Work in Progress: Studying the Factors affecting Women Recruitment and Retention in Engineering

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Abstract

Women in engineering face different challenges than men in engineering programs due to engineering being a male dominated field. This impacts their recruitment, retention, and future career paths. Women often face issues such as lowered sense of self-efficacy, poorer group experiences, and less stable support networks. The goal of this multi-semester study was to find the factors that help recruit and retain women engineering students. A survey was administered to about 1500 students, the approximate number of undergraduate students enrolled in the Rowan University College of Engineering. The questions focused on factors of recruitment and retention, including family life, classroom experiences, extra-curricular, specific course experiences at Rowan University (where the study was conducted), and more. These questions were designed to give insight on what gets the students to stay in engineering. Interview questions elaborating on these topics were also included.

The first phase of the study involved sending the surveys to students of senior standing (approximately 400 students). Of the 66 responses received, 45% of the students surveyed were female. The second phase, sent out the same survey to all the undergraduate engineering students, and received about 260 responses with about 30% female. The results were varied across six different disciplines. The results showed that the survey participants had supportive families and friends, but lacked mentorship. There was also a high interest in the subject matter of their chosen discipline, which appeared to be the main factor. During the second phase, student interviews were conducted on those who opted for it. The interview questions were based on female student experiences while attending the university. Seventeen students were interviewed to gain knowledge of their experiences. The results identify some important factors that impact recruitment and retention.

Introduction

In the US only 19.3% of the students earning undergraduate engineering degrees are women, despite them comprising 57.3% of the students earning a bachelor's degree[1]. This underrepresentation of women in engineering discipline, their retention and progression is impeded due to multiple barriers. Not only does the number of women studying engineering diminish dramatically at various stages, but of those who do complete an undergraduate engineering degree, relatively few progress to postgraduate level or beyond. Despite the fact more women are taking STEM courses in schools, women continue to be underrepresented. However, studies have proven that diversity within an organization or team, including gender diversity, is necessary as it is associated with improved productivity, creativity, and organizational profitability[2,3,4] . Owing to such a disparity, it becomes imperative to investigate the factors which lead to such an imbalance in the degrees earned.

Learning about the challenges faced by the female engineering students is valuable because it will help the policy planners to introduce changes in education so that it leads to an increase in the number of women availing opportunities in STEM, thereby arming them with tools they need to succeed in the currently male dominated engineering fields. There are a few studies done on the subject of women's recruitment and retention in engineering. One of the efforts for fostering retention of female undergraduate students[5] was a student led mentoring program to connect female students with multiple mentors or role models from diverse career backgrounds to whom they could relate to and interact personally. These group functioned as independent, close-knit environments that enabled students to share their thoughts and seek guidance without inhibitions. The connection between financial wellbeing and female retention was explored by Yang[6], by examining whether a financial incentive such as student loan repayment awarded upon graduation influenced undergraduate women's retention and academic achievement in engineering. Their findings revealed that loan repayment award not only had a positive influence on completion rates, but also influenced completion by a greater variety of students in terms of GPAs. The CalWomenTech Project[7], was a funded project to assisted eight California college technology programs in recruiting and retaining more women during an economic recession and state budget crisis. Among the factors mentioned that increased recruitment were issuing a personal invitation to female students and Advertising "CalWomenTech Role Model Posters" which were posters featuring quotes and photos of real female role models - either female graduates from the technology program, current female students, or female role models from local industry - working with authentic equipment.

De Cohen[8] argued that retention is not the primary reason for the low percentage of women in engineering, but rather, recruitment. Very few female high school seniors choose engineering in college. Their results supported the findings of other similar studies about the likelihood of men following a linear path to a STEM career, whereas in case of women, an inclination to follow a non-linear path, entering, stopping and exiting at different points in the pipeline. Geisinger[9]

identified six broad factors driving students to leave engineering: classroom and academic climate (teaching and advising, individualistic culture of engineering classrooms), low college grades and conceptual understanding (failure to conceive how mathematics maps to the physical world), self-efficacy and self-confidence (discouraged by the competitive grading structure and individualistic climate of engineering classrooms), high school preparation, interest and career goals, and race and gender. These factors were even more disadvantageous to women than to their male counterparts. A multi-year, multi-institution study of women engineering students' self-efficacy[10] using the Longitudinal Assessment of Engineering Self-Efficacy (LAESE) instrument showed a strong relationship between self-efficacy and student persistence and revealed that women engineering students perceive a lack of inclusion in the environments in which they study engineering. This could be due to negative social cues sent by fellow students and faculty to women students, either inadvertently or deliberately. The continued low female representation in engineering undergraduate studies, point towards the continued need to examine how the overall experience of studying engineering is influencing the self-efficacy and women students' sense of inclusion. A study on retention and promotion of women and underrepresented minority faculty in science and engineering[11] revealed that even in professional life female engineering faculty who started as assistant professors had higher incidence of leaving than men, particularly in years 3 through 7, and left without tenure more frequently than men. They did not see this discrepancy in the other disciplines. Servon[12] focused their study on the experience of executive level women in SET (science, engineering and technology) careers within the private sector. The findings of their study revealed that the workplace culture in general was unsupportive to women and shaped by norms of behavior and a process of professionalization. The isolation of women in SET carriers was in part due to lack of female role models or mentors.

