



Relationship between Gen Z Engineering Students' Personality Types and Topics of Technical Interest

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Introduction

In this paper we build upon a preliminary work in progress reported last year [1]. A popular personality assessment tool is the Myers-Briggs Type Indicator® (MBTI) test [2]. In this indicator, people are classified according to 16 different personality types. Results of the MBTI self-assessment test indicates whether the person tends to be sensing (S) or intuitive (N), thinking (T) or feeling (F), judging (J) or perceiving (P), and extroverted (E) or introverted (I). Personality types can be used to help people know more about their strengths, weaknesses, likes, dislikes, compatibility with other people and even potential career preferences. An ASEE-MBTI study done in 1980s showed that engineering students predominantly tend to have thinking and judging personality types and are generally introverted [3,4]. However, no study has related students' personality type to their technical topics of interest.

Data gathered last year [1] showed that engineering students generally have the same personality types as in the 1980 data gathered by ASEE. The majority of engineering students had J and T personality types. There was a shift in the introverted and extroverted personality types with a greater proportion of students being extroverted in our study last year compared to the 1980 ASEE study. During presentation of the results at last year's ASEE conference, the audience felt that this trend is reasonable since students are now engaged in more teamwork than before in K-12 education and teamwork promotes extroversion. Last year's data also showed a noticeable shift between the sensing and intuitive personality types compared to the 1980 data, with the majority of first-year engineering students being more intuitive than sensing.

In the present study, we not only compare and contrast the dominant personality types of first-year Gen Z engineering students, but also study the relationship between their personality types and their interest in different engineering topics. The personality types of undergraduate engineering students in the first-year *Introduction to Engineering* course were determined using the MBTI test. Relationships between students' personality types and different topics in engineering such as sustainability, entrepreneurship, communication, or traditional engineering disciplines and their learning preferences are presented.

Research Questions

The following research questions are explored:

1. Do first-year Gen Z engineering students have the same personality characteristics as engineering undergraduate students of the 1980s (i.e., thinking, judging and introverted)?
2. Are the personality types of first-year Gen Z engineering students related to their interest in topics such as math and physics, visualization, entrepreneurship, sustainability, and communication?
3. Is there any difference between the topics that first-year male and female students are interested in?

Data Collection

During the last week of classes, students were first asked to complete the MBTI personality test. A brief survey was then administered in 8 sections of the *Introduction to Engineering* course at the end of the fall 2019 semester. The same survey was administered in 8 sections of the course in fall 2018. Data from both years were combined for analysis. Participation in the survey was voluntary and no incentives were offered for participation. Students were asked to record their personality profile on the survey. The survey had two main questions requiring students to rank their interest level and strength in topics discussed in the course. Projects in the course emphasize different engineering disciplines while developing students' professional skills in teamwork, technical communication and problem solving, along with creativity, entrepreneurship and sustainability. The course is described in detail and the survey instrument is reproduced in Reference [1]. Students rank ordered the topics from the one that appealed to them the most (#1) to the one that appealed to them the least (#7). They also ranked a list of nine attributes related to topics covered in the course from the one in which they were the strongest (#1) to the one in which they were the weakest (#9).

Survey Results

Only about half the survey results contained usable data; surveys from students who did not take the personality test, or did not understand how to rank their topics of interest and their strengths were discarded. Of the 142 usable survey results, 115 were completed by males and 29 by females.

After examining the completed surveys, we decided to eliminate the following two attributes of the course:

- Teamwork and team learning aspect of the class
- Hands-on activities of the class such as the second (bridge design) project

More than 80% of the students ranked the hands-on activity or the team working aspect of the class as their top two choices. We wanted to focus our study on the items that had more variability in the responses, so we eliminated these two items and re-ranked the other 5 items below to study the relationship between students' personality types and these topics:

- Orthographic drawing (Visualization)
- Sustainability and ethics
- Term Project (Entrepreneurship, creativity, and customer interaction)
- Math, physics and mechanics
- Communication (Writing and presenting)

