (10.1%)	29 (7.8%)
All Other Majors	108 (28.6%)	93 (24.9%)
American Indian or Alaska Native	5 (1.3%)	2 (.5%)
Asian	53 (14%)	60 (16%)
Black or African-American	17 (4.5%)	16 (4.3%)
Native Hawaiian or other Pacific Islander	3 (.8%)	1 (.3%)
White	268 (71%)	276 (73.8%)
Other	32 (8.5%)	19 (5.1%)
Hispanic	41 (10.8%)	42 (11.2%)
Disability status: Yes	9 (2.4%)	8 (2.1%)
Total	378	374

***Numbers in demographic table reflect surveys with complete demographic data for 752 respondents. There are missing demographics for 54 respondents and they were excluded from the comparison analyses.**

Measures

We included the following measures in our survey instrument:

Intrinsic motivation/excitement about major/career. To measure excitement and intrinsic interest in the subject matter and major we asked students to rate the importance of the following four items in their choice of a major on a 7 point Likert scale: 1) Doing something that I am interested in; 2) It is fun being able to discuss difficult technological matters. 3) I am interested in the methods, theories and insights of the discipline; 4) I am interested in the subject. The Chronbach alpha reliability of the items was .75 and we averaged them to create an Intrinsic Motivation/Excitement index.

Self-efficacy/confidence in STEM activities: To measure the importance of self-confidence we asked students to 1) Assess their STEM abilities; 2) how they are doing in STEM-related courses; 3) Where they position themselves among other students in the courses related to their major. For all items students were asked to use a 7-point Likert scale. The reliability of the three items was .70 and we averaged them to form a self-efficacy/confidence in STEM activities index.

Career goal – social impact: One of the factors identified as an important determinant of career choice is having the potential for social impact. We asked participants to indicate on 7-point Likert scale the importance of the following factors for their choice of future career: 1) Potential to help people; 2) Potential to work on societal problems; 3) Potential to make a difference. The reliability was .80 and we averaged the three items to form a career goal - social impact index. We also asked participants to indicate the importance of job security, income potential, flexibility and work-life balance as other potential goals guiding career choice.

Career goal – outlet for math and science skills: We asked participants to indicate if they chose their major as an outlet for their math and science-related skills.

Career goal – participate in technological innovation: We asked participants to indicate if the potential to participate in technological innovation was an important factor in the choice of a major on a 1 – 7 Likert type scale.

Influence from parents/siblings and friends, teachers/counselors. In addition to factors more internal to the student making a choice of a major, the social cognitive career theory often identifies support/barriers from the environment as an important determinant of career choice. One of these major contextual or environmental factors may be coaching/mentoring or influence from parents, family and friends, teachers and counselors. We asked participant specifically to indicate the degree of influence from parents/siblings, friends, high school teacher/guidance counselor. In addition, we asked them to indicate the profession of their parents, family and friends to determine if previous exposure to engineering in the family will be the determining factor.

In addition, we asked about the level of significance of income potential, status, job security and flexibility as important considerations for their major choice.

Results

First, based on the number of participants from each major/field of study and their similarity/differences, we grouped all majors into four broad categories: 1) engineering – all engineering related majors; 2) biology – all biology and related fields majors; 3) business – all participants who do a major in the School of Business and 4) other – psychology, nursing, etc. We used Analyses of Variance (ANOVA) to compare the influence of all of these factors for the choice of engineering as a major vs. biology, business or other majors and careers. We believe that this is a meaningful comparison as it allowed us to compare engineering and business, as two professional degrees, with biology and liberal arts and sciences ones. In addition, biology provided a good comparison to engineering as both are good alternatives for pre-med students, both have potential to have social impact but at the same time, biology is chosen predominantly by women while engineering is usually chosen by male students. In addition, we split the sample by gender (male and female) to compare and contrast how these factors affected the choice of major for women vs. men as this is the goal of this research.

In addition to the ANOVA analyses, we used a Duncan Multiple Range Test to compare the different means within each sample. When the means were significantly different at $p < .05$ within the sample (within each row for overall, women and men), we indicated this in Table 3 with a different superscript. The results of our ANOVAs, as shown in Table 3, indicate that in the general sample of participants, the mean level of importance of social impact as a career goal $F (3, 769)=15.38$, $p<.01$), career as an outlet for math and science skills ($F(3, 769)=31.77$; $p< .01$), potential to participate in technological innovation ($F (3, 769) =26.98$, $p<.01$), intrinsic motivation in the field of study ($F (3, 769) =24.85$, $p< .01$), self-esteem/confidence ($F (3, 593) = 4.48$, $p< .01$) and influence from parents/siblings, ($F (3, 802) = 11.95$; $p<.01$ friends ($F (3, 802) = 4.26$, $p<01$) and teacher/guidance counselor ($F (3, 802) = 11.72$; $p<.01$) all demonstrated significant differences among the participants choosing the different major categories and the differences were most pronounced in comparison with engineering as a career/major choice vs. everything else. Among these factors, career as an outlet for math and science skills, potential to participate in technological innovation, intrinsic interest/motivation in the field of study and influence of parents/siblings and high school teacher/guidance counselor were significantly higher for the participants who chose an engineering major, while social impact as a career goal was higher for the participants who selected biology and there was no difference in the general sample for the influence of friends. Interestingly, there was no difference in the choice of a major for achieving work/life balance or job flexibility – these seemed to be not important differentiating factors in the choice of a major. Contrary to popular beliefs, income potential, was also not an important consideration.

