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Gender Differences in First-Year Engineering: Peer Connections in the time of COVID-19

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Abstract

Connection with peers is one of the most important factors in determining the persistence of students in engineering. During the COVID-19 pandemic, engineering classes transitioned to fully online learning. Little research has been done on the effect of online learning on students' social networks. This study sought to understand the factors that affect the connections students are making within a first-year engineering course at The Ohio State University. The study included the university's honors and standard offerings of the course. Participants were sent a Qualtrics survey that included ranking their level of connection to every student in each class on a scale from 0 (Don't Know) to 4 (Strong connection). Students were also asked Likert scale and opinion questions on their feelings of belonging in engineering and online learning. In total, there were 32 usable responses. Overall, females self-reported a higher average number of "Strong" and "Good" connections than males. A Mann-Whitney U test showed that this difference in number of connections was significant. To assess which factors affected the number of Strong and Good connections students self-reported, several ANOVA tests were conducted. These tests found that gender, feeling supported in the class, and class offering (honors vs. standard) yielded significant differences between groups. The study also found that out of all classes, over 85% of students strongly agreed that they would have formed better connections with their peers had their classes been in person. Because a majority of each class did not participate in the survey, the conclusions on gender and connections were limited to the students who responded. Future work will include creating social network diagrams in order to visualize connections within each class. Future work should also collect additional responses and include follow-up interviews to better understand student perspectives on connections and virtual learning.

Introduction

Because of gender imbalances in STEM fields, the participation and retention of women in STEM have been studied for decades [1] [2]. Many factors contribute to gender inequality in STEM education, one being social marginalization. Women often enter male-dominated fields and feel unwelcome because of their gender [3]. Additionally, engineering environments are often overtly hostile for women because of factors like sexist jokes and the use of masculine pronouns by professors [4]. Because of this, uncertainty about belonging can lead students to interpret adversities, like difficulty making friends, as evidence that they do not belong in their majors [5].

In particular, *social identity threat* occurs when people believe they are being devalued because of their membership to a group [6]. For example, Murphy et. al. studied the physical response to a gender-unbalanced situation with male and female students in STEM majors. Notably, women displayed higher measures of physiological vigilance and reported a lower sense of perceived belonging while watching a gender-unbalanced video versus a gender-balanced video [7]. Furthermore, social marginalization can "feed on itself" and worsen student's outcomes in STEM over time [8].

Conversely, "persister" is a term that refers to students who stay in their engineering major at the undergraduate level [9, 10, 11]. Studies have shown that "the most frequently utilized persistence strategies [are] social and institutional in nature", encompassing support from family, friends, clubs, tutors, etc. [11]. Moreover, one study showed that the source of support with the highest percentage of reliance was informal peer support from within the major, at 34% [11]. Another study on Hispanic female engineers found that peer groups enhanced learning, reinforced students' identity as engineers, and encouraged persistence [10].

The COVID-19 pandemic caused institutions across the country to require online learning. At Ohio State, the first-year engineering program transitioned to fully online learning in the Autumn 2020 semester. The program utilized tools like Microsoft Teams, Zoom, and Zoom breakout rooms to facilitate learning and collaboration. Though many classes in the program have transitioned back to in-person learning, many elements of a fully virtual classroom remain. Little research has been done on the effects of an online environment on the formation of vital peer groups.

The goal of this research is to understand the factors that affect the connections students are making within their fully virtual first-year engineering course. It also seeks to understand the role gender plays into the number of connections students make. This paper presents the development and deployment of a survey to first-year engineering students after their Autumn 2020 semester and a preliminary analysis of these results.

This research will be beneficial for educators and researchers interested in the factors that affect student's abilities to connect to one another. It can help to uncover the effects of online learning on students' relationships. Finally, this study could provide first-year engineering instructors with insight into how their online teaching practices can affect student success and persistence.

Methods

Population

This study aimed to collect information on students that were enrolled in fully virtual first-year engineering courses. Engineering courses taught in the fully online Autumn 2020 semester were selected. Because this study concerns the relationships of a class of students as a whole, students were recruited by class. At Ohio State, the first year engineering program has both Honors and Standard offerings. The standard Fundamentals of Engineering (FE) offering has around double the class size of the Fundamentals of Engineering Honors (FEH) offering. Because of this, two standard classes of around 70 students and three honors classes of around 30 students were selected. This number of classes was also selected so that the data would be manageable to collect and analyze within a one year timeframe. Table 1 shows the total number of students in each selected class section.

Table 1: Population of Students in Selected Classes

Class	Females	Males	Total Students
FEH 2	16	20	36
FEH 3	7	27	35
FEH 7	2	26	29
FE 1	Not provided	Not provided	66
FE 2	Not provided	Not provided	68

The Honors classes were also chosen based on their proportions of male to female students. This decision was made to determine if classes with different proportions of male to female students have any different connection results. Three classes with somewhat varying proportions of male and female students were chosen. As shown in Table 1, FEH 2 has around the same number of male and female students, whereas FEH 7 has two females and 26 males. The approximate gender breakdowns of each Honors class were disclosed by a program manager and no identifying information was provided. This information was not available for the Standard class offerings.

Survey

Next, a survey with two parts was developed. The first part of the survey collected information on students' connections to one other. In order to distinguish these connections, a scale of responses was devised. Students were instructed to rank their connection with every other student in the class on a scale of 0 to 3, as shown in Table 2. This scale was adapted from a scoring guide used to perform Social Network Analysis on networks and organizations [12].

