The Effect of Ego Network Structure on Self-efficacy in Engineering Students

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Abstract

Engineering students' self-efficacy—a self-judgment of capability in a given field—is an accepted predictor of college success. Many factors affecting self-efficacy have been identified in previous research, such as positive performance in classes, practical experiences, and access to mentors. Previous studies have also found that many of these factors are, in turn, affected by aspects of students' social circles, namely homophily and social capital. Students with more homophilous networks (that is, networks with greater similarity between the student and the people in their network) tend to demonstrate higher in-class performance and may feel a greater sense of belonging in engineering as a whole. Homophily most typically explores similarities in gender and/or race: non-male and non-white engineering students see people similar to themselves less frequently and therefore have more to gain by making social connections with people of the same gender and/or race. Social capital also plays a vital role in friendships and education, affecting social outcomes and academic achievement, including improved grades, test scores, and overall performance. Social capital is a measure of the resources a student has access to within their social network. For example, a student who has friends performing higher than themselves or friends further along in their engineering education can leverage these friendships as resources while studying for exams or working on a final project.

This study aims to draw a direct connection between students' social lives and their engineering self-efficacy by answering the following research questions: 1) *What is the relationship between homophily and self-efficacy in engineering students?* and 2) *How does the number and quality of friendships of an engineering student relate to their self-efficacy?* A survey was distributed to engineering students at a mid-sized, MidAtlantic University that included Marra's 2005 self-efficacy instrument and also asked about participants' quality and quantity of friendships with fellow engineering students. The survey found that the number of studying friends yielded the highest self-efficacy scores among engineering students, while factors such as GPA, gender, and major homophily had little to no effect on engineering self-efficacy.

Introduction

Engineering is a complex and challenging field of study with an overall attrition rate of approximately 30-50% [1]. As engineering education grows and changes, significant efforts are put towards predicting student retention and supporting those who are considered more likely to leave the field [2]. One such method for predicting retention is engineering self-efficacy: a student's belief in their ability to complete engineering-related tasks, including degree attainment. Students with greater self-efficacy are generally more likely to persist in engineering [3]. Many factors impacting engineering self-efficacy have been identified, largely falling into

three major categories: skills and achievements (getting good grades, understanding the material, mastering fundamentals, etc.), interest and enjoyment in the content, and social support [4].

The complexities of social factors and their effects on self-efficacy remain understudied. While there is evidence that working in teams can increase self-efficacy [5], students' friend groups outside of class and how they spend time with these friends may also affect engineering self-efficacy. This work leverages two concepts from social network analysis to begin exploring these factors: social capital and homophily.

Social capital is defined as "the ability of actors to secure benefits under membership in social networks or other social structures" [6]. For instance, a student with many high-performing friends can leverage these friends as resources when studying, meaning they have access to knowledge/intellectual capital through their social network [7]. A student may access any number of resources through their network: social (knowing people who are "well-connected"), intellectual (academic knowledge and support), or even emotional ("shoulder to cry on").

Homophily is defined as the observed tendency of "birds of a feather flocking together," meaning that those who are similar are likely to connect [8]. For example, same-gendered students are more likely to become friends with each other [9], and female students in these same-gendered groups tend to have higher average GPAs than those in mixed-gender student groups [10]. This suggests that high homophily—the similarity among members of a network—may be an important component of self-efficacy. If one is surrounded by those who are similar/relatable to them, their likelihood of success (and by extension self-efficacy) regarding engineering studies will be higher than someone who is not surrounded by similar people. To explore the relationship between engineering students' self-efficacy and the characteristics of their social networks, we answer the following research questions: *(1) How do the quantity and quality of friends relate to engineering students' self-efficacy?, and (2) What is the relationship between homophily and self-efficacy in engineering students?*

Background

Self-efficacy is defined as "a person's belief in his or her capability to successfully perform a particular task" [11]. Unlike self-confidence, self-efficacy is specific to particular abilities. For instance, a person might have high self-efficacy in mathematics but low self-efficacy in public speaking. The level of self-efficacy for a specific task influences motivation and effort invested in performing that task [12]-[13]. Success in academics tends to boost self-efficacy, as observed in the case of engineering students who, with a strong belief in their problem-solving abilities, are more likely to graduate [14].

The impact of self-efficacy extends beyond individual achievement. Social connections enhance an individual's self-efficacy in academic communities by contributing to a collective strength—students with more social connections gain and give more academic support to a broader network [15]. This link between self-efficacy and social networks naturally leads to the exploration of "homophily," the tendency for people to connect with those who share similar characteristics and beliefs. Individuals also tend to reshape their social networks to align with the traits prevalent in their new environment [16]. For example, students who are interested in computer science may connect and socialize through this common interest. Additionally, there may be demographic homophily among engineering students, where shared characteristics such as race/ethnicity or gender lay the groundwork for communication and trust [17].

