# Multi-Institutional Evaluation of Engineering Discipline Selection

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## Abstract

During the fall of 2014, a quantitative study of first-year engineering student discipline selection was conducted at four dissimilar institutions in the Midwest: (1) an Urban Public, (2) a Private, (3) a Large Land Grant, and (4) a Large Urban. At all four institutions, an on-line survey was conducted at the start and at the end of the semester. The questions related to how interested students are in engineering (as compared to other academic majors), how certain they are that engineering is the best field of study for them, which discipline of engineering they are most interested in studying, and how certain they are of that engineering discipline choice. Collectively, there were over 3,300 student responses from across the four institutions studied. The data illuminated some differences between the institutions. However, a common result across all 4 institutions was a decrease in interest in engineering over the fall semester which may be accounted for by a "polarizing" effect in which the students that were more neutral in terms of certainty of engineering and their engineering discipline at the start of the semester shift over the course of the fall semester to the extremes, both high certainty and low certainty.


## Background

The selection of a field of study has a significant impact on an individual's course in life. Unfortunately, especially in the case of engineering, many students are woefully uninformed about what is required for their chosen degree and what someone with that degree can do upon completion.[1] As is often anecdotally reported for many engineering students, they frequently enter engineering because they were good at math and science in high school and were "told" they should go into engineering. However, some of the factors at play when selecting engineering as a major are: general impressions of engineering, enjoyment of math and science, job prospects, and the potential to contribute to society.[2,3]

Major selection and the factors motivating that selection are incredibly important, as they have a significant impact on retention. One of the seminal works by Seymour and Hewitt[4] on persistence in science, math, and engineering found that students who did not persist in engineering often initially chose engineering for reasons unrelated to intrinsic interest, such as influences from family, friends, and counselors, financial or materialistic reasons, or because of typical mantras, such as going into engineering because one is good in math and science. Conversely, those who did persist tended to initially choose engineering because they had an interest in the field. Interest in the field was also found to be important for persistence in another study[5], as well as self-identifying with the field or linking personal traits to the qualities needed to be a successful engineer. Therefore, it is important to help students understand from an early stage what it is that an engineer does, what attributes are necessary to be a successful engineer, and specifics about the different fields of engineering so that students can make informed choices

about their major selection, ultimately improving the chance that they will persist through graduation and professionally.

Institutions handle the engineering program matriculation process in a variety of ways. In a taxonomy proposed by Chen et. al., nine different classifications were created to identify how students matriculate to their chosen engineering discipline.[6] The taxonomy was developed based on information from all 390 U.S. undergraduate institutions with ABET EAC-accredited programs. After using the taxonomy to classify the institutions, it was found that 39% of institutions allow for direct matriculation to a major and require some type of introductory engineering coursework during the first term. Comparatively, 13% of institutions allow for direct matriculation to a major with some of the majors required to complete introductory engineering coursework (but not all) and 12% of institutions did not allow for direct matriculation but instead had some form of common first-year engineering program. Regardless of the classification, 76% of the institutions required some form of introductory engineering coursework.

This large number of institutions requiring introductory engineering coursework is also witnessed by the increased focus on first-year programs in the engineering education research community. In 2005, Brannan and Wankat conducted a survey to understand the state of first-year engineering programs.[7] Of the 93 institutions that responded to the survey, 62.3% reported that they had some form of formalized first-year program, whether that be conducted by a department or division devoted to first-year programs, overseen by someone on the dean's staff, taken on by faculty in addition to their normal teaching loads, or conducted by individual departments. There are pros and cons to focused first-year engineering programs; the major advantage is that the selection of major is often delayed until the end of the first year, allowing additional time to explore the engineering disciplines for more informed decision making. However, this means that the start of disciplinary coursework is delayed, which may cause some students to lose interest. The advantage to direct matriculation into a program is that it allows an immediate start to specific disciplinary content; this approach is preferred by students that come into their undergraduate studies highly committed to a certain disciplinary path. On the other hand, since students may start disciplinary coursework as early as the first semester, it can make switching majors difficult if a student realizes a preference for a different field of engineering.