Table 2: Connection Levels

Number	Level	Description
0	Don't Know	I don't know this person.
1	Light	I have met this person but I don't have a personal/working relationship with them.
2	Good	I have a personal/working relationship with this person but I only occasionally communicate with them.
3	Strong	I have a personal/working relationship with this person, and I regularly communicate with them.

Participants were next asked their agreement on Likert-scale and opinion statements to better understand their experience in engineering and a virtual first-year engineering class. Table 3 shows these questions. Question 9 was adapted from a survey used in a study on women in a university engineering program [3]. Questions 2, 3, and 4 were based on student quotes from a study on students who leave STEM majors [11]. Questions 6, 7, and 8 were based on a study about gender-unbalanced situations [7]. Questions 1 and 5 were chosen to understand students' virtual learning experiences.

Table 3: Likert-Scale and Opinion Questions

Number	Question Type	Question
1	Yes/No	This class utilized Zoom breakout rooms.
2	Likert Scale	This class encouraged me to form relationships with my peers.
3	Likert Scale	I had an opportunity to form relationships with my peers in this class.
4	Likert Scale	I felt supported in this class by my peers.
5	Likert Scale	I would have formed better relationships with my peers if this class was in-person.
6	Likert Scale	I would prefer taking a gender-balanced class over one that was not gender-balanced.
7	Likert Scale	This class had a gender gap.
8	Likert Scale	I would have formed better relationships with my peers if this class was gender-balanced.
9	Likert Scale	I belong in engineering.

At the end of the survey, students were directed to a set of demographic questions. These included gender identity, racial identity, and major choice. Students were also provided with text boxes to self-describe their gender identity and race if they chose.

With IRB approval, the survey was distributed using Qualtrics at the beginning of the Spring 2021 semester. Students were asked to reflect on their Autumn 2020 semester experience when taking the survey. Emails were sent to each student in a selected class, and students were sent 3 reminders to participate in the survey. A drawing for a gift card was held to incentivize participation.

Results

Filtering and Coding

Before analyzing the data, each student was coded using a random number generator. Identifying information such as name and email were discarded from the dataset. Keys were made separately that kept track of each student's name and corresponding code number. Students' demographic information and class section were retained in the dataset in order to perform analysis on factors. Though students were able to select "nonbinary" or self-describe any other gender identity, no students entered these responses. Further results and analysis include only "male" and "female" identities.

Next, the data was filtered. If a participant left more than 75% of the connection questions blank, their response was removed. Any students that did not provide a gender identity were removed. After filtering, 32 responses were usable. Table 4 below shows the participation across classes and by gender after filtering.

Table 4: Survey Responses by Gender and Class

Class	Females	Males	Total Respondents	% of Class Who Responded
Honors 2	5	4	9	25.0%
Honors 3	6	2	8	23.5%
Honors 7	0	3	3	7.9%
Standard 1	1	5	6	8.3%
Standard 2	3	3	6	8.1%
Total	15	17	32	-

Counting Connections

The first stage of analysis was to determine the number of each type of connection students had. Before analysis, the data was corrected for any unanswered connection questions. If a student did not enter a relationship level to another student, a 4 ("Don't Know") relationship was assumed.

Because students were given their own name in the survey as a student they could have a connection to, the results were modified to correct a student's relationship to themself to a 4 ("Don't Know") connection.

After these steps, the result was a matrix of every participant and their self-reported level of connection to every other student in the class. Figure 1 shows a snapshot of this raw data in one Honors section class. For example, Student 181 has a "Don't Know" connection to Student 6 (outlined). Student 196 has a "Strong" connection to student 151 (outlined).

Class	Class Size	Gender	Code	6	162	194	41	27	52	73	34	151	121	109	125	225	13
FEH 2	36	1	181	4	3	2	4	3	3	1	1	3	3	3	3	3	3
FEH 2	36	1	41	2	3	4	4	4	3	3	3	3	4	3	1	4	4
FEH 2	36	2	27	3	3	3	3	4	3	3	4	3	3	3	3	3	3
FEH 2	36	1	196	2	4	3	3	4	4	3	3	1	3	4	4	3	4
FEH 2	36	1	34	3	3	2	3	4	4	3	4	3	3	3	1	3	4
FEH 2	36	2	178	4	3	4	4	4	4	4	4	4	3	3	3	4	2
FEH 2	36	1	76	4	4	3	4	3	4	2	4	4	4	4	2	4	4
FEH 2	36	2	194	2	3	4	4	4	2	4	1	1	3	3	4	4	4
FEH 2	36	2	168	4	2	4	4	3	4	3	4	4	4	2	4	4	4

1 - Strong
2 - Good
3 - Light
4 - Don't Know

Figure 1: Raw Connection Data

Next, the data was aggregated by counting the number of each type of relationship a student self-reported. Figure 2 shows each participant and the number of connections they had in each category.