Social capital is the benefit a student gets from their social network. Social capital plays an important role in education because a student's social relationships and networks can significantly impact their educational achievement. For example, having friends to study with can lead to success in school, resulting in improved grades, test scores, and overall academic performance [18]. Social capital is crucial for engineering students because it not only enhances their educational experience but also provides a foundation for personal and professional growth in the engineering field [19]. Studying with friends fosters a collaborative learning environment that goes beyond individual academic efforts. When students engage in joint study sessions, they share insights, exchange knowledge, and collectively tackle academic challenges. This collaborative approach not only enhances the understanding of academic material but also establishes a network of mutual support.

Methods

We designed a survey to understand engineering students' quantity and quality of friendships with other engineering students. The survey was created on Qualtrics (See Appendix for full survey instrument). We received 37 complete responses from the pool of approximately 1000 engineering students, which is about 3.7% of the students within the engineering program.

The first section of our survey consists of 7 basic demographic questions including age, race, gender, class year, and transfer status. The next section of the survey included a validated self-efficacy instrument for engineering students. There are 30 of these questions and they correspond to a self-efficacy instrument designed by The Assessing Women and Men in Engineering Project (AWE) in partnership with the Society of Women Engineers [20]**.** Questions revolve around a student's academic confidence level, the grades they have received, and their feelings of social inclusion. The answers for the questions use a Likert scale with an extra option for "Don't Know". The survey was scored on a scale of 0-6. A score of 0 indicates all "Strongly Disagree", and a score of 6 indicates all "Strongly Agree". The final section of the survey asked students to provide a list of their 10 closest friends in the field of Engineering at a mid-sized

Mid-Atlantic University (using nicknames or initials to keep the survey anonymous). This question also asks for the friends' gender, if they are the same race/ethnicity as the student completing this survey, and how the student interacts with the listed friend (Studying/Group Work, Extracurriculars, Coworkers, Friends outside of class, or Other), and how the listed friends interacted with each other (if at all). This data was used to determine the relationship between homophily, the number and quality of friendships, and engineering students' self-efficacy. Data analysis was conducted in Excel, Cytoscape (a software for visualizing and analyzing social networks), and IBM SPSS. Despite a small sample size, we were able to find some statistically significant relationships within our data.

Results and Discussion

We collected 37 complete responses from a pool of approximately 1000 students. This low response rate is likely due to the length and content of the survey (the self-efficacy instrument might be unfamiliar to engineering students, and social network elicitation questions can be lengthy/repetitive). The demographic details and self-efficacy scores are shown in Table 1.

Table 1: Demographic details and self-efficacy scores. For gender, M = male, F = female, NB = nonbinary, N/A = participant did not answer. For major: ECE = Electrical and Computer Engineering, ME = Mechanical Engineering, ChE = Chemical Engineering, BME = Biomedical Engineering, and EShip = Engineering Entrepreneurship.

ID	GPA	Gender (ego)	Major (ego)	# Study Buddies	# Friends	Feelings of Inclusion (0-6)	Self-Efficacy (0-6)
Silkworm	3.49 - 3	M	ECE	1	5	4.33	3.13
Owl	< 2	F	ME	1	1	3.00	3.57
Toucan	4.0 - 3.5	M	ME	5	5	4.00	4.03
Kingfisher	3.49 - 3	M	ECE	0	4	4.67	4.07
Moth	2.99 - 2.5	F	CEE	3	10	4.33	4.13
Afton	2.99 - 2.5	M	ExEEd	4	6	4.33	4.13
Heron	4.0 - 3.5	F	ME	1	6	4.33	4.13
Duck	3.49 - 3	F	ExEEd	2	6	5.00	4.17
Vulture	3.49 - 3	M	ME	3	3	2.33	4.17
Bugs Bunny	4.0 - 3.5	F	ME	5	7	4.00	4.2
Pheasant	4.0 - 3.5	F	ME	3	6	3.67	4.3
Flamingo	4.0 - 3.5	M	ECE	0	3	5.00	4.3
Beetle	3.49 - 3	F	BME	2	4	2.33	4.4