**Methods**

To explore the impacts of differences in programs for first-year engineering students, four dissimilar Midwestern academic institutions conducted surveys of their first-year engineering students at the start and end of the fall 2014 semester. This quantitative study of first-year engineering student discipline selection was conducted at: (1) an Urban Public, (2) a Private, (3) a Large Land Grant, and (4) a Large Urban. The institutions studied were selected on the basis

of program similarity and difference. A primary attribute that separates the institutions is the process by which students matriculate to a degree program. Three of the four institutions in the study have a formal First-Year Engineering Program in which students do not declare an engineering major initially. Instead, students determine their path throughout the first year as they gather information about the engineering disciplines offered at their institution; generally students begin in their selected engineering discipline in the fall of their sophomore year, after completing the First-Year Engineering Program requirements for their institution. The fourth institution, the Large Public Urban, has direct matriculation to engineering disciplinary programs (although students may still switch to another discipline due to a mostly common first year). Another differentiating factor is that the three public schools are in urban settings while the private is in a suburban location. Finally, the institutions studied vary in terms of enrollments: two are medium-sized universities with approximately 10,000-15,000 undergraduates and two are large universities with more than 30,000 undergraduates. The study design (using multiple dissimilar institutions in terms of enrollments, selectivity, campus environments, and engineering program structure) allows for statistical comparisons generalizable to other institutions about First-Year Engineering disciplinary selection. A table that summarizes the attributes of the institutions studied is shown in Table 1.

**Table 1. Summary of Institutions Studied**

| Institution Pseudoname | University Enrollment | Public or Private | Residential or Commuter | Setting | Selectivity | First-Year Engineering Program |
|---|---|---|---|---|---|---|
| Urban Public | Medium Sized ~15,000 Undergraduates | Public | Primarily Commuter (10-15% residential) | Urban | Low Selectivity-Minimal admissions | Yes |
| Private | Medium Sized ~10,000 Undergraduates | Private | Residential (~90%) | Community | Highly selective | Yes |
| Large Land Grant | Large ~45,000 Undergraduates | Public | Residential | Urban | Moderate Selectivity | Yes |
| Large Urban | Large ~30,000 Undergraduates | Public | Mixed Residential and commuter | Urban | Moderate Selectivity | No |

The number and educational focus of the instructors involved with the execution of the courses taken by First-Year Engineering students varied by institution. At the Urban Public, there are 2 faculty members that teach in the First-Year Engineering Program (primarily). At the Private,

there are four faculty members that regularly teach every semester of the course offering with approximately 4 additional instructors from the engineering departments. At the Large Land Grant, there are approximately 25 faculty (mostly lecturers or clinical faculty) who are hired solely to teach these first-year engineering courses, and about 5 additional faculty are used part-time from the engineering departments. At the Large Urban institution, there is a department with 9 faculty members responsible for administering the first-year engineering courses, but faculty are also assigned from the degree-granting departments.

The survey items were developed by engineering educators from all 4 institutions and differed only in terms of the answer choices for the engineering majors available at a given institution. The surveys were conducted on-line using the system most familiar to students at that institution. In some cases, the data was collected anonymously and in others it was not; however, in all cases, any identifying information was replaced with a randomly generated "respondent ID number" used for statistical analysis. Response rates also varied by institution and are outlined in Table 2a. During the start of semester survey there was an overall response rate of 52%, while the end of semester response rate was 34%.

**Table 2a. Summary of Response Rates by Institution**

| Institution Pseudoname | Survey 1: Start of Fall Semester | | | Survey 2: End of Fall Semester | | |
|---|---|---|---|---|---|---|
| | # of Potential FYE Respondents | # Acutal Respondents | % Acutal Respondents | # of Potential FYE Respondents | # Acutal Respondents | % Acutal Respondents |
| Urban Public | 219 | 202 | 92.2% | 210 | 194 | 92% |
| Private | 541 | 236 | 43.6% | 538 | 107 | 20% |
| Large Land Grant | 2014 | 927 | 46.0% | 1995 | 743 | 37% |
| Large Urban | 1224 | 720 | 58.8% | 1206 | 297 | 25% |
| Total | 3998 | 2085 | 52.2% | 3949 | 1341 | 34% |

Table 2b represents the approximate retention from fall 2014 to spring 2015 for first-year engineering students. The retention rates vary, but range from 76% for the Large Urban to 92% for the Private institution.

**Table 2b. Retention Approximation Fall 2014 to Spring 2015 by Institution**

| | Fall 2014 FY ENGR Course Enrollment | Spring 2015 FY ENGR Course Enrollment | Approximate Retention* |
|---|---|---|---|
| Urban Public | 208 | 177 | 85% |
| Private | 543 | 502 | 92% |
| Large Land Grant | 2014 | 1756 | 87% |
| Large Urban | 1267 | 963 | 76% |

*Approximate retention because this includes transfer students and others not enrolled in fall course

All of the questions were on a Likert scale, and the quantitative responses were coded such that a more positive response was a higher value and a less positive response was a lower value. Statistical analysis was conducted using the statistical software package STATA®. Summary statistics are reported, as well as Wilcoxon Rank-Sum Tests of statistical significance which is a non-parametric test that does not assume a normal population distribution.