						Connection Level			
						Don't Know	Light	Good	Strong
Class Type	Class #	# of Students	Gender		Code	# 4-level	# 3-level	# 2-level	# 1-level
Honors	FEH 2	36	1	Female	181	6	17	7	6
			1	Female	41	13	16	5	2
			2	Male	27	3	29	3	1
			1	Female	196	16	12	6	2
			1	Female	34	8	22	3	3
			2	Male	178	25	10	1	0
			1	Female	76	25	8	3	0
			2	Male	194	25	5	3	3
			2	Male	168	22	11	2	1
	FEH 3	35	2	Male	3	3	18	5	9
			2	Male	192	14	9	7	5
			1	Female	160	8	24	3	0
			1	Female	2	6	17	6	6
			1	Female	68	1	10	19	5
			1	Female	146	6	8	9	12
			1	Female	188	12	8	5	10
			1	Female	96	2	11	14	8
	FEH 7	29	2	Male	58	20	5	3	1
			2	Male	171	8	17	4	0
			2	Male	141	3	25	1	0
Standard	FE 1	66	2	Male	214	63	0	3	0
			2	Male	51	62	0	4	0
			2	Male	148	63	0	3	0
			1	Female	46	61	2	2	1
			2	Male	91	60	2	3	1
			2	Male	17	60	2	3	1
	FE 2	68	1	Female	4	65	0	2	1
			2	Male	62	65	0	3	0
			2	Male	5	65	0	3	0
			1	Female	220	62	2	2	2
			1	Female	10	64	4	0	0
			2	Male	100	65	0	3	0

Figure 2: Connection Counting Process

In this step, a difference in the connections of honors and standard class students appeared. As shown in Figure 2, every participant in the Standard section self-reported that they did not know a large portion of their class, and had less than five "Good" and "Strong" connections combined. Conversely, students in the Honors section self-reported that they had more "Light", "Good", and "Strong" connections overall. Following this observed pattern, the number of each type of connection was next averaged overall and by each class (Honors or Standard). Figure 3 shows these averages. Overall, students had around 31 "Don't Know" connections, nine "Light" connections, four "Good" connections, and three "Strong" connections. However, this chart shows how the number of "Don't Know" connections are likely skewed because of the large number of self-reported "Don't Know" connections in the Standard classes. On average, students in the Honors class had almost six "Good" connections and four "Strong" connections, and students in the Standard class had three "Good" connections and less than one "Strong" connection. On average, students in the Honors section self-reported at least a "Light" connection with a majority of students in their class. Students in the Standard section, on average, self-reported that they did not know most of the other students in their class.

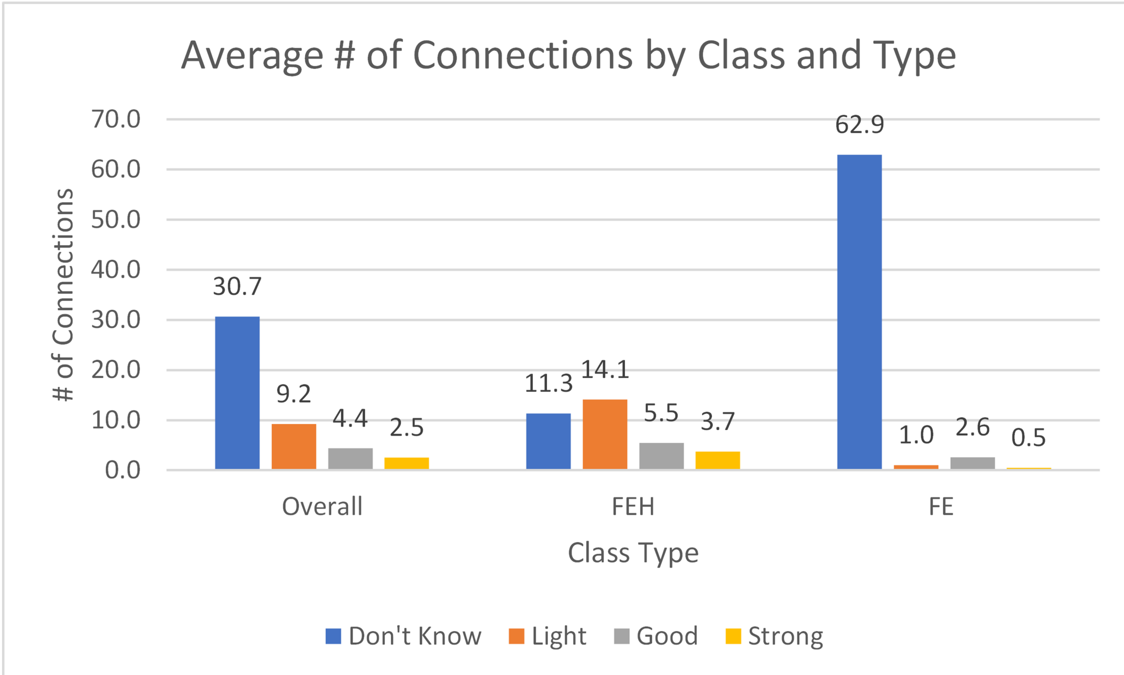

Figure 3: Average Number of Each Connection Type

Factor of Gender

The next step of data analysis was to determine if gender identity was a factor in the number of connections that students made. First, students were grouped by their self-reported "male" and "female" gender identities. The self-reported number of connections in each category was then averaged by group. Table 5 shows the average number of each type of connection across all classes by gender. Figure 4 shows the corresponding bar chart. Here, the pattern that females self-reported more "Good" and "Strong" connections than males was observed. Males self-reported, on average, a higher number of "Don't Know" connections than females.

