PARAMETERIZING MAJOR DISCERNMENT FOR FIRST AND SECOND-YEAR ENGINEERING STUDENTS

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Introduction

To address the desire for a more technically oriented workforce on a national level, several engineering educational initiatives were launched with a goal to increase the number of students that graduate with an engineering degree each year from the United States [1-2]. Subsequent engineering education research has led to a better understanding of the major discernment process for engineering students. Numerous studies exist that have focused on engineering identity formation of students [3-6], motivation for enrolling in engineering programs [7-10], and the major discernment process of engineering students [11-13]. However, little work exists on developing a better understanding of specific parameters that influence the decision-making process for first and second-year engineering students, such as required courses, technical electives, and outside the classroom "engineering major exploration" experiences (i.e., events designed to inform students about specific engineering majors). Further, prior work has only focused on analyzing quantitative data with the absence of qualitative data through open-ended student surveys or interviews. Therefore, expanded research efforts are needed to address this knowledge gap and provide a clearer understanding of major discernment for engineering students in order to help students make informed major decisions, thereby reducing the number of future major changes [11,14].

Background

Similar to other college students, engineering students switch majors throughout their academic career [9]. While prior studies have shown a significant percentage of students change their engineering major within their first-year of engineering study, some students who desire to change majors do not for reasons such as family input or the work associated with the major change process [8-9,11]. When students do not self-identify as their selected major, satisfaction and longevity in their engineering careers decrease [8]. There is a need for University initiatives that encourage engineering major exploration prior to major declaration, which should result in more satisfaction among engineering students within their academic and professional careers.

Previous research on engineering major selection has generated a better understanding of why students switch between engineering majors and which majors tend to better retain students [9,11]. It is critical to focus on the first and second-year of study in retaining engineering students, since larger attrition rates are observed during these years [5]. There have been strong correlations between higher retention rates and engineering students within common First-Year Engineering (FYE) programs [11,14-16] as well as engineering students that enter common FYE programs with a specific declared or intended major [5,11,13]. However, these studies lack sufficient investigation and conclusions regarding specific parameters (e.g., course content, outside the classroom experiences) that are most influential to the major discernment process. Further, these studies focused on first-year students and did not continue to track major changes through the second-year of engineering study. While there is a significant amount of quantitative data available regarding retention rates, graduation rates, and major changes, only one current study on major selection has included student interviews [11]. Further, only a few studies have

included student feedback through surveys [10,13,17]. Unfortunately, no significant qualitative information has been published, since these studies excluded open-ended or free response questions. This represents another part of the knowledge gap of the engineering major discernment process.

Objectives

This study is motivated towards providing engineering students with an in-depth understanding of engineering majors prior to their major declaration, increasing the likelihood that students make informed major selections and, thereby, reducing the number of future major changes and decreasing the time to graduation. This paper intends to expand upon the current knowledge basis of the engineering major discernment process by using both quantitative and qualitative data (as a limited number of studies include both data types) as well as continuing to track student outcomes over multiple years (as few studies include information beyond the first-year of engineering study). The project studies how students perceive, select, and utilize academic opportunities and experiences (during their initial years of engineering study) with respect to their long-term career goals through the major selection process. The primary research objectives were to:

1. Identify specific parameters (e.g., FYE course content, technical engineering electives, inside and outside the classroom major exploration opportunities) that influence major discernment using both quantitative and open-ended qualitative data.
2. Monitor major changes of students through the completion of sophomore year, since larger attrition rates are observed during the first two years of engineering study [5].
3. Provide recommendations (e.g., FYE course content, outside the classroom experiences) applicable to engineering programs that help students make informed major selections.

This study was limited in scope to a single University and students with the intent to major in Civil or Environmental Engineering (CE or EVEG) at the time of their enrollment as well as students that declared as CE/EVEG majors during their freshman or sophomore years. The study was conducted over three academic years and included two entering classes of students (referred to as Cohorts A and B). A comparison study of major discernment experiences for students outside of Cohorts A and B is beyond the scope of this paper. Ultimately, this work should provide a template for a larger and expanded future study that would include all engineering majors at the University.