Silbey[13] suggests that most women will have experienced being given menial tasks in group settings like classwork and projects. This causes them to doubt their problem-solving capabilities and seek approval for most of the decisions they make. Dizikes[14] describes how female engineers experience prejudices in the tasks assigned to them. In one study the engineering students recorded their experiences in diaries and found that men were more likely to regard their internship and summer job experiences as positive while women had more mixed feelings. Much of this was attributed to sexist task delegation. Ohland[15] concludes that women build self-efficacy primarily through vicarious experience and verbal persuasion, whereas men are more likely to develop self-efficacy through mastery experiences. Other observations made on the basis of similar studies were Universities and other agencies have been trying for over a decade to recruit and retain women into engineering by increasing outreach programs but studies have found that to be unsuccessful. This is possibly due to a lack of understanding of what engineering entails[16]. The misconceptions about engineering can be related to a lack of exposure to engineering while still in high school. When a female engineering student fails a course, it is not unusual for her to view it as inability to complete and understand the necessary coursework

this is required in engineering, whereas if a male student fails a course he views it as he needs to work harder for next time. This lack of confidence in female students causes them to leave the major[17].

In keeping with the above considerations, a study was undertaken at this university with the following goals (1) to find the factors that help recruit women engineering students, (2) to identify the challenges and barriers being faced by female students working in multidisciplinary non-female dominated teams engaged in project-based learning activity[18], (3) to find a correlation between their experiences and their underrepresentation and/or retention in the engineering field. The overarching goal was to identify the 'challenge variables' or the 'barriers' faced by women engineering students and tie to the current state of research already accomplished in this field.

Project Description

This project was sponsored by the Engineering Information Foundation. The goals of this project included finding the factors influencing recruitment and the barriers faced by female students in their undergraduate scholarship. Since it involved human subjects an IRB training was required. The project team got trained on the IRB protocols following which a research proposal was submitted to the IRB committee for review and approval. In the meanwhile, the team started doing a literature review and preparing survey questions. Once the IRB approval was granted, the next steps in the process; that of designing and conducting an online survey was completed. It was decided to implement this project by assimilating it with the curriculum in the form of a project based activity. The project-based learning activity[18] is a hands-on project-based series of courses implemented at Rowan University called the Engineering Clinics. The Engineering Clinics is an 8-semester sequence of courses offered by the College of Engineering that replicates industrial work environment by engaging the students in laboratory hands-on activities on projects that are often sponsored by industry partners with a focus on solving real world problems.

Assessment Method

The instrument for this study was designed to be (i) an online survey sent to all undergraduate students and (ii) personal interviews with the female students. A survey in qualtrics was implemented with questions on why the students chose engineering and what factors impacted their choice to stay or leave the engineering program. Questions probing the support of friends and family, faculty, and peers; the experiences and impact of group work in the classroom, clinic projects, and internship opportunities; the main factors which impacted their retention within the engineering discipline were also included in the survey. The interview questions for the female students were expanded upon the online survey questions with the aim to explore themes related to their undergraduate life experiences including factors that helped or hurt their retention in engineering. The survey and interview question list can be found in Appendix A and B. The

audio interviews were expected to be approximately 20-30 minutes in duration. In the first week of May 2019, the survey was sent out to the graduating seniors and students of senior status to get some of their feedback for phase one. About 60 students took the survey. The responses were lower than expected, as the target group was preparing to graduate and it was a little late in the semester too.

In fall 2019 semester, the survey was sent out once again. About 260 participants took the survey this time. Once the results were collected, data analysis on the survey responses was carried out. The interviews were the next step. An email of interest was sent to the students via a doodle poll to schedule interviews. The student interviewers met with the participants. Each interviewee was asked to sign a consent form following which the interviews were completed. There was a total of 17 participants who interviewed. All interviews were audio recorded. They ranged from approximately 10 to 45 minutes in duration. A sample of abbreviated responses of the interviews is displayed in Appendix D. The interviews were then transcribed and edited to match the exact words using Otter.ai software. They were then analyzed for themes and quotes that contained information pertinent to the project. After all the survey and interview data was collected, a complete data analysis was done as a final step.