Dominating Personality Types of Engineering Students

Figure 1 shows a comparison of the personality types of University of New Haven first-year students and the ASEE-MBTI data. The data is also displayed in tabular format in Table A.1 in Appendix A. The ASEE-MBTI survey includes results from engineering students in all majors and across all their undergraduate years. In 1980, based on the ASEE-MBIT survey, most engineering students had T and J (thinking and judging) personality types. Almost 40 years later, first-year students at the University of New Haven showed a very similar trend. The thinking (T)

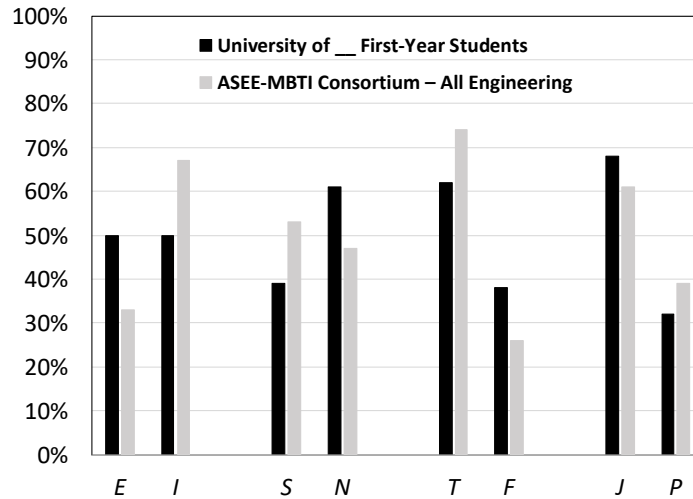


Figure 1. Personality type data from the ASEE-MBIT study and our study

personality type is less pronounced in our data compared to the ASEE-MBTI data and the intuitive personality type is more pronounced. These could be due to the particular demographics of our students, differences between first-year students and all students, or it could potentially reflect a shift in the personality of engineering students over the last 40 years.

Also, two-thirds of the students in the ASEE-MBTI were introverted, but our students were equally split between being introverted and extroverted. The shift toward extroversion may be a result of K-12 education requiring more teamwork and social interactions.

Topics of Interest

After eliminating the “Teamwork” and “Hands-on activities” items as stated earlier, the percentage of students who chose each topic as their first, second, fourth and least favorite is shown in Figure 2. Orthographic drawing (visualization), entrepreneurship and math & physics score highly as first and second choices. More than 50% of the students indicated that these three topics were their first or second choice. While the strong liking for visualization and math & physics is not surprising among engineering students, the rise in interest in entrepreneurship may be a new trend. The large survey of Gen Z students by Northeastern University indicated the dramatic rise of interest in entrepreneurship [5]. The *Introduction to Engineering* course at the University of New Haven includes two e-learning modules and related assignments on entrepreneurial topics to cater to this interest.

With respect to the least favorite topics, it is not surprising that communication takes the top spot with over 65% ranking it as their fourth or last choice. This confirms the stereotypical image of engineers being poor communicators. Since employers strongly value communication skills [6, 7], engineering programs must develop the communication skills of students during their college education.

It is disappointing that after communication skills, the topic of sustainability takes the spot as the next least favorite. More than 40% of the students ranked sustainability as their fourth or last choice and only a little over 25% ranked it as their first or second choice. Given global