Goose	4.0 - 3.5	M	BME	2	2	3.00	4.4
Mosquito	3.49 - 3	F	CEE	1	1	3.67	4.56
Brown Recluse	3.49 - 3	F	ME	7	9	4.00	4.6
Man-O-War	4.0 - 3.5	F	ECE	3	3	5.00	4.73
Kiwi	4.0 - 3.5	F	ECE	5	5	5.00	4.76
Squish-Squash	4.0 - 3.5	NB	BME	1	2	4.00	4.76
Harrier	2.99 - 2.5	M	ME	6	10	5.00	4.83
Housefly	4.0 - 3.5	M	ME	9	10	4.00	4.86
Chicken	4.0 - 3.5	M	ME	6	8	5.00	4.86
Kite	4.0 - 3.5	F	ME	3	10	5.00	4.9
Centipede	4.0 - 3.5	M	ME	1	10	4.67	4.93
Swan	4.0 - 3.5	M	ME	6	10	4.67	5.03
Fire ant	4.0 - 3.5	M	BME	1	10	2.67	5.03
Honeybee	4.0 - 3.5	M	ECE	8	8	5.67	5.1
Pelican	4.0 - 3.5	M	ME	8	10	5.00	5.13
Buzzard	4.0 - 3.5	M	ECE	5	10	5.33	5.2
Exotic Butters	4.0 - 3.5	M	ME	3	5	4.67	5.2
Big Money	4.0 - 3.5	M	CEE	8	8	5.00	5.23
Butterfly	4.0 - 3.5	M	ME	5	6	4.00	5.33
Silverfish	4.0 - 3.5	F	ME	5	6	5.67	5.46
Grasshopper	4.0 - 3.5	M	ME	5	6	5.33	5.46
Costco Hotdog	4.0 - 3.5	M	ME	1	6	5.67	5.53
Ladybug	4.0 - 3.5	M	ME	4	8	5.33	5.63
Big Bird	4.0 - 3.5	F	ECE	9	10	5.67	5.76

RQ1: How do the quantity and quality of friends relate to engineering students' self-efficacy?

A Pearson's r correlation analysis was conducted to evaluate the strength and direction of the relationship between self-efficacy and the number of study buddies. The normality of the continuous variables was checked and found to be within range. There was a statistically significant relationship between self-efficacy and number of study buddies, $r = 0.50$, 95% Bootstrap CI [0.24, 0.70], $p = 0.001$, $n = 37$. The effect size for this analysis was $r^2 = 0.25$, 95% Bootstrap CI [0.06, 0.49], indicating that 25% of the variance between self-efficacy and the number of study buddies is shared in this data. This is a medium effect size, and replications are likely to find a similar effect. Post hoc power analysis suggests that the test was adequately

powered (1-β = 0.90). This result suggests that as the number of study buddies increases the self-efficacy score also rises (Figure 1).

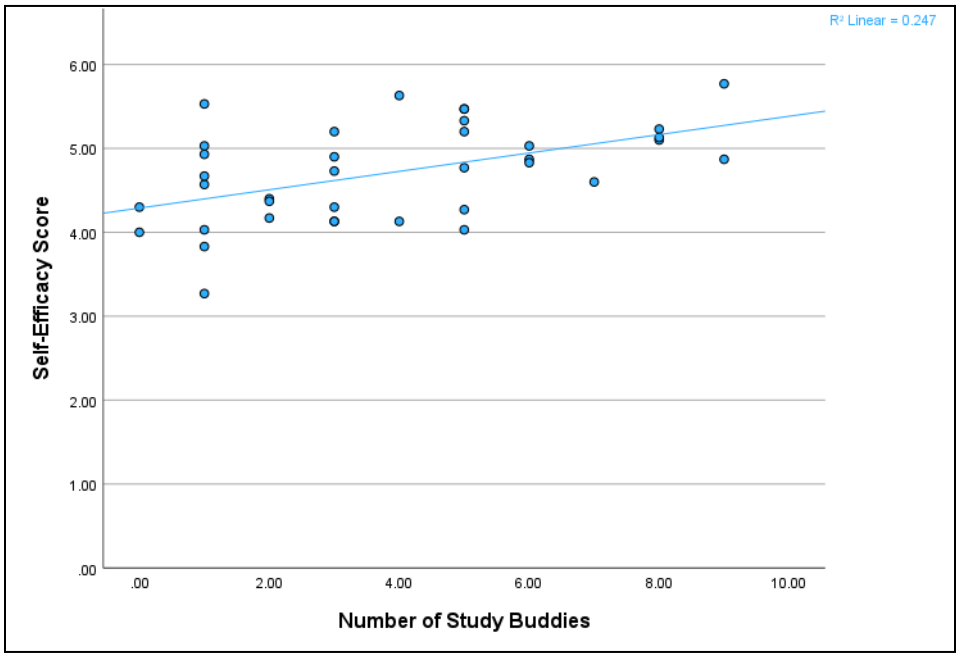

Figure 1: Scatter plot of Self-efficacy by Number of Study Buddies

Participant Big Bird had the highest self-efficacy score (5.77) and nine study buddies (Figure 2). On the other hand, participant Silkworm had the lowest self-efficacy score (3.14) and had one study friend. Participants with more study buddies typically had a 4.0-3.5 GPA with an interesting exception in Harrier who had six study buddies and a 2.99-2.5 GPA. This student also had a higher self-efficacy score than average (4.13). This implies that more study buddies generally increase self-efficacy, while GPA is not as dramatically affected.