Results and Discussion

By fall 2019 semester, about 260 students had participated in the online survey, 68.92% male, and 30.28% female and 0.8% identified as other. The online survey addressed pre-college, family background, campus life and faculty interaction, peer interaction, extra-curricular activities, internship experience, and social life. Charts reflecting this data can be seen in Appendix C. Of those surveyed, 41.67% were Mechanical Engineering students, 13.33% were Biomedical Engineering, 18.33% Civil Engineering, 16.67% Chemical Engineering, 8.33% Electrical Engineering, and 1.67% Engineering Entrepreneurship.

When surveyed about family background, almost 29.49% of the participants responded that they had an immediate family member in the engineering field. As many as 25.64% had an extended family member in the engineering field and 23.08% had a friend/acquaintance in engineering. The most interesting part was that 21.79% didn't have any family members or close family/friends in engineering to lead them to it. In response whether they had some form of family support in pursuing engineering, 96.61% of students responded they had full family support of their future career choice. The family data show that even if the students did not have family members in engineering, their families were still supportive at home for their college major choice.

On the question of being introduced to engineering prior to college, only 37.93% of students responded that they had prior engineering experience. That meant most of the students who chose to go into engineering didn't have any experience with engineering before attending this University. This indicates that not all students who are successful in engineering programs need

to have a prior experience before joining college. On the question of pursuing co-curricular activities prior to joining college, 50% of students said they had done some form of extracurriculars, promoting engineering prior to college. This is interesting as it shows that not every students' decision to pursue engineering in college is a result of their exposure to engineering before college. In terms of on campus support, 43.64% students responded they got help from their on-campus clubs/peers and 44.55% responded they got help from their academic faculty. Not many survey participants said they got help from the career or tutoring centers. This shows that many of the survey participants preferred to get help from people who were more closely aligned with their respective major. Survey participants also found male faculty to be especially supporting, with 61.82% saying that male faculty were supportive and encouraging, and only 18.18% saying female faculty were supportive. These responses could in part be due to the fact that there are less female faculty at this university, or probably because the male faculty are just generally more supportive here. But in general it was obvious that the faculty were overall very supportive of their students.

On the question pertaining to classmates' preconceptions based on gender, most students were neutral based on how their classmates perceived them. About 26.53% of the respondents answered slightly negative and most of these responses were most likely female students, based on the comments. One of these comments stated '*I think that some of the male students in engineering have negative preconceptions about female students studying engineering*'. This indicates that a slight negative preconception leans towards the females. When asked if faculty have negative preconceptions 59.18% of responses were neutral, with more students responded negative than positive on this question with 6.12% leaning towards strongly negative. This shows that the faculty treated the students equally based on their gender. However one particular comment on this topic stands out, '*Some professors appeared to be surprised when the female students answered questions, correctly*.' This still shows a little bias on their parts.

On the question which asked if the participants had been assigned challenging tasks on their projects, 51.02% slightly agreed, and 22.45% strongly agreed. Most of the participants felt like they were being challenged, which showed that no one was feeling themselves being assigned to un-challenging tasks. Comments on this section show that some participants always assigned themselves the most challenging tasks, and that all engineering projects are challenging and can be difficult and stressful. On the question probing whether the participant felt like they were acting mostly as scribe of the group, most responded either neutral or strongly disagree with 24.49% of the responses responding 'strongly agree', 22.45% 'slightly agree', and 18.37% 'strongly disagree'. Some of the comments for this section show that students prefer taking their own notes for themselves, even if they are not considered the scribe of the team. Most of the survey participants agreed to the statement '*I often act as the leader*' with 48% slightly agreeing, and 22% strongly agreeing to it, 22% responding neutral. This shows that either most of the participants were student leaders in their respective teams, or there was an even distribution of leadership/management responsibilities. One of the comments stated '*I lead when necessary*'

showing that this particular participant liked to lead, but would also let someone else take charge if that person would like to. These results show that most students, male or female prefer to lead the group over other roles.

The next set of questions focused on mentorship. 74% of participants said they did not receive any mentorship in STEM, but 56.82% found meeting with their faculty advisor beneficial. This shows that even students who do not have mentors find meeting with their advisors helpful. These statistics also show that the survey participants don't have mentors to guide them, so they rely on their other resources.

The next few questions focused on design/research projects, tying the survey into the University's unique projects, which all junior and senior students are required to complete. The first one focused on why students choose their particular project. The reasons for choosing a specific project were varied, showing every survey participant had their own reason for choosing their specific project. Most students choose their specific projects because they were interested in the topic. Other responses included friends, time, complexity, the advisor(s), and potential benefits. Questions in this set also targeted what skills these clinics have improved. The most popular responses were technical competence, teamwork with 22.10% each, then communication at 21.55%, professional skills at 18.78%, and leadership at 14.36%. These are all very close because clinics are designed to improve upon all these skills and students get experience improving all of them with their projects. Other questions in this set also targeted if students would recommend their project to peers, and most students would, showing interest and improvement of skills engineers need in their projects.