Next, we looked at the means of all of these factors separately for male and female participants to determine if there were any significant differences in how important they were in the choice of a major for the two populations. Unlike the general sample, when we split the samples, social impact as a career goal had a similar effect on the choice of engineering and biology. The only difference was that for male students, while still an important factor, the overall mean of this particular career goal was significantly lower than for female students ($F (1, 267)=11.26$, $p<.01$). Career goals - outlet for math and science skills, as well as the desire to participate in technological innovation showed significantly higher importance for the participants who chose engineering as their major, for both the male and the female groups.

Interestingly, the level of influence of intrinsic motivation in the fields of study, career as an outlet for math and science and the potential to participate in technological innovation had the same effect on male and female students and predicted the choice of engineering above any other major for both groups. Surprisingly, there was no significant difference between the two populations for these factors and the pattern of the means was identical.

Self-efficacy/confidence as a determining factor showed some very interesting results. Self-efficacy seemed to be more important for the profession oriented majors – engineering and business - but only for the male group. For the female group, there was no significant difference between the level of self-efficacy among the different majors. The role of high school teacher/guidance counselor seemed another factor with higher importance for engineering majors vs. all other majors in the overall sample and in the male group. For the female group, high school teachers/guidance counselors seemed to have an equal impact on engineering and on other majors but lower impact on business and biology related majors.

All of these results do not show a consistently different profile for the female vs. male engineering student, on the contrary, they show that the two groups are motivated by very similar criteria with very similar priorities. Our most unexpected significant results are the influence of parents/siblings and friends. While parents/siblings seemed to have a significant influence on the whole sample in our first analysis, when we split the sample we found that they had a significant effect on the female participants' choice of engineering as a career and had no effect on the male participants. In addition, while friends had no differential effect on the whole sample, they were a significant factor for female students to choose engineering and they had no effect on the choice of a major for the male students. Supplementary ANOVAs confirmed these significant differences. We also tested whether the profession of the parents (engineering vs anything else) played a role and found no significant difference between parents with or without engineering related occupations.

Discussion

The goal of this research study was to explore the factors that influence the choice of engineering as a major and as a career and whether they had differential effects on female and male students and our results paint a very interesting picture. In designing the study, we were guided by the social cognitive career theory, which suggests career goals, expectations, motivation and interests and self-efficacy as well as barriers and supports may be the determining factors for career choice. Our results confirm the importance of all of these factors as significant influences in this process. Our findings also demonstrate that self-efficacy or confidence in abilities, intrinsic interest in major and potential to make a difference were significant factors for all individuals' choices of a major but there were no significant differences among majors or gender on how these factors played a role. As expected, aspirations to use math and science skills and participation in technological innovation were determining factors for the choice of engineering. We believe that these results provide support for the social cognitive career theory and show that these factors had very similar effects for both women and men. The most interesting finding from our study is that parents/siblings and friends played a significant role in the selection of engineering as a major for women. They were not a significant influence for male students and the result did not depend on the profession or qualification of the parents. These results are in unison with some previous studies that demonstrate the importance and influences of others for the choice of a major, including George - Jackson (2012)[23] and Correll (2001)[24] and Kniveton (2004)[25], who discuss the importance of parental influences on children's career development through support, advice and expectations. Kniveton's study also demonstrated that parents may have a much larger influence than that of teachers and that the same sex parent was more influential. While the influence of parents has been documented before, we did not expect it to be significantly more important for female engineering students. In addition, we believe that the role of friends is an interesting development. While previous research may have recognized the role of friends, a lot of times the expectation is that female students would like to stay together with their friends and will choose a major similar to theirs and not a nontraditional major like engineering. At the same time, in previous studies undergraduate women in science majors frequently reported that support from family and friends played a large role in influencing their choice of major as they looked for guidance and role-models.[26] We argue that this finding demonstrates that women still need more support and acceptance than men to choose engineering as a career and they need this in addition to their own intrinsic interest in the field. The importance of support from both family and friends signifies that women are still trying to overcome traditional gender stereotypes and need additional encouragement to make these decisions and undertake a non-traditional career path.