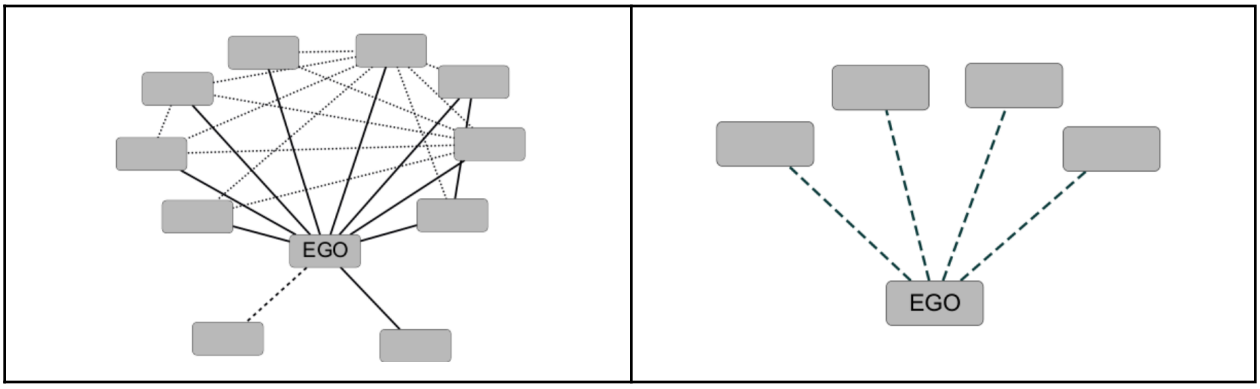

Figure 2: Big Bird (left, SE=5.77) and Kingfisher (right, SE=4.07) Ego Networks. Line type indicates the type of friendship (solid = study buddies, dashed = friends but not study buddies, dotted = friends but study relationship is unknown).

The relationship between the number of study buddies and self-efficacy is likely significant because having a network of study buddies can provide mutual support. Previous research has found that "social support from peers will make individuals more resilient in dealing with problems and foster academic self-confidence" [21]. This suggests that individuals feel supported and encouraged by their study buddies, leading to a belief in their academic abilities. Furthermore, interacting with study buddies can facilitate constructive criticism and feedback. Interactions with colleagues around teaching and learning, including conversations about instruction, peer observation and feedback, and advice seeking about instruction, illustrate that collaborative interactions with study buddies can increase an individual's belief in their ability to succeed in the classroom [22]. Finally, the support of study buddies in study groups can help alleviate anxiety. Previous research has found that friendships often help anxious students build resilience and improve their emotional well-being [23]. Overall, it would appear that engaging in study groups with friends provides mutual support, and a sense of belonging, and alleviates anxiety associated with studying, which can positively influence self-efficacy in the individual.

Additionally, a Pearson's r correlation analysis was conducted to evaluate the strength and direction of the relationship between the Number of Friends and the inclusion subscale score. The normality of the continuous variables was checked and found to be within range. There was a statistically significant relationship between the Number of Friends and the inclusion subscale score, $r = 0.40$, 95% Bootstrap CI [0.04, 0.64], $p = 0.01$, $n = 37$. The effect size for this analysis was $r^2 = 0.16$, 95% Bootstrap CI [0.00, 0.41], indicating that 16% of the variance between the Number of Friends and the inclusion subscale score is shared in this data. This is a very low correlation, and replications are likely to find a similar effect. Post hoc power analysis suggests that the test was adequately powered ($1-\beta = 0.70$). This result suggests that as the number of friends increases the student's feeling of inclusion score also increases (Figure 3).

The more friends a person has, the greater the likelihood of feeling included, as a broad network of friends often leads to a stronger sense of inclusion. This is because friends offer different experiences and support. Each friend adds a unique connection, creating a sense of belonging. Furthermore, studies have indicated that individuals with larger friendship networks experience increased opportunities for social engagement and support, leading to a greater sense of belonging and inclusion [24]. Moreover, as evidenced in an article on social interaction and friendship networks, frequent interaction contributes to a sense of acceptance and belonging, while occasional interaction still plays a vital role in broadening social circles and providing diverse support systems [25]. With more friends, there are more opportunities for shared activities and conversations, which can foster a sense of acceptance. When people have a larger social network, they are more likely to encounter individuals with similar interests and values, reducing feelings of isolation. Diverse friendship networks not only enhance a sense of inclusion but also promote flexibility and creativity, as exposure to different perspectives and backgrounds encourages individuals to think more broadly and innovatively [26]. In conclusion, having

multiple friends provides access to different social circles, which can lead to connections in various communities. In conclusion, the more friends one has, the greater the sense of inclusion, as each friendship enriches life with empathy and a sense of belonging.