The next few questions focuses on the participants internships. 74% held an internship, and 77.5% felt that they were assigned meaningful tasks. This shows that internships the participants held benefitted them in giving them real life engineering skills.

The questions based on social life primarily focused on peer support. 78.43% of participants felt that their non-engineering friends supported them, despite the rigor that an engineering major has to face opposed to other college students. And 65.31% of participants had friends who were also engineering majors. This is due to the support that working with peers offer. As stated above, many participants rely on their peers for support. The University has many student run organizations, 50.68% of survey participants participated in their major specific clubs. 12.33% and 8.22% of students participated in Women in Engineering (WIE) and Society of Women Engineers (SWE) respectively. Considering the amount of female survey participants, this is a good number of participation in these organizations because the membership is primarily female. About 12.33% participated in other student organizations that are not engineering related, most of these being athletics or service-based organizations.

The next set of questions focused on why participants chose engineering. Most participants said that they had a STEM interest. But other responses were high, including expected salary, job security, problem solving interest, and aligns closest with future career goals. The lowest

responses were desire to help society and external influence. This shows that the participants have an overall interest in STEM but they all had other reasons also. On what made students chose engineering and their specific discipline, the appeal of job security, and a good salary upon graduation, as well as an overarching interest in STEM, problem solving, or the discipline specific topics, and even helping people were all responses to the online survey. Questions on whether the female students face discrimination, some of the comments were, "I think that some male students in engineering have negative preconceptions about female students studying engineering" and "I have been condescended to by ONE fellow student over the entire four years I spent studying engineering. No one else has treated me any differently, and I appreciate that."

Interview responses

Seventeen interviews of female students picked from the survey data were conducted to help support the survey data. The highlights have been presented in Appendix D. From the interview data, a few key themes were picked out to affect women's recruitment and retention in engineering. The selected themes mirror a lot of the findings of the survey data. These include family, peers and group work, mentorship, relevant coursework, career goals, internships and research, pre-college engineering, and professors and other university staff. The candidates who were interviewed had family members in engineering, or relied on their families for support. Three of the candidates had older siblings in engineering, which helped them decide on their specific major, and acted as someone to talk to when classes and life got tough. A few of the interviewees did not have family members in engineering, but their families were their main support system. And some of the candidates had family members who are in engineering or STEM, who pushed them towards it.

Most, if not all of the interviewees had something to say about their peer support system and group work, in both a positive and negative way. Most interviewees rely on their friends for support. Most of the interviewees had friends in their major who motivated them to do well and help with tough assignments. One interviewee said that when her friends were doing well, she feels even more motivated to do well. Group work was talked about in both a positive and negative light. A lot of interview participants said they enjoyed working in groups and have had fairly positive experiences that is if their group mates work hard. Some were not a big fan of it because they have had difficult group mates who did not get their work done, or were forced into the same role every time when they would have liked to experience a different role where they could learn more. On the note of unresponsive group members, most of the interviewees with this experience said they picked up the slack for that groupmate and learned more in the process. In terms of group roles, some of the candidates said they were usually the leader, but some said they get lost in the shuffle or they will only lead if no one else steps up. Overall, peers and friends provided a good support system, and group work is a necessary thing to succeed in both engineering and a support system.

Mentorship was also something that was talked about in the interviews. With the survey data, the percent of students with mentors was only 20%. Three of the interviewees talked about mentorship, and all three of them were given these mentors in their internship programs. Their mentors ranged from being someone to bounce ideas off of and help with projects they were working on, to being sexually harassed. On a lighter note, one interviewee had an older friend when she was an underclassman who acted like a mentor, and helped her adjust to college and be there for any kind of support. She said that it was a different, more casual approach to mentorship really helped with her adjustment to being an engineering major in college.

Relevant coursework was another theme that was common among the interviewees. Most of them had an interest in their classes, or were working towards their degree for a specific career goal. And 4 of them said that they loved STEM, but the other engineering disciplines did not make sense. Over half of the participants said they loved math and science or they were good at it. An interesting trend was that most of the freshmen who were interviewed said they were very excited about the projects the upperclassmen were doing and would like to do those projects. On another note, the candidates who were unhappy with their coursework said they liked other non-engineering related things better, the content is not what they were expecting, or they spent too much time on classwork.

One thing that was found to be a motivator for some of the interview candidates was their future career goals. These candidates had a particular career field in mind for after graduation. They were excited to learn skills to help them achieve them. There was one candidate in particular who did not want to continue in her discipline, but decided she spent too much time on her degree and wanted to impress future employers with her degree. Some of the interviewees were also interested in the salaries and job security that comes with their chosen major.

Another topic that was discussed was internships and research. Only some of the interview candidates have had internships, but this is because the interviewees were from all years of study, and the underclassmen have not had internship experience. Most of the students with internships have had positive experiences and felt their work was meaningful and appreciated, which correlates to the survey where about 80% of those had meaningful experiences. Those with positive experiences were doing stuff in their chosen fields. But some said their work was just doing background research for others who did the “real engineering” and were disappointed. Based on the interviews and surveys, those with internships who had the opportunity working hands on in their desired field, were the happiest.