## Results

In the following sections each of the 4 primary survey questions are compared between and within each institution. Survey question 1 asked students how interested in engineering they were (as compared to other academic majors). Table 3a shows a summary of the start- and end-of-semester responses by institution. All institutions saw a slight overall decrease in interest in engineering, as indicated by the difference in means before and after the course, shown in Table 3b. However, at the Private institution, there was an increase in the percentage of students "very interested" in engineering. Statistically, there appears to be a shift in the number of students at the Private institution that indicated "somewhat interested" in engineering initially to "very interested" at the end. The Large Land Grant experienced the next largest shift, but it was a shift from the "very interested" and "somewhat interested" to lower interest levels.

**Table 3a. Summary Interest in Engineering as a Major**

| Survey Question | Urban Public | | | | Private | | | | Large Land Grant | | | | Large Urban | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Start of Semester | | End of Semester | | Start of Semester | | End of Semester | | Start of Semester | | End of Semester | | Start of Semester | | End of Semester | |
| How interested are you in engineering (as compared to other academic majors)? | # of Students | % of Students | # of Students | % of Students | # of Students | % of Students | # of Students | % of Students | # of Students | % of Students | # of Students | % of Students | # of Students | % of Students | # of Students | % of Students |
| Very Disinterested | 4 | 2.0% | 6 | 3.1% | 3 | 1.3% | 8 | 7.5% | 10 | 1.1% | 31 | 4.2% | 9 | 1.3% | 12 | 4.0% |
| Somewhat Disinterested | 0 | 0.0% | 10 | 5.2% | 3 | 1.3% | 2 | 1.9% | 7 | 0.8% | 26 | 3.5% | 3 | 0.4% | 7 | 2.4% |
| Neutral | 6 | 3.0% | 8 | 4.1% | 8 | 3.4% | 3 | 2.8% | 18 | 1.9% | 29 | 3.9% | 6 | 0.8% | 7 | 2.4% |
| Somewhat Interested | 29 | 14.4% | 22 | 11.3% | 67 | 28.4% | 10 | 9.3% | 201 | 21.7% | 152 | 20.5% | 138 | 19.2% | 43 | 14.5% |
| Very Interested | 163 | 80.7% | 147 | 75.8% | 155 | 65.7% | 84 | 78.5% | 691 | 74.5% | 505 | 68.0% | 564 | 78.3% | 227 | 76.4% |

Table 3b is a summary of the Wilcoxon Rank-Sum results for the same question of interest in engineering as a major. These results indicate the shift noted from the summary statistics for the Private institution was not statistically significant; however, the shift for the Large Land Grant was statistically significant. The mean shift noted was negative, indicating that after completing one semester students were collectively less interested in engineering as a major; overall there were just more students in the lower interest categories (11.6% of respondents were neutral, somewhat disinterested, or very disinterested). These are likely the students that did not persist to the spring semester course (as shown in Table 2b); some attrition is natural and to be expected. Further, a study by Alpay and associates reported that for many students motivation and interest diminish over time, shifting from aspirations to make significant impact to financial security[8] which may be one potential explanation for the shift.

**Table 3b. Rank-Sum Statistical Test Interest in Engineering as a Major**

| 5 Pt Likert Scale (higher value = more positive response) | Urban Public | Private | Large Land Grant | Large Urban |
|---|---|---|---|---|
| Average Start of Semester | 4.718 | 4.559 | 4.679 | 4.729 |
| Average End of Semester | 4.523 | 4.495 | 4.445 | 4.559 |
| Difference (End - Start) | -0.195 | -0.064 | -0.233 | -0.170 |
| P Value (Rank Sum Test) | 0.164 | 0.077 | **0.000*** ** | 0.423 |

Students were asked which engineering discipline they are most interested in and the results are summarized in Table 4. For simplicity, responses to the four core engineering disciplines offered at all of the institutions studied are reported (the Large Land Grant and Large Urban have several other programs offered which are not offered at the others). Mechanical Engineering was the most frequently indicated engineering major at all of the institutions at both the start and end of the semester with the exception of the Private institution (Chemical was highest there at the start of the semester only). The interest in a particular major remained rather stable at the Urban Public and the Large Land Grant. However, there were substantial change in the distribution at the Private and Large Urban schools.