It is also interesting to note the non-significant differences in the importance of income or job stability and flexibility between the two groups. It may be that income becomes more important at a later stage, when the choice of a job and career is concerned and not so much in the choice of a major or things may be changing in the values both women and men in the new generation place on higher income as a priority.

Limitations

Our study is not without limitations. We used a survey of mostly freshmen, and some sophomore and junior students and this may not be the right moment to reflect on the factors facilitating the choice of a major or may not indicate enough about intention to change career paths or factors and values for career development after graduation. Supplementary analyses did not indicate any differences in these factors between students who were surveyed as freshmen vs. sophomore or higher in our study but it may be important to compare and contrast how similar distribution of majors reflect on the same factors before they start their studies and immediately after making the choice of a major for college applications or later in their development, before graduation. Future studies may want to explore the development of these values and priorities and career goals through a longitudinal design as well.

In addition, while we find differences between the students from the different majors and the male and female groups, our results need to be interpreted with caution as our study cannot establish causality and it may be that the different majors shape different values and not that these values and goals lead to different majors.

Implications

Our findings have considerable implications for the attraction, retention and development of female engineering students. It is encouraging that both male and female students drawn to engineering perceive it as an outlet for their math and science skills, as a way to participate in technological innovation and as an area that is intrinsically motivating and exciting for them. It is also important to mention that both groups see the potential social impact as an important career goal and need to recognize it in engineering in order to choose it as a major. Our findings show that parents/siblings and friends and their support and encouragement is particularly important for women's choice of engineering as a career. In this respect, we need to investigate more why this support is so important and are there other ways to provide it. If this is an indication of a struggle with a stereotype or an outdated cultural norm, it is important to start working on this early on to not allow gender stereotypes to prevent women from entering engineering careers or to facilitate their process of overcoming these biases. In addition, some more interventions and work and exposure of parents to engineering may be as important as the exposure and outreach engineering schools do with schools.

Concluding remarks

The social cognitive career theory is a good model to predict major choice and in particular the choice of engineering as a major for both male and female students. Women are influenced by the same factors like intrinsic motivation and excitement in the subject matter, desire to use math and science skills and participate in technological innovations and aspiration to have societal impact as a career goal. It seems that the internal factors for both groups are similar but the external influences are a lot stronger for women as they still have to overcome considerable stereotypes to undertake an engineering career and should not feel excluded and not accepted by making this choice. Intervention that provide more support and educate parents and peers to do it will be very beneficial for increasing the representation of women in engineering careers.

Table 3. Cell Means for Factor Importance for Career Choice

Major		Engineering	Biology	Business	Other
Career goal – social impact	Overall	4.02ii	4.29i	3.61iii	4.02ii
	Women	4.27i	4.37i	3.76ii	4.13i
	Men	3.91i	4.01i	3.49ii	3.91i
Career goal – outlet for math and science skills	Overall	4.13i	3.76ii	3.27iii	3.84ii
	Women	4.21i	3.79ii	3.13iii	3.86ii
	Men	4.09i	3.64ii	3.38iii	3.79ii
Career goal - participation in technological innovation	Overall	3.87i	3.13iii	2.93iii	3.37ii
	Women	3.76i	3.09ii	2.66iii	3.15ii
	Men	3.94i	3.28iii	3.13iii	3.59ii
Intrinsic motivation/excitement about career/major	Overall	4.31i	3.86ii	3.49iii	3.97ii
	Women	4.15i	3.84ii	3.45iii	3.86ii
	Men	4.40i	3.90ii	3.51iii	4.07ii
Self-efficacy/confidence	Overall	5.39i	5.07ii	5.30i	5.03ii
	Women	5.22	5.04	4.92	4.97
	Men	5.43i	5.14ii	5.60i	5.13ii
Influence of parents/siblings	Overall	.63i	.48ii	.49ii	.37iii
	Women	.69i	.48ii	.39ii	.44ii
	Men	.59	.49	.58	.47
Influence of Friends	Overall	.22i	.13i/ii	.16i/ii	.11ii
	Women	.29i	.13ii	.17i/ii	.12ii
	Men	.19	.16	.16	.15
High school teacher/guidance counselor	Overall	.42i	.20ii	.18ii	.28ii
	Women	.45i	.20ii	.17ii	.42i
	Men	.40i	.18ii	.18ii	.29i/ii

Note: Different superscripts are used to indicate significantly different means. Means having the same superscripts within a measure and within a sample (in the same row) are not significantly different at $p < .05$ using a Duncan Multiple Range Test.

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