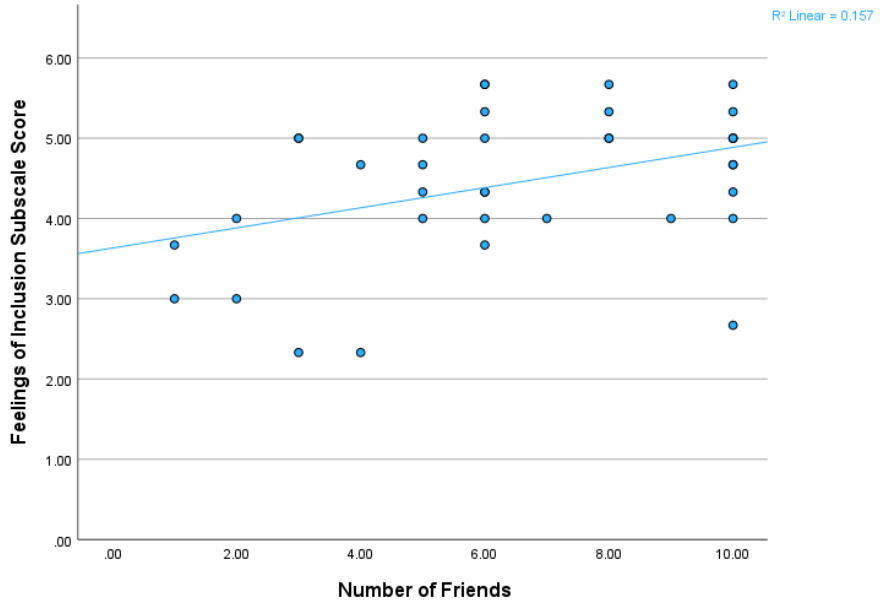

Figure 3: Scatter plot of Feelings of Inclusion Subscale Score by Number of Friends

RQ2: What is the relationship between homophily and self-efficacy in engineering students?

When we compared the self-efficacy levels of students to the gender homophily among their friends, we found students with mostly same-gendered friends yielded slightly higher self-efficacy scores on average. However, those students who only had friends of the same gender (100% gender homophily) tended to have lower self-efficacy scores, with there being only one exception to this finding in the results. While there was not enough data gathered to draw a statistical connection between gender homophily and self-efficacy, those with a higher self-efficacy (upper quartile, >5.165) averaged 0.67 gender homophily, and those with lower self-efficacy (lower quartile, <4.220) averaged 0.81 gender homophily.

Male students tended to have higher gender homophily, likely due to the fact there are more male engineering students than females at the target institution [27], although this trend has also been found to be a latent preference for male university students [28]. All cases of complete gender homophily in the dataset were males. Female engineering students with high gender homophily tended to have smaller friend groups overall (3-5, compared to 6-8 in lower homophily groups). There were also negative trends when it came to gender homophily (as a percentage) and self-efficacy for both the male and female engineering students, however, there were positive trends when comparing the number of same-gender friends and self-efficacy. Having more engineering friends of the same gender seemed to benefit male students more than female

students, though this may be due to the limited pool of possible female students within engineering majors. Although there were multiple attempts at comparing gender homophily and self-efficacy, there was not enough data and too many confounding factors to come to a solid conclusion of how gender homophily is related to self-efficacy.

There appears to be a nonlinear relationship between major homophily and self-efficacy in our data. The trend that we observed was that students who had a major homophily greater than 0%, but less than 100%, tended to do better than those with either 0 or 100% major homophily [26]. However, due to the small sample size, we were unable to define this relationship statistically. The relationship, if it exists, suggests that students who have friends from multiple different fields of engineering including their field may be more likely to have higher self-efficacy than those students with only friends from different engineering fields or only friends from the same engineering field as themselves. However, it is also possible that engineering students are experiencing induced major homophily—becoming friends with those physically near them who happen to share similar traits (in this case, major), and not seeking connections beyond this environment [29]-[30].

Limitations and Future Work

This work could be expanded by gathering more details regarding students collaborative study habits: the number of friends different students study with, how often they study with each friend per week, how often they study alone, where they study with friends, where they study when they are alone, if they studied with groups or one-on-one, how students communicate with study buddies, etc. These questions could help build more complete social networks for study groups. This data could also be enriched via interviews with students to gain a better understanding of their relationships with their friends and the qualities of their social circle. Additionally, offering compensation to participants may yield a larger sample size.

Conclusion

This study aimed to explore the relationship between engineering students' self-efficacy and various social factors, including homophily and social capital. The findings revealed a statistically significant correlation between the number of “study buddies” a student had and their self-efficacy. This implies that a larger network of study buddies contributes to an increase in self-efficacy. We also found that there was a statistically significant correlation between the number of friends and a student’s feeling of inclusion. So, as a student’s number of friends increased, they had an increased feeling of being included within the engineering program. These results suggest that engineering students should strive to make as many friends within the engineering program as possible and study with as many of those friends as possible.