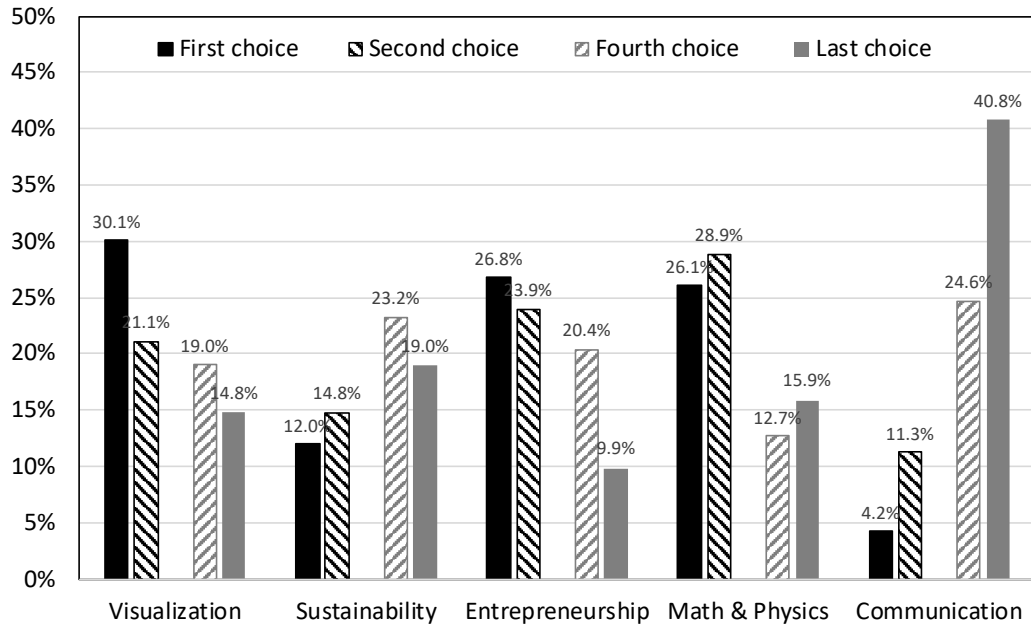


Figure 2. Percentage of students who ranked each topic as first, second, fourth and last

problems associated with climate change and sustainability being prominently featured among the engineering grand challenges, students need to be made more aware of the importance of sustainability within an engineering context. It would appear that engineering students are not developing sufficient appreciation for sustainability from their K-12 education and engineering programs in higher education must cover the topic strongly.

It might be surprising that just over 25% of the students ranked math & physics as their fourth or least favorite topic since the general belief is that students who are attracted to engineering are strong in math and physics [8]. However, a significant fraction of our students who declare that they want to be engineers have weak math skills and start out in remedial math (pre-calculus). It is likely that these students ranked math & physics low.

The percentage breakdown of the first choice of students with different personality types is shown in Figure 3 (and Table A.2 in Appendix A). In Figure 3, each pair of overlapping bars shows the data for the I/E, S/N, T/F and J/P personality type pairs.

Statistical analysis was done to compare differences between pairwise proportions. The hypothesis to be tested is:

The proportion of students of two different personality types who select the same topic as their first choice is the same. i.e.,

$$H_0: p_1 - p_2 = 0 \text{ (Null hypothesis)}$$

$$H_a: p_1 - p_2 \neq 0 \text{ (Alternate hypothesis)}$$

The Bootstrap Confidence Interval method was used to determine the confidence interval for the difference in proportion between two observations [9]. The bootstrap approach generates multiple samples based on resampling from the original sample (with replacement) to create new

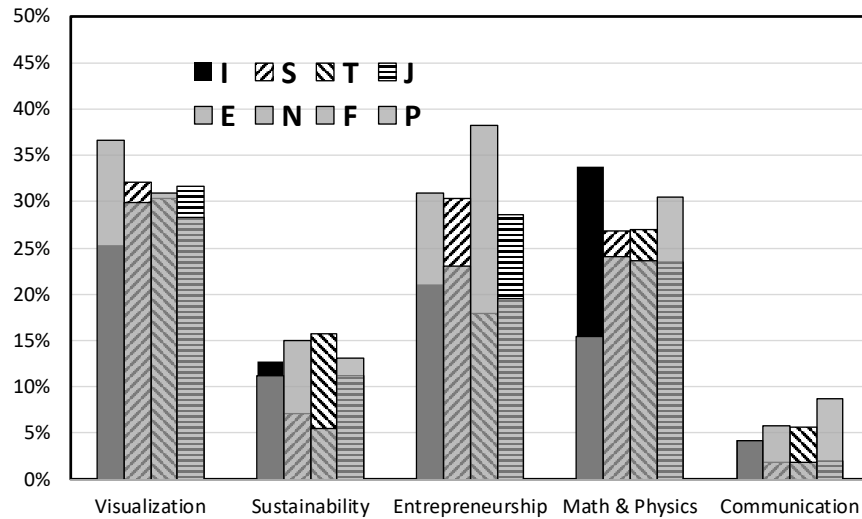


Figure 3. Percentage breakdown of topic ranked first by each personality type

samples. The confidence interval for the difference in proportions is estimated from the collection of all generated samples. The StatKey software that is publicly available was used to produce the confidence intervals based on 4000 samples [10]. For example, the distribution of bootstrapped proportions generated by StatKey and the 95% confidence interval for the proportions of “Thinking” and “Feeling” students who selected sustainability as their first choice (15.7% vs. 5.5%) is shown in Figure 4. Since zero is outside the confidence interval [0.0055, 0.209], the difference in proportions is statistically significant at the 0.05 significance level.