When interviewing younger students, the conversation was geared towards some of their high school and pre-college experiences. One candidate said she did a camp in middle school and it sparked her interest in engineering because of how hands on it was. Another was in a special high school program for engineering and this helped her pick her exact discipline. She also said that she loved her current courses and could not wait to delve into more major specific courses and work on the projects the upperclassmen do. Some of the candidates also said that they had no

prior exposure to engineering because their school did not offer it and went into it because of their interests or it was “what the smart kids did”. Pairing these responses with the survey responses makes sense because only about 40% of participants had pre-college engineering experience. Pre-exposure helps make the transition easier and gets students more excited about their chosen fields, but it is not necessary to be successful.

Another trend that was noticed was professors and other staff providing or lacking support for the interview candidates. Some of the candidates felt they could go to their professors for advice, that they were particularly encouraging, or that they could go to them for needed support. Some of the other candidates felt that their professors either ignored them for being female, or did not know how to act with a female student in the class. Compared to the survey data about faculty preconceptions about them, most of the survey participants were neutral on this matter.

Conclusions

Overall the surveys and the interviews displayed similar trends with the responses and the comments into what recruit and retain women. The main factors show to be family, friends, mentorship, coursework, career goals, internships/research, pre college engineering, and professors/staff. Since the interviews are still ongoing a well-established conclusion cannot be drawn at this point of time. Once the interviews are completed and all data is processed we would be able to discuss a presentable conclusion. We are sure that the interviews will be completed within the next 1 month. The survey and interview data contributes to the themes.

For the theme of family, some participants had family members (parent/older siblings) in engineering that influenced them, others used their family’s as their main support system those with older siblings in engineering relied on them for a lot of support For the theme of peers and group work, friends make the participants want to work harder because their friends motivate them but some participants bad experiences where teammates did not contribute their share, or participant is pigeonholed into the same role. For the theme of mentorship, it was closely related to the theme of internships, where most students who had mentors got them with their internship or had a close friend who acted as a mentor. For the theme of coursework, most if not all participants had a love of math and science or were good at it and like the hands-on projects offered by university, but some participants thought the classes were a little hard or too long. For the theme of career goals, most participants picked their major because it aligned with their career goals, but some were not sure what they wanted to do but wanted a lot of options provided by engineering. For the theme of internships, there was very mixed intern experiences, a lot of interviewees had good experiences where they got hands on experience, but it was limited, and some participants felt that they were pigeonholed into a certain role. For the theme of pre-college engineering, younger students were excited to get in to engineering but most didn’t have too many engineering experiences, but some participants took part in pre-college engineering where they learned helpful skills and an expanded interest in engineering. For the theme of professors

and staff, most participants had good experiences with professors and staff and felt encouraged, but some felt ignored or that their professors did not know how to treat female students

Because women's recruitment and retention is an ongoing struggle, there is still more to be done on this project. More progress can be made by doing more interviews and getting a wider representative of the female students in engineering, as well as being able to use these results to compare the factors among year of study. Also, asking the same question set to a few male students to see how their answers differ from their female counterparts to see if these factors are exclusive to women, or if men benefit from the same factors. Something else that can be done is follow up interviews with the younger candidates when they get to their higher level classes in a year or two, to see what has changed and what has stayed the same. Due to the low number of women in engineering, ongoing research in recruitment and retention is a must to ensure that the number of women in engineering rises.

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APPENDIX A: Survey Questions

Background data (team demographics)

1. What is your Gender
   a. Female b. Male c. Other
2. What is your year of study: 1, 2, 3, 4, 4+
3. What is your Major: BME, CE, ChE, ECE, ME, Entrepreneurship

Family support or family background in engineering

4. Do you have any family or friends in a STEM field prior to choosing an Engineering major?
   a. Immediate Family member
   b. Extended family member
   c. Friend/acquaintance
   d. none
5. Does your family support your interest in engineering?
   a. Yes
   b. No
   c. Optional Comment:
6. Did you have prior engineering experience before coming to this University?
   a. Yes b. No

Attitudes about engineering, Campus climate indicators, Support resources in Engineering,

7. Do you feel you have received support from any of the following groups? (select all that apply)
   a. Clubs/Peers
   b. Professors/Academic Advisors
   c. Career center, peer tutoring
8. Have there been any particular faculty who encouraged you or were personally supportive of you?
   a. Yes, female faculty
   b. Yes, male faculty
   c. No

Experiences inside and outside of classroom

These next questions answer Strongly Positive, Slightly Positive, Neutral, Slightly Negative, Strongly Negative, and included an optional comment.