Gender and major homophily were not linearly related to self-efficacy. However, the data suggests a “sweet spot” between 0% homophily and 100% homophily for both genders and majors, but this is difficult to confirm with a small sample size. Additionally, gender homophily likely has a different impact on male students’ versus non-male students’ self-efficacy, given that non-male students are a minority group in engineering.

The importance of social connections in shaping students' academic beliefs, along with the roles of study buddies and social capital, are significant factors in enhancing self-efficacy. This work’s preliminary findings contribute to a deeper understanding of the social dynamics influencing engineering students' perceptions and performance in academics.

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Appendix - Survey Instrument

Q1 Informed Consent

You are invited to participate in this online research survey entitled Engineering Quality of Friends and Self-Efficacy. You are included in this survey because you are a current student of engineering at X University.

The survey will take approximately 5-10 minutes to complete. Your participation is voluntary. If you do not wish to participate in this survey, do not respond to this online survey. Completing this survey indicates that you are voluntarily giving consent to participate in the survey.

The purpose of this research study is to analyze engineering student relationships between homophily and self-efficacy in marginalized students. This study also intends to analyze the number of quality friendships and how it relates to self-efficacy in engineering students as a whole.

Your response will be kept confidential. We will store the data in a secure computer file and the file will be destroyed once the data has been published. Any part of the research that is published as part of this study will not include your individual information. If you have any questions about the survey, you can contact the PI, <Redacted for Peer Review>. **You do not have to give your personal identification.** The Principal Investigator and the research team are being paid to conduct this study according to a budget that will cover the costs of the study. The costs that are covered include faculty salary support, curriculum development materials, travel and publication fees.

If you have any questions about your rights as a research subject, please contact the Office of Research Compliance. This study has been approved by the X University IRB, PRO-2023-358.

To participate in this survey, you must be 18 years or older AND you must be a current engineering student in the X University College of Engineering.

Please complete the checkboxes below.

Q2 Please select either both "I agree" and "I consent" or only the third option.

[] I agree that I am 18 years old or older and I am currently enrolled at X University as an undergraduate engineering student.

[] I voluntarily give consent to participate in the survey. Begin the survey.

[] I am not 18 years old or older, and I am not currently enrolled at X University as an undergraduate engineering student, or I do not consent, do not begin the survey.

Q3 What is your race/ethnicity?

[] White or caucasian

[] Black or African American

[] American Indian or Alaska Native

[] Latino or Hispanic

[] Asian

[] Native Hawaiian or Pacific Islander

[] Other

Q4 What is your age (in years)?

_____

Q5 What is your gender identity?

[] Male

[] Female

[] Non-binary / third gender

[] Self-describe _____

[] Prefer not to say

Q6 What is your class year?

[] First-Year

[] Sophomore

[] Junior

[] Senior

[] Super Senior

Q7 What is your major?

[] Electrical and Computer Engineering or EET

[] Mechanical Engineering or MET

[] Chemical Engineering

[] Civil and Environmental Engineering

[] Biomedical Engineering

[] Engineering Entrepreneurship

[] Other _____

Q8 What is your current approximate GPA?

[] 4.0-3.5

[] 3.49-3.0

[] 2.99-2.5

[] 2.49-2.0

[] Less than 2.0

Q9 What is your transfer status?

[] Transferred to X University from a different institution

[] Transferred to engineering from a different major at X University

[] Not a transfer student

Q10 Directions: Below are statements about studying engineering. For each statement, indicate whether you Strongly Disagree, Disagree, Slightly Disagree, Neither Disagree nor Agree, Slightly Agree, Agree, Strongly Agree, or Don't Know.

1. I can relate to the people around me in my classes
2. I can succeed in an engineering curriculum
3. I have a lot in common with the other students in my classes
4. Someone like me can succeed in an engineering career
5. I can succeed in an engineering curriculum while not having to give up participation in my outside interests (e.g. extracurricular activities, family, sports)
6. I can relate to the people around me in my extracurricular activities
7. I will succeed (earn an A or B) in my physics courses
8. I will succeed (earn an A or B) in my math courses
9. I will succeed (earn an A or B) in my engineering courses
10. I am confident that I can complete the math requirements for most engineering majors
11. I am confident that doing well at math will enhance my career/job opportunities
12. I am confident that a degree in engineering will allow me to obtain a well paying job
13. I am confident that I can do well in an engineering major during the current academic year