First-Year Engineering: Course Structure

All incoming students interested in engineering at the subject University are required to participate in a common FYE program. The coursework consists of a multi-disciplinary, two-class sequence, with one course offered in each the Fall and Spring semesters. Each course is three credits and meets twice per week for 75-minutes per meeting. The Fall semester course teaches engineering skills and concepts that focus on the general engineering design process, including forming design statements, performing needs assessment, identifying pertinent theories, equations and approaches needed for problem solving, analyzing and evaluating potential solutions, and selecting the most appropriate option for implementation into a final

design. The Spring semester course primarily focuses on computer programming. Major exploration and discernment are incorporated into both courses in a variety of ways (discussed in detail in the following section). Each academic year, approximately 500 students participate in the FYE courses, divided among 12 course sections per semester with each section having fewer than 50 students. The courses are taught by faculty members from different departments within the College of Engineering. In an effort to determine the impact of the instructor on the major discernment process, the department affiliation of the instructor for the students within this study was documented.

Both courses use project-based learning as an essential aspect of the class. The Fall semester course incorporates two common group projects, where student groups are provided with similar design statements, requirements, and constraints. The Spring semester course features one open-ended design project, where student groups can determine individualized design statements that align with their academic interests or, alternatively, student groups can select a design statement from a list of "mentored" projects (where course instructors, engineering faculty from outside the course, and/or representatives from engineering companies unaffiliated with the University volunteer to work with the student group to act as a technical mentor and resource in support of the project).

First-Year Engineering: Major Exploration Opportunities

Within both courses, students had the opportunity to explore their potential engineering majors throughout the semester, both inside and outside of the classroom. For Cohorts A and B, both the Fall and Spring semester courses required students to attend at least four engineering exploration activities (i.e., activities intended to help a student's growth as an engineer and/or understanding of the options available within the College of Engineering) outside of normal class meeting times. Acceptable engineering exploration activities included, but were not limited to, student club meetings, departmental or college guest lecture series, departmental information sessions, and meetings with individual faculty members. For those students specifically interested in CE or EVEG, the following additional major exploration opportunities were created for all students enrolled in the Fall semester course: (1) guided construction site tours of a large campus project, (2) CE/EVEG major information session, (3) faculty and student departmental picnic, (4) guided tours of academic and research laboratories, and (5) lunches between small groups of FYE students and individual CE/EVEG faculty members. Table 1 provides a summary of these major exploration opportunities. For each event, sign-in sheets were used to track student attendance. Several additional major exploration opportunities were offered within the classroom or in lieu of class meeting time for only Cohort B students during the Fall semester (as shown in Table 1). This change was part of a greater effort by the FYE program to incorporate major discernment within the classroom. In addition to attending four outside the classroom major exploration events, three new opportunities were incorporated as required elements to the Fall course for Cohort B students: (1) undergraduate student panel discussions focusing on specific majors (to allow students to better understand their future academic experiences), (2) alumni panel discussions focusing on specific majors (to allow students to better understand their post-graduation experiences), and (3) guided tours of academic and research laboratories. During each of these three events, simultaneous meetings occurred featuring all engineering departments/majors and students selected which meeting to attend based on their personal

interest. Both quantitative and qualitative data regarding attendance and student experiences for the CE/EVEG specific events was gathered.

Table 1. CE/EVEG Major Exploration Opportunities for FYE students

Major Exploration Opportunities	Offered to Cohort A	Offered to Cohort B	Incorporated w/in Classroom	Associated FYE Course
Construction Site Tours	Yes	No	No	Fall
CE/EVEG Information Session	Yes	Yes	No	Fall
Faculty and Student Picnic	Yes	Yes	No	Fall
Laboratory Tours	Yes	Yes	Cohort A: No Cohort B: Yes	Fall
FYE Guest Lecture	Yes	Yes	Yes	Fall
Student Panel Discussion	No	Yes	Yes	Fall
Alumni Panel Discussion	No	Yes	Yes	Fall
Lunch with Faculty Member	Yes	No	No	Spring
CE/EVEG Technical Elective	Yes	Yes	No	Spring
FYE Mentored Design Project	Yes	Yes	Yes	Spring
FYE Instructor with CE/EVEG Background	Yes	Yes	Yes	Both