Differences that are statistically significant at the 0.05 significance level are discussed below:

- **Sustainability:** There is a significant difference in the proportion of students who indicated sustainability as their first choice between “Thinking” (15.7%) and “Feeling” (5.5%) students. This is a surprise to us since we expected that “Feeling” students would be more passionate toward sustainability. However, a similar study of civil engineering students at Manhattan College concluded that “Thinking” students were initially more interested in sustainability, but the interest of “Feeling” students increased after they were exposed to sustainability related topics [11].
- **Entrepreneurship:** There is a significant difference in the proportion of students who indicated entrepreneurship as their first choice between “Thinking” (18.0%) and “Feeling” (38.2%) students. Perhaps “Thinking” students rationalize that the chances of them getting wealthy through entrepreneurship is slim, while “Feeling” students go with their emotions and are willing to take a chance.
- **Math & Physics:** There is a significant difference in the proportion of students who indicated math & physics as their first choice between “Introverted” (33.8%) and “Extroverted” (15.5%) students. It is not surprising that introverted students gravitate more toward math & physics than extroverted students.

Figure 5 (and Table A.3 in Appendix A) shows the percentage of students in each personality type who expressed each topic as their last choice. All personality types strongly

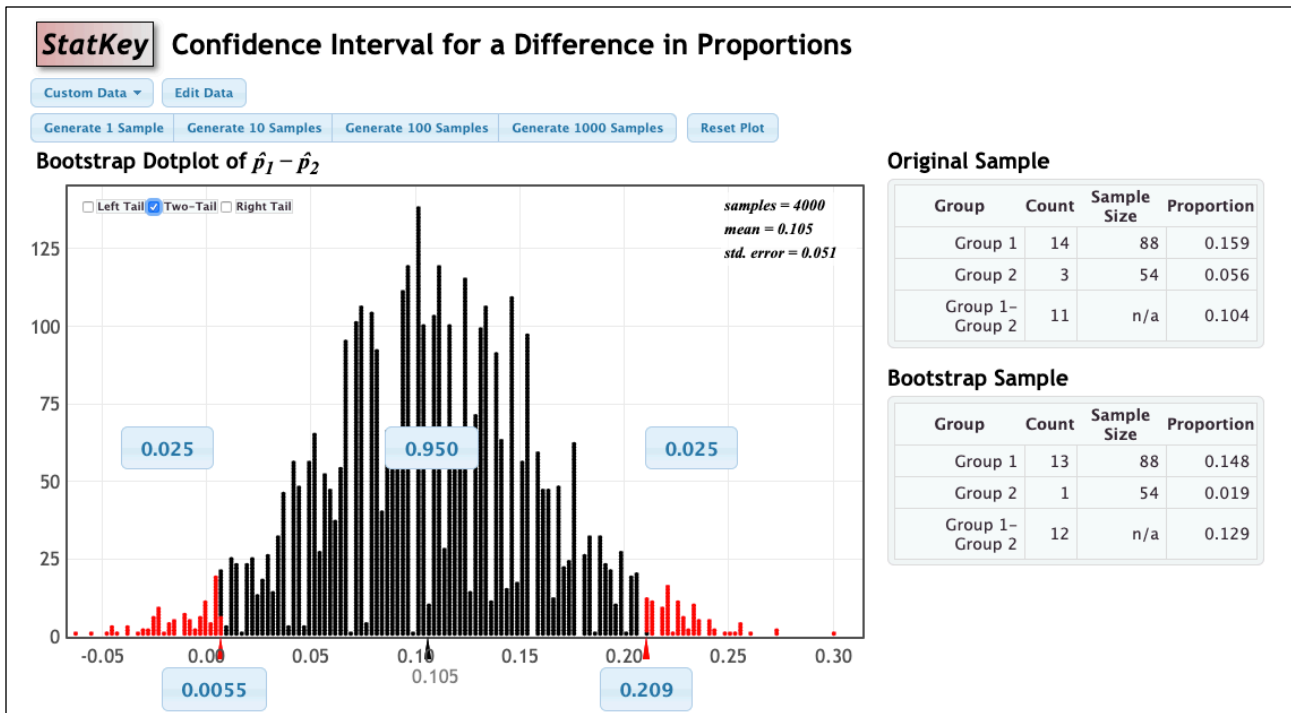


Figure 4. Bootstrap confidence interval for difference in proportions of T and F students who selected sustainability as their first choice

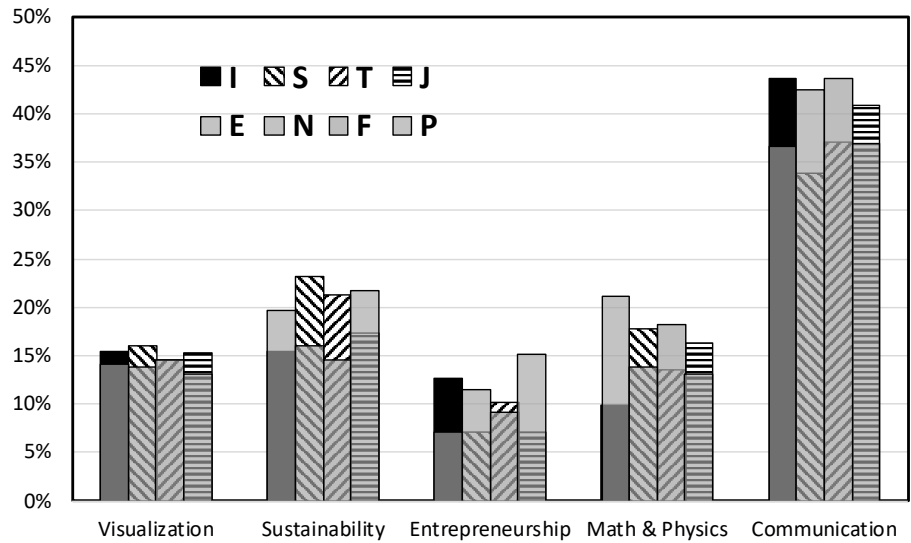


Figure 5. Percentage breakdown of topic ranked last by each personality type

dislike communication, which is a corollary of the data in Table A. The proportion of students who ranked math/physics last shown in Figure 2 (15.9%) is fairly consistent across the personality types. While visualization was the strongest first choice for all personality types (see Figure 3 and Table A.3), 13-16% of the various personality types rated it as their last choice.

Interests Across Gender

The survey asked students to identify their gender. While options were given for students to not disclose gender or to indicate a gender other than male or female, there were no students who chose these options. The first and last choice topics for men and women are shown in Figures 6 and 7. The data for men is similar to that in Figure 2 since the data from the large number of men dominates the overall data. Therefore, the general observations made for all students also applies to the men.