14. I am confident that I will be treated fairly on the job. That is, I expect to be given the same opportunities for pay raises and promotions as my fellow workers if I enter engineering.
15. I am confident that I can complete any engineering degree at this institution.
16. I am confident that I can cope with doing poorly (or not as good as I had hoped) on a test in one of my engineering classes.
17. I am confident that a degree in engineering will give me the kind of lifestyle I want.
18. I am confident that I can make friends with people from different backgrounds and/or values.
19. I am confident that doing well at math will increase my sense of self-worth.
20. I am confident that I will feel "part of the group" on my job if I enter engineering.
21. I am confident that I can complete the physics requirements for most engineering majors.
22. I am confident that taking math courses will help me to keep my career options open.
23. I am confident that I can cope with friends' disapproval of my chosen major.
24. I am confident that a degree in engineering will allow me to get a job where I can use my talents and creativity.
25. I am confident that I can cope with being the only person of my race/ethnicity in a class.
26. I am confident that I can persist in engineering during the current academic year.
27. I am confident that I can approach a faculty or staff member to get assistance with academic problems.
28. I am confident that I can adjust to a new campus environment.
29. I am confident that a degree in engineering will allow me to obtain a job that I like.

30. I am confident that I can complete the chemistry requirements for most engineering majors.

Q11 Who are your closest friends in X University College of Engineering (up to 10): Please DO NOT give full names, provide initials or nicknames.

Friend 1 _____

Friend 2 _____

Friend 3 _____

Friend 4 _____

Friend 5 _____

Friend 6 _____

Friend 7 _____

Friend 8 _____

Friend 9 _____

Friend 10 _____

Q12 Select each friend's major

	Elec Engr	Mech Engr	Civil Engr	Chem Engr	Biomed Engr	Engr Entr	Unsure
Friend 1	[]	[]	[]	[]	[]	[]	[]
Friend 2	[]	[]	[]	[]	[]	[]	[]
Friend 3	[]	[]	[]	[]	[]	[]	[]
Friend 4	[]	[]	[]	[]	[]	[]	[]
Friend 5	[]	[]	[]	[]	[]	[]	[]
Friend 6	[]	[]	[]	[]	[]	[]	[]
Friend 7	[]	[]	[]	[]	[]	[]	[]

Friend 8	[]	[]	[]	[]	[]	[]	[]
Friend 9	[]	[]	[]	[]	[]	[]	[]
Friend 10	[]	[]	[]	[]	[]	[]	[]

Q13 Select each friend's current class year

	First-year	Sophomore	Junior	Senior	Super Senior	Unsure
Friend 1	[]	[]	[]	[]	[]	[]
Friend 2	[]	[]	[]	[]	[]	[]
Friend 3	[]	[]	[]	[]	[]	[]
Friend 4	[]	[]	[]	[]	[]	[]
Friend 5	[]	[]	[]	[]	[]	[]
Friend 6	[]	[]	[]	[]	[]	[]
Friend 7	[]	[]	[]	[]	[]	[]
Friend 8	[]	[]	[]	[]	[]	[]
Friend 9	[]	[]	[]	[]	[]	[]
Friend 10	[]	[]	[]	[]	[]	[]

Q14 Select each friend's gender identity

	Male	Female	Nonbinary/ Third-Gender	Self-Describe	Prefer Not to Say	Unsure
Friend 1	[]	[]	[]	[]	[]	[]
Friend 2	[]	[]	[]	[]	[]	[]
Friend 3	[]	[]	[]	[]	[]	[]
Friend 4	[]	[]	[]	[]	[]	[]
Friend 5	[]	[]	[]	[]	[]	[]
Friend 6	[]	[]	[]	[]	[]	[]

Friend 7	[]	[]	[]	[]	[]	[]
Friend 8	[]	[]	[]	[]	[]	[]
Friend 9	[]	[]	[]	[]	[]	[]
Friend 10	[]	[]	[]	[]	[]	[]

Q15 Select friend's race/ ethnicity

	Same as Me	Different from Me	Unsure
Friend 1	[]	[]	[]
Friend 2	[]	[]	[]
Friend 3	[]	[]	[]
Friend 4	[]	[]	[]
Friend 5	[]	[]	[]
Friend 6	[]	[]	[]
Friend 7	[]	[]	[]
Friend 8	[]	[]	[]
Friend 9	[]	[]	[]
Friend 10	[]	[]	[]

Q16 Select friend's transfer status

	Transferred to X University from another institution	Transferred to engineering from another major at X University	Not a transfer student	Unsure
Friend 1	[]	[]	[]	[]
Friend 2	[]	[]	[]	[]
Friend 3	[]	[]	[]	[]
Friend 4	[]	[]	[]	[]

Friend 5	[]	[]	[]	[]
Friend 6	[]	[]	[]	[]
Friend 7	[]	[]	[]	[]
Friend 8	[]	[]	[]	[]
Friend 9	[]	[]	[]	[]
Friend 10	[]	[]	[]	[]