Inside the classroom major exploration opportunities were also provided in the form of common course content for both courses (as shown in Table 1). During the Fall semester course, FYE students were exposed to one guest lecture focusing on CE/EVEG majors. For Cohort A, the guest lecture expanded upon one of the required group projects (where students designed a floating platform) by discussing real world applications related to CE/EVEG. No other engineering department provided a guest lecture to Cohort A. For Cohort B, the guest lecture was part of a larger major discernment module (which exposed students to guest lectures from all departments within the College of Engineering over several weeks). For Cohort B, the guest lecture focused on defining CE/EVEG majors and career paths, and included interactive activities that the students completed as part of their daily participation grade for the course. During the Spring semester course for Cohorts A and B, six to eight design statements for "mentored" projects were provided to FYE students as an option for their semester-long design project. No other engineering department offered design statements for mentored project; however, design statements were offered by engineering companies/organizations unaffiliated with the University. Both quantitative and qualitative data regarding project selection and student experiences was gathered.

While unrelated to the FYE program, FYE students within Cohorts A and B could enroll in major-specific technical engineering electives during their Spring semesters. These courses have been recently developed to provide the opportunity for students to begin academic study within their intended major prior to declaring a major (which occurs near the conclusion of their first-year of study). In addition to a CE/EVEG focused technical elective, courses were offered in each chemical engineering and electrical engineering.

Research Methodology

The project approach and research framework both follow the social cognitive career theory, where career development can be analyzed through relationships such as the development of academic and career interests, educational and career choices, as well as academic and career success. Each student in the study was classified as shown in Table 2. Three general classifications were identified for each major: retained (i.e., those students who started and ended the study with the same major), added (i.e., those students who ended the study as CE/EVEG majors, but started the study as a different major), and lost (i.e., those students who started the study or declared during the study as CE/EVEG majors, but ended the study as a different major). Student were also given a specific classification based on the timeline of their major classification (as shown in Table 2). Major classifications were tracked at three points in time. Intended majors were based on student surveys conducted by the Office of the Registrar prior to enrollment at the subject University before the first year of engineering study. Major declarations were completed by students near the end of their first-year of engineering study and obtained via the College of Engineering. Final majors for students in this study were defined as a student's major at the conclusion of the second-year of engineering study and also obtained via the College of Engineering. Table 3 provides the number of students included in the study based on their CE/EVEG major classification and cohort group. Students that switched between CE and EVEG majors during the study were simultaneously counted as an added student for one major and a lost student for the other major. There was one such student from Cohort A and eight such students from Cohort B.

Table 2. Student Classification[a]

General Classification	Specific Classification	Intended Major	Declared Major	Final Major
Retained	Fully Retained	CE	CE	CE
	Partially Retained	CE	non-CE	CE
Added	Early Added	non-CE	CE	CE
	Late Added	non-CE	non-CE	CE
Lost	Early Lost	CE	non-CE	non-CE
	Late Lost	CE	CE	non-CE
	Temporary Added	non-CE	CE	non-CE

[a] Table completed for CE. A similar classification was created for EVEG.

Table 3. Study Participants[a]

General Classification	CE Students		EVEG Students	
	Cohort A	Cohort B	Cohort A	Cohort B
Retained	21	18	10	6
Added	17	14	4	9
Lost	17	17	15	12
Total	55	49	29	27

[a] There were 512 and 483 FYE students in Cohorts A and B, respectively.