Table 5: Average Number of Connections by Gender Overall

Connection Type	Female	Male
Don't Know	23.7	36.8
Light	10.7	7.8
Good	5,7	3.2
Strong	3.9	1.3

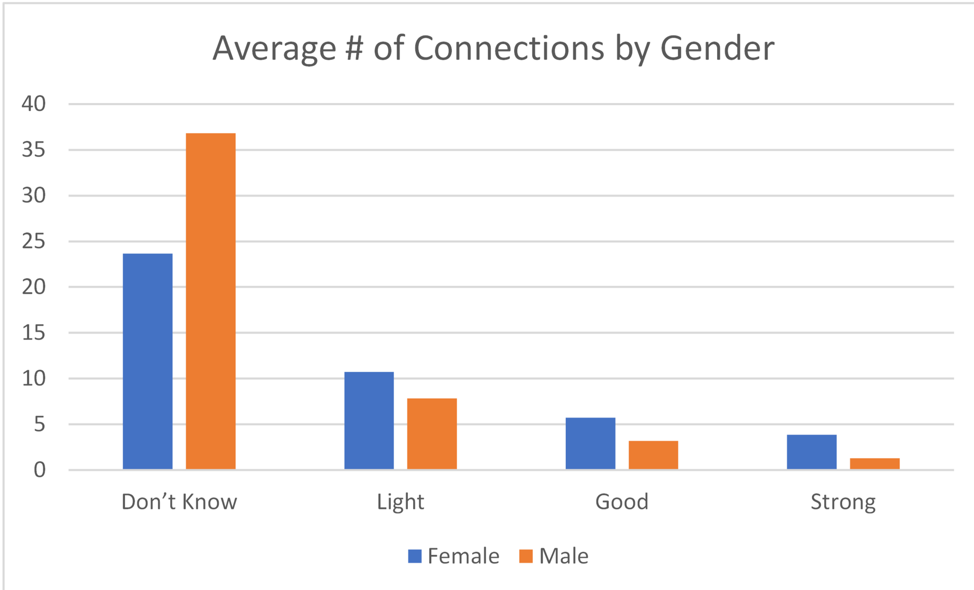

Figure 4: Average Connections by Gender, All Classes

To determine if this pattern also existed within each class type, students were similarly grouped within both the Honors and Standard sections. Table 6 and Figure 5 show these results in the Honors section. Here, this pattern is observed again, where females self-reported more "Good" and "Strong" connections, whereas males self-reported more "Don't Know" and "Light" connections.

Table 6: Average Number of Connections, Honors

Connection Type	**Female**	**Male**
Don't Know	9.7	13.7
Light	13.6	14.3
Good	7.3	3.2
Strong	4.8	2.2

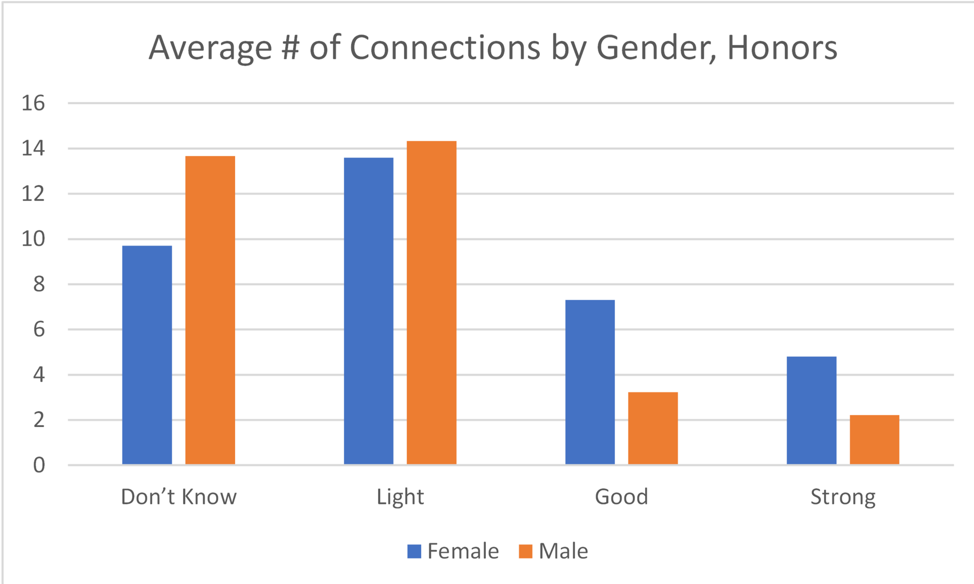

Figure 5: Average Connections by Gender, Honors

Finally, these steps were repeated for students in the Standard section. Table 7 and Figure 6 show these results. Unlike the results overall and in the Honors classes, male and female students reported a similar number of each type of connection. Further, both males and females reported over 60 “Don’t Know” connections on average.

Table 7: Average Number of Connections, Standard

Connection Type	Female	Male
Don’t Know	63.0	62.9
Light	2.0	0.5
Good	1.5	3.1
Strong	1.0	0.3