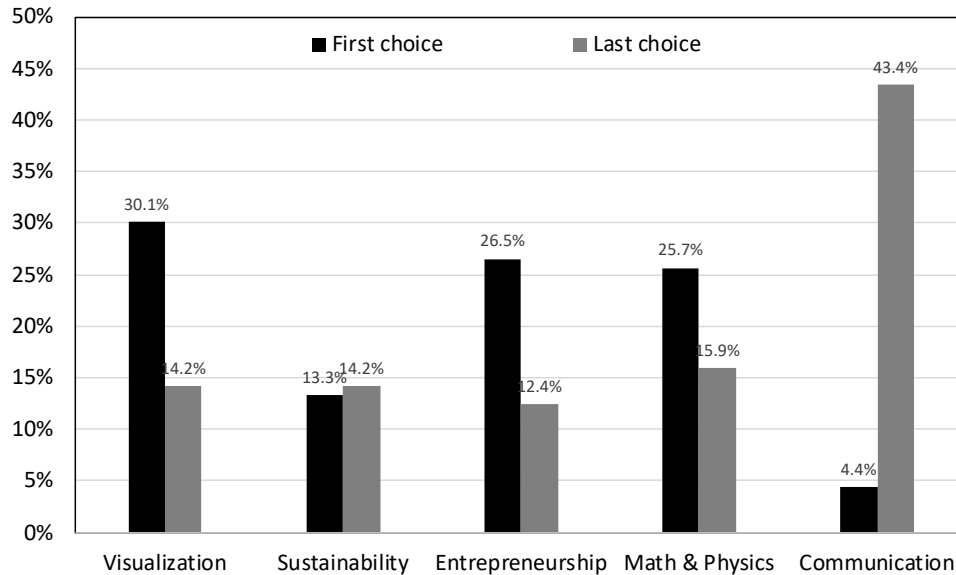


Figure 6. Percentage breakdown of topic ranked first by men ($n = 115$)

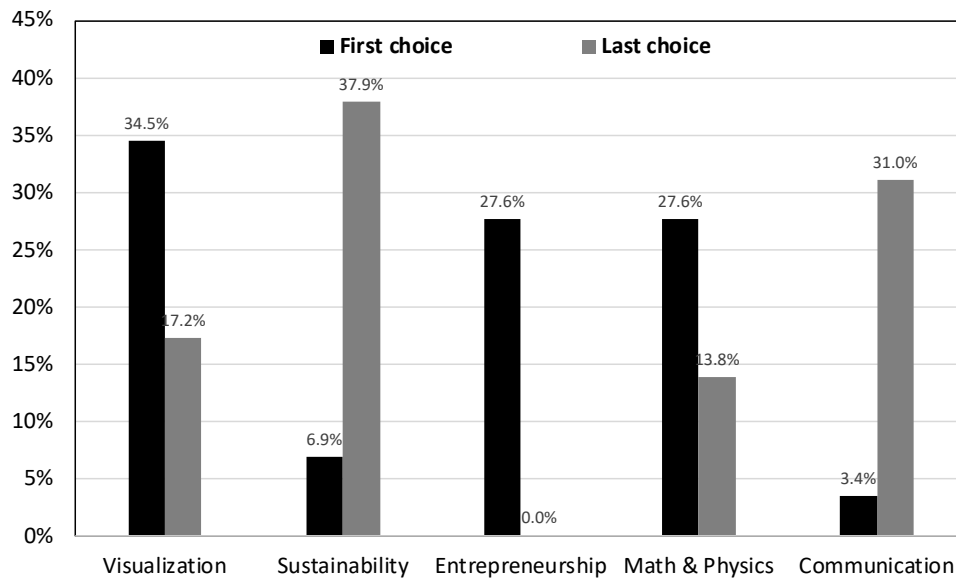


Figure 7. Percentage breakdown of topic ranked first by women ($n = 27$)

There are two topics for which the first and last choices of women vary drastically from those of men. Almost 38% of the women chose sustainability and none chose entrepreneurship as their least favorite topic. The proportion of women who chose sustainability as their most favorite topic was also only about half that of men. This result runs counter to the common notion that women are more concerned about sustainability than men [12, 13].

The data does not show that women dislike visualization more than men as some other studies have asserted.

The percentage breakdown of first choice topics for men and women of each personality type are shown in Tables 1 and 2. Again, the data for men is similar to the data for all students (Table A.2), since men dominated the data. Due to the small number of women in the sample, the difference in proportions between men and women for any given item is not statistically significant at the 0.05 significance level. The only statistically significant observation is that the proportion of “Feeling” women who selected entrepreneurship as their first choice was drastically more than the proportion of “Thinking” women who did the same.