9. Do you feel that classmates have preconceptions, positive or negative, about you based on your gender?
10. Do you feel that faculty have preconceptions, positive or negative, about you based on your gender?
11. When working in groups do you feel you've been assigned challenging tasks?
12. When working in groups, do you feel that you often act as the "scribe"?
13. When working in groups, do you feel that you often act as the "leader"?

Help from college faculty member, advisor, teaching assistant

14. Do you receive mentorship in STEM?
    a. Yes b. no
15. Does meeting with your faculty advisor benefit you?
    a. Yes b. No c. N/A

Clinic assignments

16. List your top 3 reasons for choosing your clinic project (select 3 that apply)
    a. Time
    b. Friend(s)
    c. Interest
    d. Complexity
    e. Advisor(s)
    f. Potential benefits (publications, conferences, business contacts, internship opportunity)
    g. Other: Comment

Competition experienced, Interest level in subject matter

17. Has your clinic experience improved any of the following?
    a. Professional skills
        i. Yes
        ii. No
    b. Technical competence
        i. Yes
        ii. No
    c. Teamwork
        i. Yes
        ii. No
    d. Communication
        i. Yes
        ii. No
    e. Leadership
        i. Yes
        ii. No
18. Would you recommend your clinic project to a peer?
    a. Yes
    b. No
    c. Why?

Any prior internship, field trips or research experience and how did it help

19. Have you had an engineering internship previously?
    a. Yes
    b. no
20. Do you feel you were assigned meaningful tasks? - Explain
    a. Yes
    b. No
    c. Optional comment

Attitude of peers, Spouse/partner

21. Do you feel that your non-engineering peers support you?
    a. Yes
    b. No
    c. Optional comment
22. Are most of your friends engineers or non-engineers?
    a. More engineers
    b. More non-engineers
    c. An even mix of both

Involvement in social events, engineering societies, club activities

23. Are you involved in any of the following clubs?
    a. Engineering Discipline specific (IEEE, AIChE, ASME, ASCE, BMES, etc.)
    b. WIE
    c. SWE
    d. Engineers without borders (EWB)
    e. Other non-engineering clubs
    f. Other:____

Recruitment

24. Why did you choose to be an engineer? (select all that apply)
    a. Expected salary
    b. Job security
    c. STEM interest
    d. External influence- family/friends/teachers
    e. Problem solving interests
    f. Aligns most closely with desired future career goals
    g. Desire to help society
    h. Optional comment:
25. Before college, did you participate in any extra/co-curricular activities promoting engineering?
    a. Yes
    b. No
    c. Optional Comment
26. List your top three reasons why did you choose your engineering discipline? ; 50 Character Short answer

Audio Interview

27. Are you willing to participate in an audio interview?
    a. Yes
    b. No

APPENDIX B: Interview Questions

28. What is your year of study and Major?
29. What factors caused you to choose engineering?
30. What factors keep you in engineering?
31. Why did you choose your specific major?
32. Have you had any internship or participated in research? What were your experiences?
33. Do you feel working in groups is effective for your learning?
34. Are you still happy with your engineering major? Why or why not?
35. Do you have a support system? If so, describe it.