One potential reason why the Large Urban University saw a decrease in the interest in Mechanical Engineering stems from an interesting issue related to major selection. As indicated previously, the Large Urban University allows for direct matriculation to degree programs, though a sizable percentage (approximately 10%) of the incoming class chooses to enter as undeclared engineering. These students must then select a major by the end of their first year at the latest, though typically students apply to the degree programs following their first semester. As with the other institutions in this study, Mechanical Engineering is by far the most popular at the Large Urban University. However, since Mechanical Engineering is so popular, it often fills up through direct admits. This poses a problem for the undeclared students who have decided they wish to pursue Mechanical Engineering, as they have a very difficult time getting into the major. This is especially problematic when the undeclared students have very strong GPAs and are unable to pursue Mechanical Engineering while there are students who were admitted directly and are barely maintaining the 2.0 required to stay in the major. The drop in interest in Mechanical Engineering may be a result of this process of undeclared engineering students choosing to look at another discipline if they have found out they are unable to get into Mechanical Engineering. The most popular engineering majors at the Large Land Grant University also have enrollment limits, but since students do not apply to their majors until completion of the first-year sequence, it does not appear to have an effect at this point in their undergraduate careers.

**Table 4. Interest in Engineering Discipline**

| At this point, which engineering discipline are you most interested in? | Urban Public | | | | Private | | | | Large Land Grant | | | | Large Urban | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Start of Semester | | End of Semester | | Start of Semester | | End of Semester | | Start of Semester | | End of Semester | | Start of Semester | | End of Semester | |
| | # of Students | % of Students | # of Students | % of Students | # of Students | % of Students | # of Students | % of Students | # of Students | % of Students | # of Students | % of Students | # of Students | % of Students | # of Students | % of Students |
| Civil Engineering | 32 | 15.8% | 26 | 13.4% | 14 | 8.2% | 3 | 2.8% | 41 | 4.4% | 42 | 5.7% | 54 | 14.6% | 30 | 10.1% |
| Chemical Engineering | 37 | 18.3% | 30 | 15.5% | 78 | 45.6% | 28 | 25.9% | 125 | 13.5% | 108 | 14.5% | 114 | 30.7% | 45 | 15.2% |
| Electrical Engineering | 40 | 19.8% | 29 | 14.9% | 12 | 7.0% | 4 | 3.7% | 87 | 8.1% | 59 | 7.9% | 59 | 15.9% | 24 | 8.1% |
| Mechanical Engineering | 81 | 40.1% | 81 | 41.8% | 67 | 39.2% | 34 | 31.5% | 215 | 23.2% | 150 | 20.2% | 144 | 38.8% | 57 | 19.2% |

There were two survey questions focused on student certainty: (1) certainty in engineering as a major and (2) certainty in an engineering discipline. Table 5a shows a summary of the responses to both of these questions by institution. At all 4 institutions, a larger percentage of students indicated they were "very certain" of their major and their engineering discipline at the end of the semester than they were at the start. But there was also an increase in the percentage of students that were "very uncertain" of engineering as a major and their engineering discipline at the end of the semester. As can be seen from the shaded cells in Table 5a which indicate a net increase, the fall semester seems to help pull the students that are more neutral about engineering or their discipline in one direction or another. In effect, there is a "polarizing" effect observed at all 4 institutions throughout the first semester of engineering. As a goal of the first-year engineering programs at all of the schools is to help students determine whether or not engineering is a good major for them, this data seems to indicate that the goal is being met. The Private and the Large Urban institutions observed the largest increases in student percentages indicating greater certainty of engineering as a major with 17.8% and 12.2% increases respectively.