Q17 Select friend's age

	Younger than me (5 years or more)	My age (less than 5 year difference)	Older than me (5 years of more)	Unsure
Friend 1	[]	[]	[]	[]
Friend 2	[]	[]	[]	[]
Friend 3	[]	[]	[]	[]
Friend 4	[]	[]	[]	[]
Friend 5	[]	[]	[]	[]
Friend 6	[]	[]	[]	[]
Friend 7	[]	[]	[]	[]
Friend 8	[]	[]	[]	[]
Friend 9	[]	[]	[]	[]
Friend 10	[]	[]	[]	[]

Q18 Describe your friend's performance in engineering:

	Performing at a higher level than me	Performing at the same level as me	Performing at a lower level than me	Unsure
Friend 1	[]	[]	[]	[]
Friend 2	[]	[]	[]	[]

Friend 3	[]	[]	[]	[]
Friend 4	[]	[]	[]	[]
Friend 5	[]	[]	[]	[]
Friend 6	[]	[]	[]	[]
Friend 7	[]	[]	[]	[]
Friend 8	[]	[]	[]	[]
Friend 9	[]	[]	[]	[]
Friend 10	[]	[]	[]	[]

Q19 How do you spend time with this friend?

	Studying / Group Work	Extracurriculars	Coworkers	Friends outside of class	Other
Friend 1	[]	[]	[]	[]	[]
Friend 2	[]	[]	[]	[]	[]
Friend 3	[]	[]	[]	[]	[]
Friend 4	[]	[]	[]	[]	[]
Friend 5	[]	[]	[]	[]	[]
Friend 6	[]	[]	[]	[]	[]
Friend 7	[]	[]	[]	[]	[]
Friend 8	[]	[]	[]	[]	[]
Friend 9	[]	[]	[]	[]	[]
Friend 10	[]	[]	[]	[]	[]

Q20 Is Friend 1 friends with any of the following people?

	Strangers	Moderate Friends	Close Friends	I Don’t Know

Friend 2	[]	[]	[]	[]
Friend 3	[]	[]	[]	[]
Friend 4	[]	[]	[]	[]
Friend 5	[]	[]	[]	[]
Friend 6	[]	[]	[]	[]
Friend 7	[]	[]	[]	[]
Friend 8	[]	[]	[]	[]
Friend 9	[]	[]	[]	[]
Friend 10	[]	[]	[]	[]

Q21 Is Friend 2 friends with any of the following people?

	Strangers	Moderate Friends	Close Friends	I Don't Know
Friend 3	[]	[]	[]	[]
Friend 4	[]	[]	[]	[]
Friend 5	[]	[]	[]	[]
Friend 6	[]	[]	[]	[]
Friend 7	[]	[]	[]	[]
Friend 8	[]	[]	[]	[]
Friend 9	[]	[]	[]	[]
Friend 10	[]	[]	[]	[]

Q22 Is Friend 3 friends with any of the following people?

	Strangers	Moderate Friends	Close Friends	I Don't Know
Friend 4	[]	[]	[]	[]

Friend 5	[]	[]	[]	[]
Friend 6	[]	[]	[]	[]
Friend 7	[]	[]	[]	[]
Friend 8	[]	[]	[]	[]
Friend 9	[]	[]	[]	[]
Friend 10	[]	[]	[]	[]

Q23 Is Friend 4 friends with any of the following people?

	Strangers	Moderate Friends	Close Friends	I Don't Know
Friend 5	[]	[]	[]	[]
Friend 6	[]	[]	[]	[]
Friend 7	[]	[]	[]	[]
Friend 8	[]	[]	[]	[]
Friend 9	[]	[]	[]	[]
Friend 10	[]	[]	[]	[]

Q24 Is Friend 5 friends with any of the following people?

	Strangers	Moderate Friends	Close Friends	I Don't Know
Friend 6	[]	[]	[]	[]
Friend 7	[]	[]	[]	[]
Friend 8	[]	[]	[]	[]
Friend 9	[]	[]	[]	[]
Friend 10	[]	[]	[]	[]

Q25 Is Friend 6 friends with any of the following people?

	Strangers	Moderate Friends	Close Friends	I Don't Know
Friend 7	[]	[]	[]	[]
Friend 8	[]	[]	[]	[]
Friend 9	[]	[]	[]	[]
Friend 10	[]	[]	[]	[]

Q26 Is Friend 7 friends with any of the following people?

	Strangers	Moderate Friends	Close Friends	I Don't Know
Friend 8	[]	[]	[]	[]
Friend 9	[]	[]	[]	[]
Friend 10	[]	[]	[]	[]

Q27 Is Friend 8 friends with any of the following people?

	Strangers	Moderate Friends	Close Friends	I Don't Know
Friend 9	[]	[]	[]	[]
Friend 10	[]	[]	[]	[]

Q28 Is Friend 9 friends with any of the following people?

	Strangers	Moderate Friends	Close Friends	I Don't Know
Friend 10	[]	[]	[]	[]