Table 1. Percentage Breakdown of Topic Ranked First by Men of Each Personality Type

Personality Trait	Sample Size (N)	Visualization	Sustainability	Entrepreneurship	Math and Physics	Communication
I	57	22.8%	15.8%	19.3%	35.1%	3.5%
E	58	36.2%	10.3%	31.0%	15.5%	5.2%
S	43	32.6%	9.3%	30.2%	23.3%	2.3%
N	71	28.2%	15.5%	22.5%	25.4%	5.6%
T	74	29.7%	16.2%	20.3%	24.3%	5.4%
F	41	29.3%	7.3%	34.1%	26.8%	2.4%
J	73	31.5%	13.7%	27.4%	21.9%	1.4%
P	42	26.2%	11.9%	21.4%	31.0%	9.5%

Table 2. Percentage Breakdown of Topic Ranked First by Women of Each Personality Type

Personality Trait	Sample Size (N)	Visualization	Sustainability	Entrepreneurship	Math and Physics	Communication
I	14	35.7%	0.0%	28.6%	28.6%	7.1%
E	13	38.5%	15.4%	30.8%	15.4%	0.0%
S	13	30.8%	0.0%	30.8%	38.5%	0.0%
N	16	37.5%	12.5%	25.0%	18.8%	6.3%
T	15	33.3%	13.3%	6.7%	40.0%	6.7%
F	14	35.7%	0.0%	50.0%	14.3%	0.0%
J	25	32.0%	4.0%	32.0%	28.0%	4.0%
P	4	50.0%	25.0%	0.0%	25.0%	0.0%

Usefulness of Results in Recruitment and Retention

Recruitment of students into engineering programs and retaining them until graduation requires programs to cater to student interests and help them with their weaknesses. Many engineering programs have focused on sustainability over the last decade, both to educate students about global concerns and to cater to the seeming interest of the youth on this topic. However, the results of this study indicate that Gen Z engineering students are not as interested in sustainability topics as we might have assumed. Therefore, emphasis of sustainability topics may need to be downplayed during the recruitment process.

On the other hand, Gen Z engineering students seem to have a strong interest in entrepreneurship. Therefore, engineering programs may want to consider building stronger initiatives around entrepreneurship to both recruit and retain students.

It is well-known that engineering students generally dislike writing and oral communication, and even though faculty might think their writing may be adequate, employers typically assess their communication skills as being weak [14]. The dislike of communication skills has not changed with Gen Z engineering students. Technical communication skills are highly valued by engineering employers. Many universities around the country have made efforts to strengthen students' technical communication skills. These efforts need to be continued and can be advertised during the recruitment process.

Limitations of the Study

It is possible that students' likes and dislikes of topics could have been skewed by the presentation of the topics in classes and the assignments. However, the data was collected across 6-7 sections of the course taught by different instructors in each of the two years during which data was collected. Therefore, the data should reflect some averaging. For example, if one instructor taught sustainability well and with enthusiasm in one class, while another taught the topic poorly, then the responses of students from one class should offset the responses from the other class when the data is pooled.

Summary and Conclusions

A survey-based study of first-year engineering students was conducted at the University of New Haven to determine their personality types and interest in topics such as visualization (orthographic drawing), sustainability, entrepreneurship, math and physics, and communication. A total of 142 usable survey responses were collected in fall 2018 and fall 2019, 115 from men and 27 from women. The survey was administered in the *Introduction to Engineering* course taken by all first-year engineering students. The course introduces students to the various topics included in the survey.

The results of this two-year study suggest the following regarding three research questions:

1. In general, the distribution of personality characteristics amongst first-year Gen Z engineering students at the University of New Haven today are reasonably similar to the national distribution of personality characteristics across all undergraduate engineering students in the 1980s. One noticeable difference is in the split between extroverted and introverted students, with the proportion of extroverted and introverted students being more balanced in our students.

2. There are relationships between the personality types of engineering students and their interest in specific topics. While the overall interest in sustainability is low among first-year Gen Z students, it was surprising that “Thinking” students were attracted more to sustainability than “Feeling” students. “Feeling” students were attracted more to entrepreneurship. Introverted students were attracted more to math and physics than extroverted students.
3. Due to the small number of women in the sample, none of the observed differences between the interests of men and women are statistically significant at the 0.05 significance level. Therefore, the study resulted in no conclusive finding between the interests of first-year men and women engineering students.