Quantitative data regarding student participation in the CE/EVEG major exploration opportunities (as listed in Table 1) was gathered and analyzed for both general and event specific trends. To complement the quantitative data as well as to better assess if particular student experiences had a significant impact on major selection and major certainty, direct feedback from both first and second-year engineering students was acquired through open-ended surveys. As shown in Table 4, surveys were given to participants in Cohorts A and B at the end of the

first-year of engineering study and at the start of the second-year of engineering study (to allow students time to reflect on their major discernment process and determine the certainty of their major selections). In these surveys, the main question asked participants to reflect on their first-year of engineering study (e.g., FYE courses, major exploration opportunities) and indicate why they selected their specific engineering major. Another survey was conducted of both cohorts at the end of the second-year of engineering asking a similar question, but reflecting on student experiences during the second-year of engineering study. An additional survey was given to both cohorts of FYE students who participated in the CE/EVEG mentored projects during the Spring FYE course. This survey asked students why they selected their projects and if the project experience changed their interest in CE/EVEG or influenced their major selection. The survey data was collected anonymously. Table 5 shows the total number of student CE/EVEG major exploration experiences for both cohorts. When appropriate, the quantitative and qualitative databases were analyzed to identify trends using chi-squared tests (with a p-value of 5% or less to reject null hypothesis).

Table 4. Open-Ended Student Feedback Opportunities

Student Feedback Opportunities	Offered to Cohort A	Offered to Cohort B
Major Discernment Paper	No	Yes
Mentored Design Project Survey[a]	Yes	Yes
End of 1st Year of Eng. Study Survey	No	Yes
Start of 2nd Year of Eng. Study Survey	Yes	Yes
End of 2nd Year of Eng. Study Survey	Yes	Yes

[a] Distributed to only students participating in CE/EVEG mentored projects.

As part of the incorporation of major discernment within the Fall FYE course for Cohort B, all FYE students were asked to write a paper (worth 10% of their final grade) discussing their major discernment process, their certainty of their current intended major, and how their major exploration experiences and opportunities influenced their current major intention and certainty (including those experiences listed in Table 1). Papers from the participants in this study were read and each applicable CE/EVEG major exploration experience was documented as either positive, neutral or negative. Table 5 shows the total number of experiences contained with the major discernment papers for Cohort B. Students were categorized as having positive experiences when they discussed a positive change in their major (towards CE/EVEG) as a result of participating in a CE/EVEG major exploration opportunity (e.g., realization what type of career opportunities were available to CE/EVEG majors). Students were categorized as having a neutral experience if they attended an event, but did not include discussion of those events in their papers or discussed the event as not having an impact on their

Table 5. Participant Experiences

General Classification	Student Experiences for Cohort A	Student Experiences for Cohort B	Student Experiences discussed within Discernment Papers[a]
Retained	117	129	50
Added	52	97	31
Lost	72	91	31
CE/EVEG Total	241	317	112
Non-CE/EVEG[b]	220	116	--

[a] For Cohort B only; Cohort A did not complete FYE major discernment papers.
[b] Indicates students that attended a CE/EVEG major exploration event, but were not participants in this study due to major classifications other than CE/EVEG.

major decision. Students were categorized as having a negative experience if they indicated the event was either unhelpful (e.g., student expressed disappointment in an aspect of the event) or decreased their likelihood of majoring in CE/EVEG (e.g., due to lack of interest in CE/EVEG career paths or due to limited study abroad opportunities). Combined with the quantitative data, the open-ended responses from student surveys and the major discernment papers helped to provide perspective in achieving the research objectives.

Results: Quantitative Data

While participation in major exploration events was found to be definitively linked to the major discernment process, no individual CE/EVEG event proved more effective in consistently retaining or adding students (i.e., events deemed effective, neutral, or ineffective during year one of the study did not maintain those labels during year two). In terms of impacting major selection, no difference was observed between inside and outside the classroom events during the first year of engineering study. However, FYE experiences that occurred later in the academic year did have slightly better student retention and addition data. This may be related to association rather than causation, as students likely limited their potential major selections as they progressed through their first year of engineering study (i.e., students attending exploration events later in the academic year were more seriously interested in CE/EVEG as majors). Events with smaller student-to-faculty ratios did appear to be more successful (i.e., higher retention and addition rates). Further, the retention and addition rates were higher amongst FYE students exposed to a CE/EVEG faculty member as their FYE instructor. However, the sample size for these observations were small and did not warrant a definitive conclusion as to the significance of these data trends.