**Table 5a. Certainty in Engineering**

| Certainty Survey Questions | | Certainty of ENGR Major | | | Certainty of ENGR Discipline | | |
|---|---|---|---|---|---|---|---|
| | | Start | End | Difference | Start | End | Difference |
| Urban Public | Very Uncertain | 0.5 | 4.6 | 4.1 | 0.5 | 2.1 | 1.6 |
| | Somewhat Uncertain | 3.5 | 5.7 | 2.2 | 4 | 3.1 | -0.9 |
| | Neutral | 6.4 | 6.2 | -0.2 | 12.4 | 7.2 | -5.2 |
| | Somewhat Certain | 50.5 | 33 | -17.5 | 57.4 | 27.8 | -29.6 |
| | Very Certain | 39.1 | 50 | 10.9 | 25.7 | 59.3 | 33.6 |
| Private | Very Uncertain | 3.8 | 4.7 | 0.9 | 8.5 | 7.5 | -1 |
| | Somewhat Uncertain | 9.7 | 5.6 | -4.1 | 16.1 | 15 | -1.1 |
| | Neutral | 8.9 | 5.6 | -3.3 | 14.8 | 10.3 | -4.5 |
| | Somewhat Certain | 54.2 | 43 | -11.2 | 43.2 | 40.2 | -3 |
| | Very Certain | 23.3 | 41.1 | 17.8 | 17.4 | 27.1 | 9.7 |
| Land Grant | Very Uncertain | 1.6 | 6.6 | 5 | 2.9 | 5.9 | 3 |
| | Somewhat Uncertain | 4.9 | 5.7 | 0.8 | 9.7 | 6.3 | -3.4 |
| | Neutral | 6 | 6.1 | 0.1 | 9.6 | 8.2 | -1.4 |
| | Somewhat Certain | 46.5 | 39 | -7.5 | 47 | 44.4 | -2.6 |
| | Very Certain | 41 | 42.7 | 1.7 | 30.7 | 35.1 | 4.4 |
| Large Urban | Very Uncertain | 0.6 | 3.4 | 2.8 | 1.1 | 3.7 | 2.6 |
| | Somewhat Uncertain | 2.6 | 4.4 | 1.8 | 6.8 | 5.4 | -1.4 |
| | Neutral | 5.2 | 3.7 | -1.5 | 9.7 | 4.7 | -5 |
| | Somewhat Certain | 51.9 | 36.4 | -15.5 | 51 | 45.8 | -5.2 |
| | Very Certain | 39.7 | 51.9 | 12.2 | 31.3 | 39.7 | 8.4 |

Values are percentage of students selecting each category

The Rank-Sum test of statistical significance for certainty in engineering as a major is shown Table 5b. The increases noted from the summary statistics were statistically significant for the Private and Large Urban institutions. Given that the mean shift was positive for both the Private and Large Urban institutions, this indicates that in both institutions students increased in their level of certainty that engineering is the correct academic major for them.

**Table 5b. Rank-Sum Statistical Test Certainty in Engineering as a Major**

| 5 Pt Likert Scale (higher value = more positive response) | Urban Public | Private | Large Land Grant | Large Urban |
|---|---|---|---|---|
| Average Start of Semester | 4.243 | 3.826 | 4.204 | 4.264 |
| Average End of Semester | 4.187 | 4.103 | 4.055 | 4.279 |
| Difference (End - Start) | -0.056 | 0.277 | -0.149 | 0.016 |
| P value (Rank Sum Test) | 0.287 | **0.003**** | 0.120 | **0.0157**** |

The Rank-Sum test of statistical significance for certainty in engineering discipline is shown Table 5c. The increases noted from the summary statistics were statistically significant for the Urban Public and Large Urban institutions. Given that the mean shift was positive for both the Private and Large Urban institutions, this indicates that in both institutions students increased in their level of certainty in their engineering discipline selection.

**Table 5c. Rank Sum Statistical Test Certainty in Engineering Discipline**

| 5 Pt Likert Scale (higher value = more positive response) | Urban Public | Private | Large Land Grant | Large Urban |
|---|---|---|---|---|
| Average Start of Semester | 4.0396 | 3.4322 | 3.9299 | 4.0403 |
| Average End of Semester | 4.3990 | 3.6449 | 3.9650 | 4.1044 |
| Difference (End - Start) | 0.3594 | 0.2127 | 0.0351 | 0.0641 |
| P value (Rank Sum Test) | **0.000*** ** | 0.076 | 0.863 | **0.0065** ** |

These results may be a reflection of the ways in which each of the institutions addresses the engineering disciplines in the first semester. A prior study by Hoit and Ohland reported up to 17% increase in retention based on the redesign of a first-year engineering course to focus on disciplinary knowledge.[9] The Urban Public institution's first-year engineering program includes a 1-credit course devoted to selection of an engineering major. This includes hands-on activities lead by faculty and industry professionals to learn about each of the engineering disciplines offered.

At the Private institution, the students are exposed to a basic engineering design process through multi-week projects that are not intended to aide in engineering discipline selection. However, students complete a series of homework assignments throughout the semester that aid in selecting their major, understanding engineering career options, and integrating into the College of Engineering.

At the Large Land Grant, the students are exposed to a variety of engineering disciplines through weekly laboratory experiences, but selection of a major is not a primary focus. The students do simultaneously take a one- or half-credit "survey" course run through their intended departments, but there is little content that is discipline-specific in it; the focus is more on a general adjustment to college academics and life.