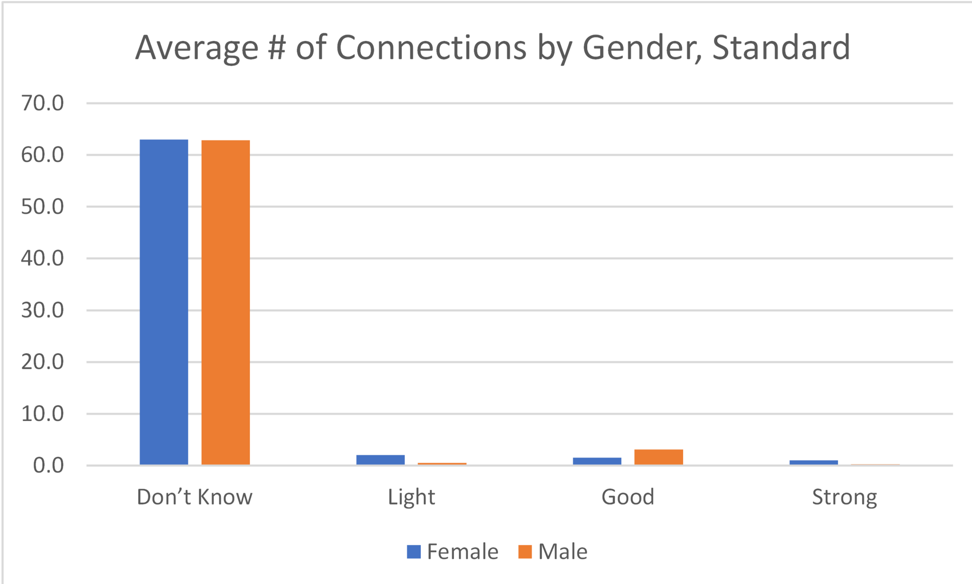

Figure 6: Average Connections by Gender, Standard

In order to determine if the difference in number of connections between males and females was significant, Mann-Whitney U tests were conducted. A Mann-Whitney U test is the non-parametric equivalent to a t-test that tests whether two populations are equal [13]. Because this dataset did not meet the distribution assumptions for a t-test due its small sample size, a Mann-Whitney U test was chosen. This test was repeated across each type of connection ("Strong", "Good", "Light", and "Don't Know") to determine if the two groups (male and female) were equal. Figure 7 shows the four tests conducted on each level.

Test Statistics[a]

	numStrong	numGood	numLight	numDontKnow
Mann-Whitney U	76.000	72.500	101.000	89.500
Wilcoxon W	229.000	225.500	254.000	209.500
Z	-1.984	-2.111	-1.013	-1.441
Asymp. Sig. (2-tailed)	.047	.035	.311	.150
Exact Sig. [2*(1-tailed Sig.)]	.053[b]	.037[b]	.331[b]	.153[b]

a. Grouping Variable: GenderNum

b. Not corrected for ties.

Figure 7: Mann-Whitney U Tests by Connection Level, All Students

The results indicate a significant difference between groups in all classes on the "Strong" level, [U=76.0, p=0.047], and the "Good" level [U=72.5, p=0.035]. Applying these results to the trend seen in Figure 4, it can be said that the number of self-reported “Good” and “Strong” connections is significantly higher for females than for males.

These tests were also repeated for the Honors and Standard classes individually. For the Honors class, the results indicated a significant difference between groups on the “Good” level [U=19.5, p=0.020]. Similarly applying these results to the trend seen in Figure 5, we conclude that the number of self-reported “Good” connections is significantly higher for females than for males in the Honors section. In the Standard class, the results indicated a non-significant difference between groups.

Factors of Likert Scale and Opinion Questions

This study next sought to find which other factors had an effect on the self-reported number of “Good” or “Strong” connections students have in a class. In this study, these factors were assessed using Likert-scale and opinion questions, as shown in Table 3.

In order to assess the answers to these questions as factors, an An Analysis of Variance test, or ANOVA, was chosen. An ANOVA test is used when the independent variable is subdivided into levels. This test asks whether these different levels have reliably different means of a dependent variable [14].

To test these factors for Likert-scale questions, the dependent variable was chosen as the sum of the “Good” and “Strong” connections a student self-reported. Likert-scale responses were transformed into numerical levels, 1 being “Strongly Disagree” and 5 being “Strongly Agree”. ANOVA tests were conducted on nine factors, as shown in Table 8.

In a one-way ANOVA test, the dependent variable is a continuous variable [15], meaning the variable can take any value in the scale being used (i.e. decimal values). In this study, the dependent value is the sum of the *number* of “Strong” or “Good” connections being made. This variable is discrete, since a student could only select one type of connection per person. In this study, this assumption will be disregarded and the number of connections a student self-reported will be regarded as continuous.

Table 8: ANOVA Factors

Number	Factor
1	Gender
2	Honors or Standard Class
3	This class encouraged me to form relationships with my peers.
4	I had an opportunity to form relationships with my peers in this class.
5	I felt supported in this class by my peers.
6	I would prefer taking a gender-balanced class over one that was not gender-balanced.
7	This class had a gender gap.
8	I belong in engineering.
9	I am pursuing an engineering major.
10	Honors Class 1, 2, or 3

One-way ANOVA tests were conducted on every factor from Table 8. Factors 1, 2, 5 and 10 yielded significant results. The following sections discuss these significant results. All other factors had no statistically significant differences in mean number of “Good” and “Strong” connections.

Gender

A one-way ANOVA was performed to compare the effect of gender on the number of Good/Strong connections. This test revealed there was a statistically significant difference in the self-reported number of Good/Strong connections between at least two groups (F (between groups 1, within groups 30) = 6.014, p = .020). Table 9 shows the number of participants in each group and their mean number of Good/Strong connections. Figure 8 shows the means plots for this factor, 1 indicating female and 2 indicating male. As shown in the chart, female students had significantly higher self-reported numbers of Good/Strong connections than male students.

Table 9: ANOVA Gender Group Descriptives

Group	**n**	**Mean**
Females	15	9.6
Males	17	4.5

The results of this test align with the Mann-Whitney U test for the effect of gender, since this test also yielded significant results when testing for “Good” and “Strong” connections individually.