Students majoring in CE/EVEG at the end of sophomore year most likely started freshman year as intended CE/EVEG majors, as 47.4% (55 students) of intents over both cohorts were retained within their major. As shown in Table 6, the likelihood of retention was linked to participation in two or more exploration events, as 65.7% (44 students over both cohorts) of students that participated in at least two CE/EVEG major exploration experiences were retained, while only 22.4% (11 students over both cohorts) of students that participated in one or fewer CE/EVEG major exploration experiences were retained. Similarly, the likelihood of losing a student was linked to their lack of participation, as 62.3% (38 students) of "lost" students over both cohorts attended no more than one event. Students that left CE/EVEG most commonly left the College of Engineering, representing 26.2% (16 students) of lost students. A chi-squared analysis led to small p-values, confirming the statistical significance.

Table 6. Student Retention

General Classification	Cohort A		Cohort B	
	Attended 0 or 1 Event	Attended 2+ Events	Attended 0 or 1 Event	Attended 2+ Events
Retained	10 students	21 students	1 student	23 students
Lost	25 students	7 students	13 students	16 students
P-Value	2.49E-4		8.31E-4	

Students that changed their major to CE were most commonly Mechanical Engineering intents, representing 41.9% (13 students) of "added" CE students. Students that changed their major to

EVEG were most commonly Chemical Engineering intents, representing 46.2% (6 students) of added EVEG students. As shown in Table 7, the likelihood of students switching into CE/EVEG was again indicated by their participation in at least two major exploration experiences, as 56.8% (25 students) of "added" students participated in at least two experiences. A chi-squared analysis led to small p-values, confirming the statistical significance. Also shown in Table 7, significantly more students that started their first year of engineering study as non-CE/EVEG intents participated in a CE/EVEG major exploration experience in Cohort A (188 students) than in Cohort B (109 students). Further, the non-CE/EVEG intents that participated from Cohort B were added at a higher rate [i.e., 53.1% (17 students) of students that participated in two or more exploration events were added from Cohort B while only 16.3% (8 students) of these students were added from Cohort A]. This was likely related to the creation of major exploration experiences for all majors within the College of Engineering (a result of changes to the FYE course structure, as previously discussed). This change not only distributed students among a diverse selection of major exploration experiences, but also likely forced students to be more thoughtful and selective about their participation in these events. As expected, fewer students changed majors after the completion of their first year of engineering study (17.5% or 28 students within the participant pool made sophomore year major changes). There was no observable difference in the quantitative data between students that switched majors in their first or second year of engineering study.

Table 7. Student Addition

General Classification	Cohort A			Cohort B		
	Attended 0 Events	Attended 1 Event	Attended 2+ Events	Attended 0 Events	Attended 1 Event	Attended 2+ Events
Added	6 students	7 students	8 students	3 students	3 students	17 students
Not Added	256 students	132 students	41 students	326 students	74 students	15 students
P-Value	1.04E-4			1.60E-36		

Results: Qualitative Data

The open-ended survey data was collected anonymously and typically had a moderate response rate (about 40% of students responded), which prevented significant statistical analysis. However, it did allow for assistance in understanding the decision-making process of participants in this study. Within the surveys provided to the participants at the end of the first year of engineering study as well as at the beginning and end of the second year of engineering study, both retained and added students typically stated they ultimately majored in CE/EVEG due to the broad variety of career paths, ability to make a positive impact on society through their career choices, and positive one-on-one interactions with faculty members during exploration events. Some lost students indicated a similar desire to impact society, but also a realization that any engineering degree could be used to serve society. The most common reported reasons for students to change majors was an experience during their first year of engineering study (commonly major exploration opportunities provided through the FYE courses) that inspired them and/or interest in job opportunities within their selected field. It was unclear if major certainty was impacted by specific events, as there was no clear delineation between major certainty, student classifications, and specific events.