APPENDIX C: Figures

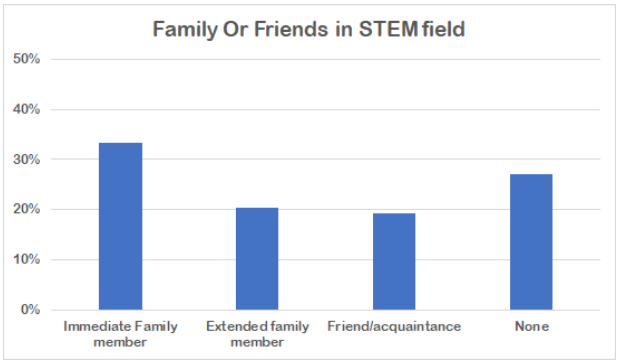

Figure 1: Students with family in STEM

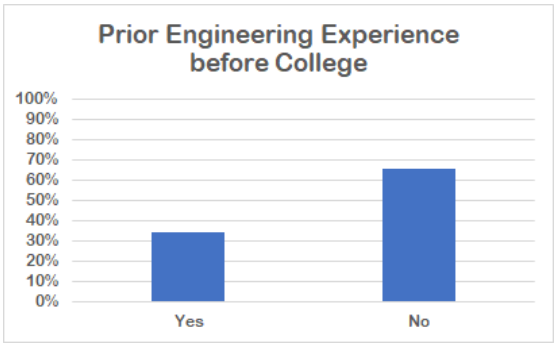

Figure 2: Students with Pre-College Engineering

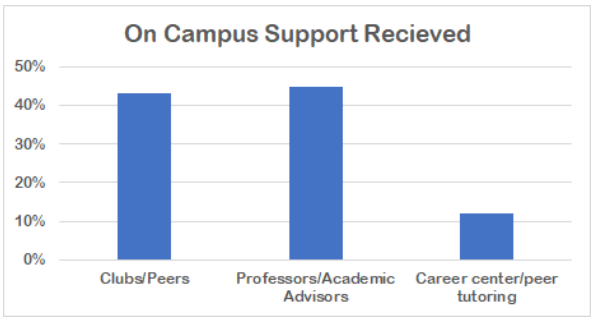

Figure 3: Where Students received on campus support

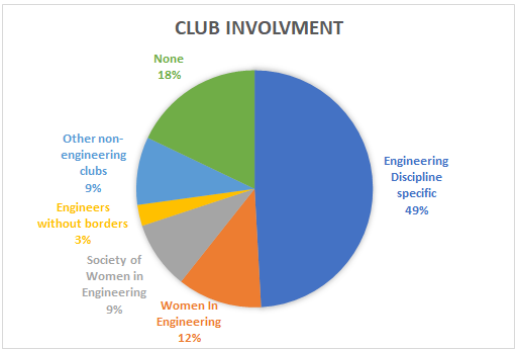

Figure 4: What Clubs Students are involved in

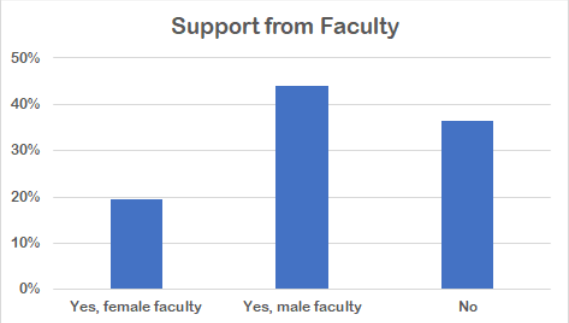

Figure 5: What Faculty support students

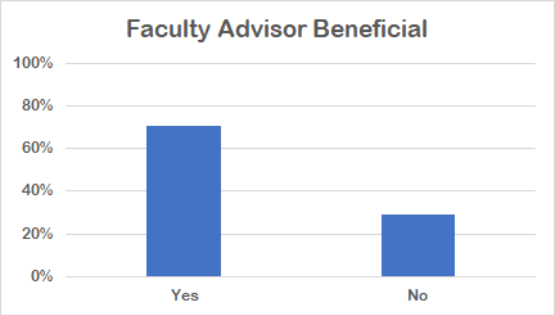

Figure 6: Percent of Students who find meeting with their Faculty advisor beneficial

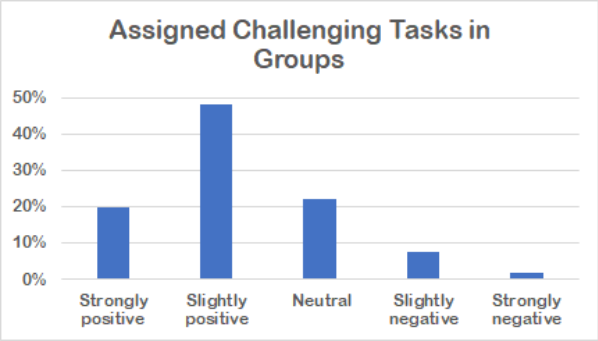

Figure 7: How Students Perceived group tasks

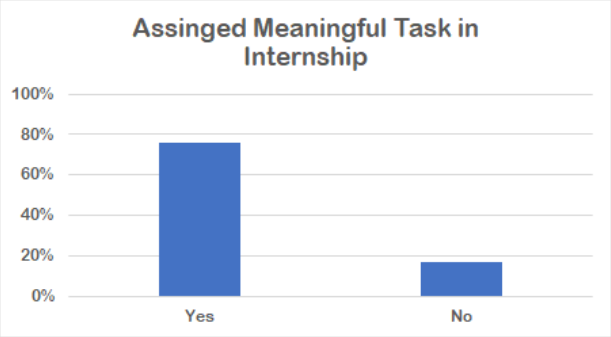

Figure 8: Percent of Students with Internships who were assigned meaningful tasks