Other findings of the study include:

- Communication was by far the least favorite topic for both male and female students.
- The topics of strongest interest are visualization, entrepreneurship, and math & physics.
- Surprisingly few students indicated strong interest in sustainability. This is unexpected, since the common notion is that the new generation of students are highly tuned to issues such as global climate change, recycling, and so on.

Acknowledgment

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Appendix A: Data in Tabular Format

Table A.1. Personality Type Data from the ASEE-MBIT Study and Our Study

Personality Type Preference	Univ. of New Haven First-Year Students	ASEE-MBTI Consortium – All Engineering
Extroverted	50%	33%
Introverted	50%	67%
Sensing	39%	53%
INtuitive	61%	47%
Thinking	62%	74%
Feeling	38%	26%
Judging	68%	61%
Perceiving	32%	39%

Table A.2. Percentage Breakdown of First Choice Topic for Each Personality Type

Personality Trait	Sample Size (N)	Visualization	Sustainability	Entrepreneurship	Math and Physics	Communication
I	71	25.4%	12.7%	21.1%	33.8%	4.2%
E	71	36.6%	11.3%	31.0%	15.5%	4.2%
S	55	32.1%	7.1%	30.4%	26.8%	1.8%
N	87	29.9%	14.9%	23.0%	24.1%	5.7%
T	88	30.3%	15.7%	18.0%	27.0%	5.6%
F	54	30.9%	5.5%	38.2%	23.6%	1.8%
J	97	31.6%	11.2%	28.6%	23.5%	2.0%
P	45	28.3%	13.0%	19.6%	30.4%	8.7%

Table A.3. Percentage Breakdown of Topic Ranked Last by Each Personality Type

Personality Trait	Sample Size (N)	Visualization	Sustainability	Entrepreneurship	Math and Physics	Communication
I	71	15.5%	15.5%	12.7%	9.9%	43.7%
E	71	14.1%	19.7%	7.0%	21.1%	36.6%
S	55	16.1%	23.2%	7.1%	17.9%	33.9%
N	87	13.8%	16.1%	11.5%	13.8%	42.5%
T	88	14.6%	21.3%	10.1%	13.5%	37.1%
F	54	14.5%	14.5%	9.1%	18.2%	43.6%
J	97	15.3%	17.3%	7.1%	16.3%	40.8%
P	45	13.0%	21.7%	15.2%	13.0%	37.0%

Appendix B: EASC 1107 Term Survey

Please go to the following link and find out your personality type

<http://www.humanmetrics.com/cgi-win/jtypes2.asp>

Answer the following questions:

Student ID _____ Course Section: _____

Gender: ___ Female ___ Male ___ Prefer not to answer ___ Not listed

Please indicate your personality type as determined by the Myers-Briggs Personality Type Indicator:
(E/I, S/N, T/F, J/P) _____

What topic in the class was your favorite (Please rank them from 1 to 7, with 1 being your most favorite and 7 your least favorite. Rank each of the sub-category items from 1 to 2 or 1 to 3)

- ___ Teamwork and team learning aspect of the class
- ___ Hands on activities of the class such as the second (bridge design) project
- ___ Orthographic drawing
 - ___ Hand sketching
 - ___ Inventor modeling
- ___ Sustainability and ethics related lecture and activities
- ___ Term Project
 - ___ Creating something new of value (entrepreneurship, creativity)
 - ___ Customer interaction (pre-and post-surveys)
- ___ Traditional physics, math, and mechanics related lectures
 - ___ Vector analysis, (Mechanics)
 - ___ Math essential (Math)
 - ___ Circuits (Physics)
- ___ Writing memos and presenting your work to the class
 - ___ Writing
 - ___ Presenting

Which of the following do you think you were strong at (irrespective of your likes and dislikes)? Please rank each item from 1 to 9, with 1 being your strongest and 9 your weakest.

___ I am a good team player

___ I am good in physics (circuit design)

___ I am good at working with my hands

___ I am good at writing

___ I am good at 3-D visualization

___ I am good at presenting

___ I am good in mechanics (vector analysis)

___ I feel comfortable speaking/ interacting

___ I am good in math (math essentials)

with people