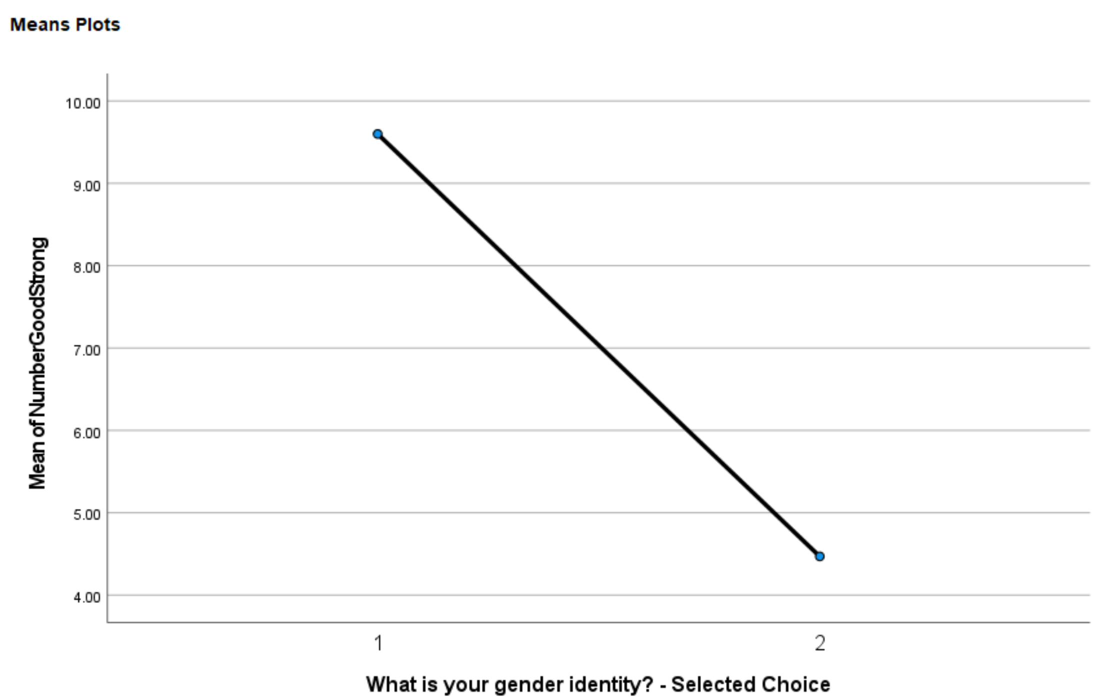

Figure 8: ANOVA test for Gender Difference

Class

A one-way ANOVA was performed to compare the effect of class type on the number of Good/Strong connections. The two groups in this test were Honors and Standard class types.

This test revealed there was a statistically significant difference in the number of Good/Strong connections between at least two groups (F (between groups 1, within groups 30) = 8.455, p = .007). Table 10 shows the number of participants in each group and their mean number of Good/Strong connections. Figure 9 shows the means plots for this factor, 1 indicating the Honors class and 2 indicating the Standard class. As shown in the chart, students in the Honors class had significantly higher numbers of self-reported Good/Strong connections than the Standard offering.

Table 10: ANOVA Class Type Group Descriptives

Group	**n**	**Mean**
Honors	20	9.15
Standard	12	3.08

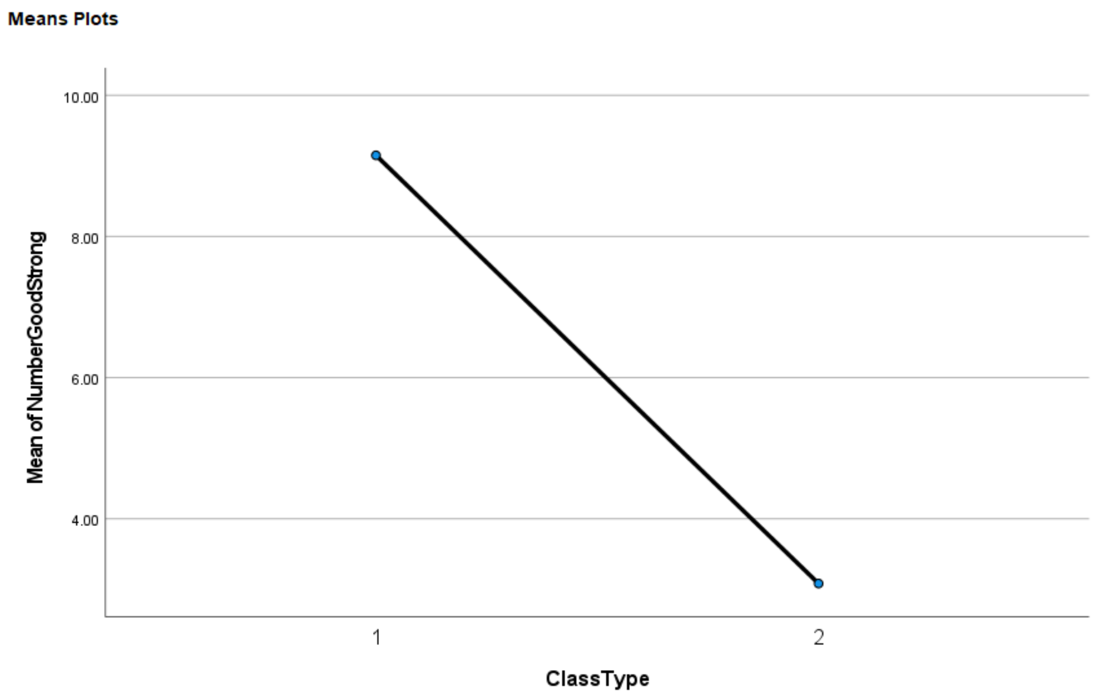

Figure 9: ANOVA test for Class Difference

Support

A one-way ANOVA was performed to compare the effect of ’feeling supported’ on the number of Good/Strong connections. Students were asked their agreement on the statement “I felt supported in this class by my peers” from “Strongly Disagree” to “Strongly Agree”.