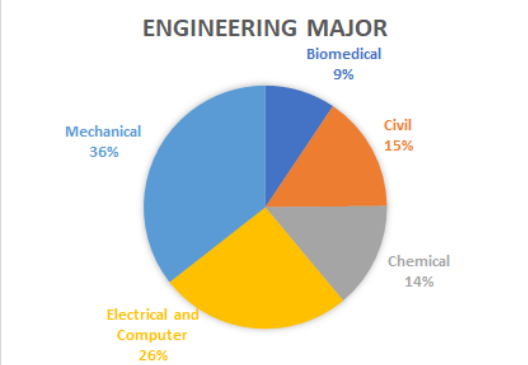

Figure 9: Major Distribution of Students who took the survey

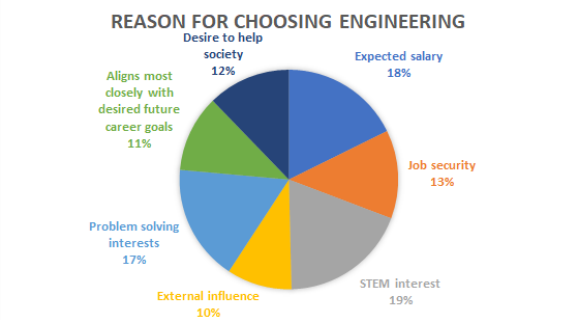

Figure 10: Students reasons for choosing engineering

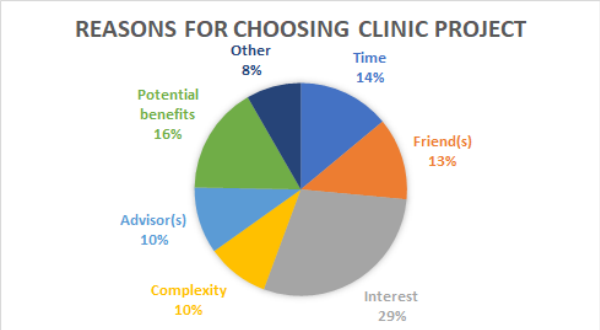

Figure 11: Students Reasons for Choosing Clinic Projects

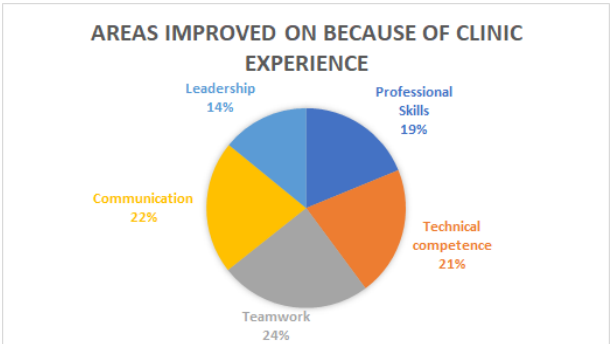

Figure 12: Skills improved because of clinic projects

APPENDIX D: Interview Data

SL No	What factors caused you to choose engineering?	What factors keep you in engineering?	Why did you choose your specific major?	Internship experiences if any	Experience working in groups	Comments about support system?
1	Liked math and sciences Bothers are engineers	Hands on projects Feels like a good fit	Involved in an automotive program Older brother Mechanical Engineer	Research assistant with Vehicle Safety Worked at Optics Company past two summers, doing a lot of Solid Works – did redesign on product	Yes, if group works well Really found group this year (senior)	Within class, definitely the group does project with. Roommates – one engineer two not
2	Watched Myth Busters, making things with hands like crafts. Good at Math and Sciences. Hated other subjects wanted to do something good at academically along with skills	Contemplating changing major, but met a good group of engineers. Support from peers and being surrounding by people who are passionate about it.	Mechanical Engineering seemed like best way to apply being crafty. Get into special effects engineering, like prop building, so seemed like most applicable	Internship in architecture firm, first half doing normal intern stuff, second half building models in makerspace with 3D printing and foam cutters. Did some CAD. Product Development.	Group work is effective for learning, skills slacked in was picked up and was able to contribute in other skills. But, allows to avoid things so not well rounded.	Was a shut in, got involved with honors and hanging out with engineers. Met close friends in summer class. They are motivated, makes other want to be successful. Helps each other grow
3	Likes to build things	Building things + hands on projects offered at University	An engineering class in high school	1. Civil internship with a construction company2. coding camp-built robots. But wasn't what she wants to do	Learn a lot by talking to other people	Friends show up to events presenting at/cheer on. They motivate when self-doubt.
4	Suggested by sister because liked building things	Has a really good time. Mech Design class solidified path	Broadest major. Likes moving things and gears	Last summer and will be returning this summer. Only one girl out of 15 total people.	Group work is good to learn subjects that they do not know and help out friends and work together.	Friends and family. Text family things they are doing and they support them
5	Combine Math and Science	Interesting coursework, the feeling of getting to closer to where they want to be. Choose elective that are interesting and relevant	Interested in aerospace, picked Mechanical because it broad ECE minor, opens different options. Liked working with electronics and soldering	Two summer experiences. With defense contractor, mainly code verification software work. More computer science than engineering Intern for NASA. A lot of 3D printing, prototyping, hands on mechanical work	Can't do study group but projects its nice. Groups are a good first resource to go to if you have problems	Family is definitely one. Can talk to brother because he went through engineering in same school. Parents are supportive. Friends, solid group of girlfriends, Take same classes, talk about coursework, study in same room but not work together. Also good moral support SWE and WIE

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