The results of the surveys provided to participants in the mentored FYE design projects indicated that the projects were not instrumental in changing students' minds about their major. While nearly all responding students reported interest in the project design statements, students who indicated the projects were selected due to an interest in CE/EVEG as potential majors were almost exclusively retained or added students, demonstrating that their interest existed prior to their participation in the projects. Further, lost students (and non-CE/EVEG students) were far more likely to report that group members influenced their project selection and rarely reported that interest in CE/EVEG as potential majors was a factor in their project selection. This demonstrates that students did not appear to change their majors as a result of participating in the projects; however, the projects also did not discourage students from leaving the CE/EVEG majors.

Table 8 shows the results from the major discernment papers for Cohort B, categorizing each CE/EVEG experience discussed within the papers as either positive, neutral, or negative and grouped based on general student classifications. The overwhelming majority of major exploration experiences were positive and a similar amount of experiences were reported as each neutral and negative. As expected, both retained and added students had very high relative percentages of positive experiences (86.0% and 71.0%, respectively), while lost students typically did not have positive experiences (only 45.2%), as they reported the largest percentage of neutral and negative experiences. A chi-squared analysis led to a very small p-values, confirming the association between types of experiences and general student classifications. The discussion within the discernment papers demonstrated that certainty, understanding, and stability in careers after graduation were all important aspect of the discernment process for students. Retained students typically indicated they attended CE/EVEG exploration events to confirm their interest or major decision, while many lost students attended non-CE/EVEG major exploration events to gain basic knowledge or confirm interest in other majors. As expected, students intending to major in CE/EVEG at the start of their first year of engineering study typically reported a strong initial certainty in their major intention; however, an equal amount of those students were retained (14 fully retained students) as were lost (13 early lost students), indicating that a student's initial major certainty may not be a good predictor of their final major selection. None of the added students indicated a strong initial certainty in their non-CE/EVEG major intention.

Table 8. Categorization of Experiences

General Classification	Positive Experiences	Neutral Experiences	Negative Experiences
Retained	43	5	2
Added	22	6	3
Lost	14	7	10
Total	79 (70.5%)	18 (16.1%)	15 (13.4%)
P-Value	1.12E-15		

Several of the CE/EVEG major exploration events were discussed by the students with enough detail and frequency within the major discernment papers to allow for a focused analysis (as shown in Table 9). Students that discussed the faculty and student picnic as well as the CE/EVEG information session reported only positive and neutral experiences. For both events, the retained students had an overwhelmingly higher percentage of positive experiences, while lost students reported more neutral experiences than positive experiences (as would be expected). The student and alumni panel discussions had more total experiences reported, the likely result

of these events being incorporated within the allotted FYE classroom time. Participants who attended these panel discussions reported mostly positive experiences (76.2% and 66.7% for the student and alumni panel discussions, respectively). Nevertheless, a noteworthy amount of negative experiences during the alumni panel discussion were also reported (26.7%), particularly among those students that did not start their first year of engineering study as a CE/EVEG intent (e.g., lost students reported that 61.5% of their experiences were negative). The negative impressions of the panel discussions were based on narrow job field discussions by panelists (e.g., EVEG students or alumni were not present on all panels) and a general disinterest in the topics discussed by the panelists, causing some students to feel they did not gain a clear understanding of CE/EVEG classes and/or careers. Similar frustrations were expressed with regards to the engineering career fair (which occurs near the beginning of each Fall semester). While the engineering career fair was not a tracked CE/EVEG exploration event (see Table 1), students in each general classification (but particularly lost EVEG students) reported negative experiences in terms of available employers, providing valuable insight and supporting the notation that post-graduation plans strongly influence major selection. Among the events discussed within the discernment papers, the student panel discussion appeared to be the most successful, due to the relatively high student participation (42 total experiences) and overall positive impact across all student major classifications.