Table 11: ANOVA “Felt Supported” Group Descriptives

Group	n	Mean
Strongly Disagree	0	N/A
Disagree	3	6.7
Neither Agree nor Disagree	9	6.2
Agree	17	5.4
Strongly Agree	3	17.3

This test revealed there was a statistically significant difference in the number of Good/Strong connections between at least two groups (F (between groups 3, within groups 28) = 3.877, p = .019). Tukey’s HSD Test for multiple comparisons found that the mean value of connections was significantly different between Strongly agree and neutral (p = 0.030, 95% C.I. = [-21.3560, -.8663]). Table 11 shows the number of participants in each group and their mean number of Good/Strong connections. Figure 10 shows the means plots for this factor, 2 indicating a student answering “Disagree”, 3 indicating “Neutral”, 4 indicating “Agree”, and 5 indicating “Strongly Agree”. No students answered “Strongly Disagree”. As shown in the chart, students who indicated that they Strongly Agreed with the statement “I felt supported in this class by my peers” had significantly higher numbers of self-reported Good/Strong connections.

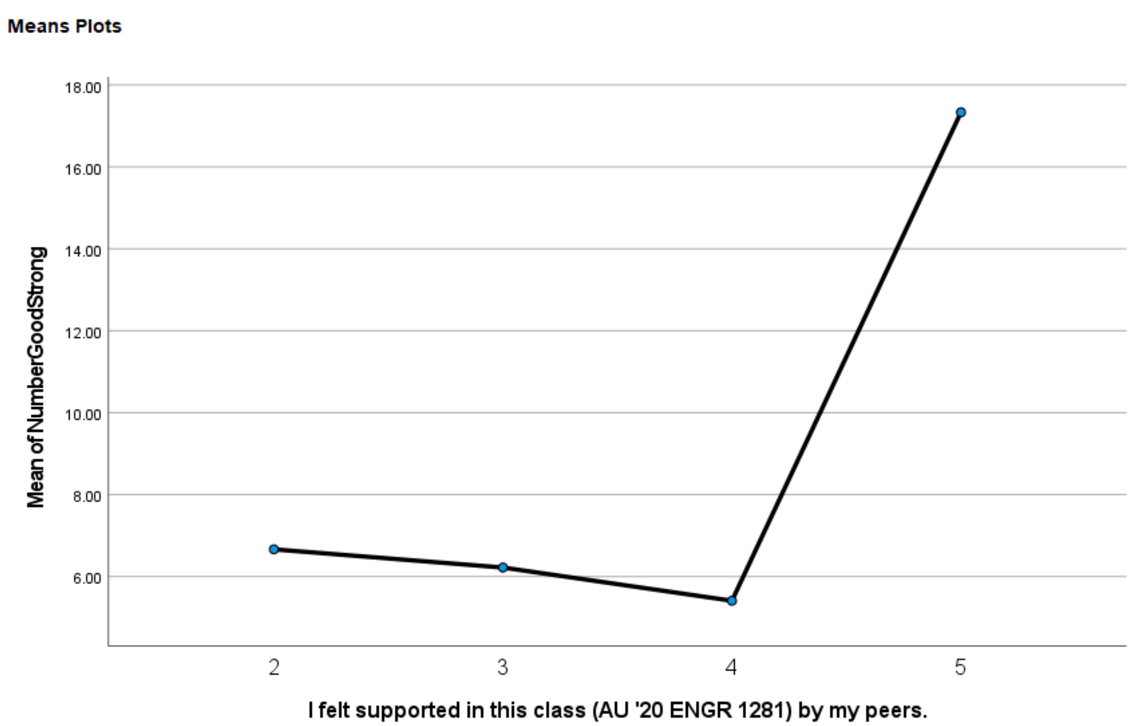

Figure 10: ANOVA test for feeling supported by peers

Honors Class Number

A one-way ANOVA was performed to compare the effect of Honors class number on the number of Good/Strong connections. This test was conducted on students in the Honors class to test whether or not the specific class had any impact on connections.

Table 12: ANOVA Honors Class Group Descriptives

Group	**n**	**Mean**
FEH 2	9	5.7
FEH 3	8	15.4
FEH 7	3	3.0

This test revealed there was a statistically significant difference in the number of Good/Strong connections between at least two groups (F (between groups 2, within groups 17) = 10.436, p = .001). Tukey's HSD Test for multiple comparisons found that the mean value of connections was significantly different between class 3 and 2 (p = 0.030, 95% C.I. = [-16.0058, -3.4109]) and 3 and 7 (p = 0.006, 95% C.I. = [-21.1490, -3.6010]). Table 12 shows the number of participants in each group and their mean number of Good/Strong connections. Figure 11 shows the means plots for this factor, each number indicating a specific honors class. As shown in the chart, students in class number 3 self-reported a significantly higher number of Good and Strong connections than other classes.