At the Large Urban institution, direct matriculation into a major is allowed. However, students are still required to take several common first-year engineering courses. Instead of focusing on introducing the various engineering disciplines, these courses focus more on developing problem-solving and basic analytic skills and promote the development of connections between the different fields of engineering and the math and science content being covered in the other first-year STEM courses. Activities in these courses include examples from each of the different engineering disciplines, which may help to solidify each student's initial choice of major or help in deciding which field is of most interest for those who have yet to select a major.

One potential explanation for the differences observed is the structure of the First-Year Engineering Programs previously described. It is possible that since the first-year engineering courses at the Private and Large Land Grant institutions tend to have a broader content focus on

skills required for all engineering students, not necessarily specific to learning about or selecting an engineering discipline, the differences are not reflected from just the fall semester.

**Discussion / Conclusions**

All 4 of the institutions reported lower mean values for "interest in engineering" at the end of the semester than at the start. The Large Land Grant was the only institution in which that shift was statistically significant, which could be a result of the number of responses (Since that program is larger than the others, a smaller shift can be found to be statistically significant). Given that the retention numbers for the Large Land Grant were in the middle of the institutions, it does not appear that they are "chasing students away." Also, by surveying the students at the start of the semester there is a certain excitement and energy at that time as opposed to the end of the semester when students are feeling the pressure of their first college level final examinations. We suspect that these four institutions are not alone in this phenomenon in which students, before they necessarily have any experience within a major, initially indicate a very high interest in it; after a semester within the major all students should have a clearer picture of what it means to be in that major and whether they see themselves in that role (engineering identity).

The Private and Large Urban showed students with an increased certainty in engineering as a major. While the Urban Public and Large Urban both reported greater certainty in which engineering discipline students intend to pursue. The Urban Public's course devoted to exploring and selecting engineering major is a likely contributor to student certainty of their engineering discipline. One possible explanation for the higher averages at the start of the semester and the positive trends in certainty for the Large Urban institution is that the program likely attracts a different type of student, namely ones that are already highly committed to engineering. First, given that the institution allows for direct matriculation of students to majors, students already come in having done some research about the different disciplines. While they may not have a firm grasp of what each discipline does, they at least know enough to make some broad categorizations. Additionally, starting with the second semester, students begin their disciplinary coursework, with each discipline offering one major specific course. As a result, there is added pressure for students to be sure that their chosen discipline is the right one during their first semester. Finally, the engineering program at the Large Urban institution is a mandatory co-op program, with students starting rotations as early as the fall of their sophomore year. Students must be admitted to a major before starting co-op, so there is additional incentive for students to select a major (for those who may have enrolled as undeclared engineering) and the right major (for those who were admitted directly to a major), as any delay in starting co-op rotations can ultimately lead to delays in graduation. Also, since co-op is a major component of each engineering degree program, the institution often attracts students who are already highly interested and eager to experience engineering. The authors do not make any suppositions that one approach to First-Year Engineering is "better" than another; rather it is believed that the

First-Year Engineering approach is part of the overall university culture and all aspects of that culture "attract" a certain type of student that identifies with that environment.

The selectivity of the institution may also contribute to the results observed. The Private institution is considered highly selective, while the others were moderate or low selectivity. The Private institution also observed the highest retention rates from fall to spring which may indicate either a more academically prepared or committed student. Prior literature indicates that math preparation and high school GPA influence retention.[10] A recent work-in-progress reported that grades may impact student major selection – specifically student interest may be reduced as a function of course grades.[11] And overall every institution has its own "culture" and attracts a certain student population depending on the environment[12] (commuter vs. residential), Greek life, the number and type of degree programs, geographic location (and if students are primarily in-state or out of state).

## Future Work:

The current study would benefit from expansion to other programs beyond the MidWest and consideration of how major selection varies by different underrepresented groups, including women. Additionally, the current students could be followed longitudinally to determine if there are differences by institution in terms of engineering major selection, retention within engineering disciplines, and time to graduation. One area of interest in particular that has arisen from this study is to see whether the effects potentially attributed to departmental enrollment caps at the Large Urban university surface at the Large Land Grant in the sophomore year, when most students apply to their majors. Finally, the "polarizing" interest observed in this study raises questions about which students are shifting and where are they going? Are these the same students that come in undeclared? A follow-up study in the 2015-2016 school year is planned to further explore these issues.

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