Table 9. Categorization of Specific CE/EVEG Major Exploration Opportunities

General Class.	Faculty and Student Picnic			CE/EVEG Information Session		
	Positive Experience	Neutral Experience	Negative Experience	Positive Experience	Neutral Experience	Negative Experience
Retained	4	1	0	5	0	0
Added	0	1	0	5	2	0
Lost	1	2	0	2	2	0
Total	5 (55.6%)	4 (44.4%)	0 (0%)	12 (75.0%)	4 (25.0%)	0 (0%)
General Class.	Student Panel Discussion			Alumni Panel Discussion		
	Positive Experience	Neutral Experience	Negative Experience	Positive Experience	Neutral Experience	Negative Experience
Retained	18	2	1	16	2	1
Added	8	2	0	9	1	3
Lost	6	3	2	5	0	8
Total	32 (76.2%)	7 (16.7%)	3 (7.1%)	30 (66.7%)	3 (6.7%)	12 (26.7%)

Summary and Recommendations

This study focused on identifying specific parameters that influence major selection for engineering students using a combination of quantitative and open-ended qualitative data. Major exploration opportunities (both associated and unassociated with common FYE courses) were provided to students throughout their first year of engineering study. The major discernment process of students with documented interested in CE/EVEG was monitored through the completion of their second year of engineering study using a combination of participation data

from CE/EVEG major exploration experiences, open-ended student surveys, and major discernment papers (assigned through the Fall semester FYE course). While participation in more than one major exploration event was found to be definitively linked to the major discernment process (as participation in two or more major exploration events more closely correlated to student retention and addition within a major), no individual CE/EVEG event proved more effective in consistently retaining or adding students. Students most commonly stated that their CE/EVEG major selection was influenced by the broad variety of career paths, ability to make a positive impact on society through their career choices, positive one-on-one interactions with faculty members during exploration events, and/or interest in job opportunities within their selected field. Students who were added into the CE/EVEG majors (i.e., students who ended the study as CE/EVEG majors, but started the study as a different major) most commonly reported changing majors after being inspired by one of their major exploration experiences. Lost students (i.e., students who started the study or declared during the study as CE/EVEG majors, but ended the study as a different major) had lower participation in CE/EVEG major exploration events and more frequently reported neutral or negative experiences during these events. The discussion within the major discernment papers demonstrated that certainty, understanding, and stability in careers after graduation were also important aspect of the discernment process for students.

The following is a list of general recommendations when creating and implementing department specific major exploration experiences for engineering students in their first year of study:

- Multiple outside the classroom experiences should be offered throughout the academic year, as participation in two or more major exploration events more closely correlated to student retention and addition within a major. Inside the classroom experiences are also valuable, as it allows a larger number of students to more easily participate in the activity.
- Specific major exploration event should be centered around themes that are unique and important to the characterization of the department or major. While the specific focus of a singular event (e.g., lab tours, information sessions) may not have a significant influence on the major discernment process, students reported they were attracted to CE/EVEG majors by the ability to make a large and positive impact on society as well as the diversity of the academic and post-graduation experiences.
- Experiences where first-year engineering students interact with older engineering students appear to have the most value, followed by experiences which discuss career paths and post-graduation opportunities. In addition, FYE instructors with major-specific backgrounds appear to be advantageous towards influencing the major selection process of their students (despite the small sample size for this observation).
- The contents of a major exploration opportunities should match what is advertised (e.g., providing panelists from all applicable fields) to help minimize negative student experiences. This approach should be extended to events sponsored by the College (e.g., engineering career fairs) or University, ensuring equal representation on a departmental and/or major level.
- When creating opportunities, it is important to understand that larger student attendance does not equate to larger major enrollment (via student retention or addition). Events that

feature a smaller, but more focused student audience and events that feature smaller student-to-faculty ratios were more successful in terms of retaining and adding students.

- The source(s) of potential added students should be recognized when creating major exploration opportunities. Added CE students most commonly intended to major in mechanical engineering while added EVEG students most commonly intended to major in chemical engineering. This information can be valuable in creating events to attract new students to a particular department or major.

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