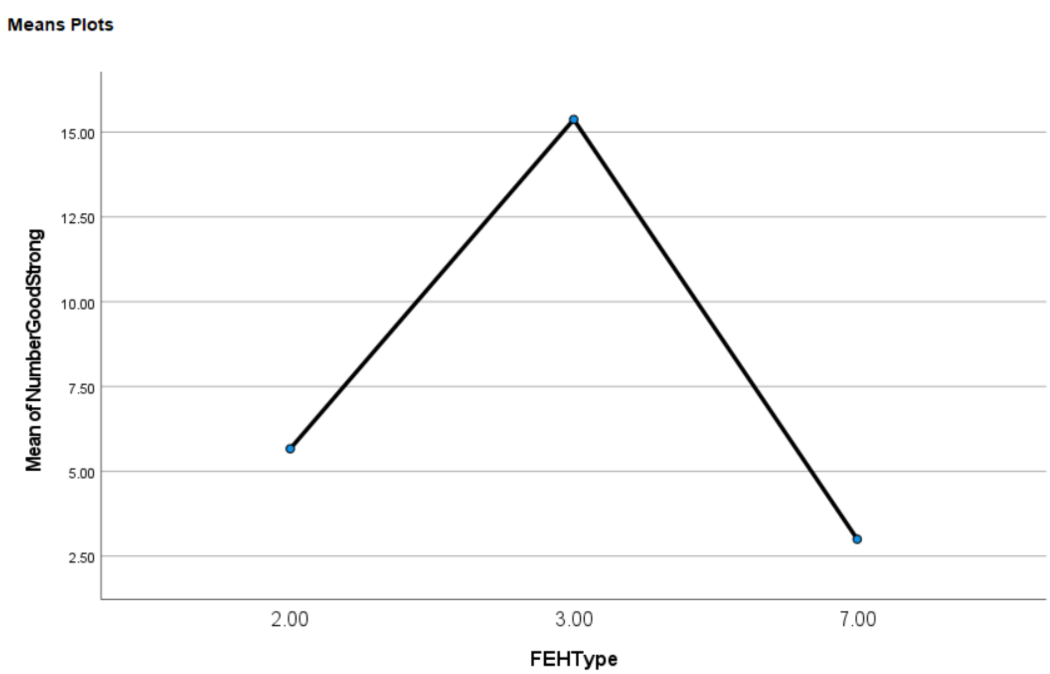

Figure 11: ANOVA test for Honors Class Number

Online Classes

One notable Likert scale question was “I would have formed better relationships with my peers if this class was in-person”. As shown in Table 13, 87.5%, or 28 out of the 32 students indicated that they Strongly Agreed with this statement.

Table 13: Likert Scale Responses for In-Person Classes

Response	**n**	**%**
Stronly Disagree	0	0
Disagree	0	0
Neither Agree nor Disagree	1	3.1
Agree	3	9.4
Strongly Agreed	28	87.5

Conclusion and Future Work

This study sought to understand the factors that contribute to the number of connections first-year students have. To quantify peer support, the number of ”Good” and ”Strong” connections students self- reported in their first-year engineering course was used. The results showed that overall, females made a significantly higher number of self-reported “Good” and “Strong” connections than males. Research in the differences in social connectedness in women and men have indicated that women had higher levels of social connectedness than men [16]. However, further study into these relationships with more students is necessary to fully understand why this pattern was observed.

This study also observed a significant difference between the Honors and Standard offerings of the first-year engineering class. Honors students had significantly more self-reported “Good” and “Strong” connections than students in the Standard class. One possible reason for these differences is Zoom breakout rooms, where students in the Standard class were in one group the entire semester and Honors students switched rooms every few weeks. This could provide instructors with insight into collaboration methods and opportunities to meet with other students in their classes. However, low participation in the survey meant that several students were underrepresented in this data.

One large limitation of this study was that many students in each class did not participate in the survey. In each class, the number of respondents was under 10, though class sizes were almost 30 and above. This means that the connections of a large fraction of each class is not represented. One future step would be to collect more responses, ideally including every student in a class. A larger sample size could also allow for analysis on types of connections between genders, such as whether female students make more connections with other females, males, or other gender identities.

Another limitation of this study was the nature of the survey used. All connection information is self-reported, so there is no way to verify whether or not connections were actually “Good” or “Strong”. Students in the Standard class also had a longer survey because of the larger number of students in their class. Therefore, there was no way to distinguish between students who filled "Don't Know" or another response for a majority of responses in order to complete the survey in a timely manner. A possible future step would be to conduct student interviews to better understand what students characterize as "Good" and "Strong" connections. Interviews could also help to explain whether or not it is better to have many lighter connections or a few stronger connections. With more participants, connections could also be verified if two participants both identified a "Good" or "Strong" connection to each other.

Education and student success is a complex social process that needs appropriate analysis tools that can handle this complexity [17]. One of these possible analysis tools is social network analysis, which is a qualitative method of studying relational data that shows promise for investigating education systems [18]. A prior study using social network analysis in a STEM field allowed researchers to identify students' social isolation in a class and determine its impact on grades [19], demonstrating the usefulness of this analysis method. Further research will include constructing social networks of all students in each class based on their self-reported connections, connection levels, and demographics. This could help to identify patterns such as cliques or isolated students.

Over 80% of students indicated that they "Strongly Agreed" that they would have formed better relationships in an in-person class. To understand this response, follow-up interviews with students could provide insight into the parts of an online class that are detrimental to making good connections. Further iterations on this survey could also include more questions on students' usage of Zoom breakout rooms or other collaboration methods. This could also explore if the online class format allows for a difference in the number and quality of connections for certain demographics of students. This study could be replicated in-person or hybrid classes to determine if any differences exist in connection data.

Finally, a longitudinal study could be used to understand whether having more connections translates to retention and overall success in an engineering major.

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