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Examining Student Motivation to Persist in Engineering when Turned Away from their First-Choice Major

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Examining Student Motivation to Persist in Engineering when Turned Away from their First-Choice Major

This Empirical Research Brief describes a study conducted to examine undergraduate engineering students' perceptions of what affected their application to a specific engineering major and how these perceptions related to their motivation to persist in engineering. Previous research has examined how students learn about, select, and apply to engineering majors across various universities and disciplines, but not all students get into their first-choice major, disrupting their academic plan. Understanding how this disruption affects student motivation is important in the continued work in attracting a diverse range of students to engineering and creating an inclusive and supportive environment to promote student success, retention, and graduation. An academic plan disruption, such as not being admitted into their major or program of choice, may communicate the wrong message, appearing to push students away from engineering rather than encouraging participation. Examining students' perceptions of experiencing academic plan disruptions can help the field to design support programs, aid, and guidance for students who may have to adjust their plan to complete an engineering degree.

To examine the impact of academic plan disruptions to students' motivation, attribution theory was used as a theoretical framework to guide this study. This theory was used to connect what students believe affected not being admitted into their first-choice major and examine how their motivation to persist in engineering was affected. This study collected qualitative data through semi-structured interviews, where the students' perceptions were examined through causation and thematic coding. Causation coding was used to develop causation maps to trace what students believe affected their major application, and thematic coding used to apply the theoretical framework and examine how their motivation to persist in engineering may have been affected. These themes were examined to help answer the research questions of: *What factors do students attribute to not getting into their first-choice major, and how do students describe their next steps and motivation after not getting into their first-choice major?*

The results of this study can be used to better understand the experiences students face when they reach a point at which they may need to redesign their pathway to an engineering degree after they experience a disruption in their original academic plan. The focus on this research brief will be on the findings of how students' experiences and decisions relate to their sensitivity to social rejection. Through understanding these experiences, we can identify how to better prepare students for engineering major applications, support them when they face disruptions to their academic plans, and help them explore and select a path forward past academic challenges toward completing an engineering degree.

Key words: motivation, engineering major application, persistence

Introduction

One of the first steps a student takes toward becoming an engineer is selecting an engineering major. These majors exist to focus a student's studies and experiences in a specific direction, but they also help people quickly identify what skills and courses students are expected to have for a specific engineering major. While most modern engineering work is done through trans-

disciplinary teams whose skills may overlap [1], students are still expected to choose a specific major that often connects them to a specific engineering department, coursework, and requirements. Because of how much this decision can shape a student's experiences in college, students often seek help and advice in finalizing this decision. There exists a collection of research that examine how students select engineering and an engineering major (e.g., [2], [3]), which has helped develop exploration activities for students trying to decide (e.g., [4], [5]). Many engineering programs also offer support to students when making this decision, such as through first-year courses and labs or through conversations with faculty and peers (e.g., [3], [6], [7]).

The narrative of selecting and then majoring in a specific engineering discipline is typically represented as a story that ends with students choosing a major and studying it, but this is not the end of this process for all students. Engineering majors continue to be popular choices for college students, causing the demand for these majors to exceed the available spaces and resources in these programs [8], resulting in a process where not all students that go into engineering are able to major in their preferred discipline. Additionally, engineering and other STEM programs have also historically faced challenges in student retention and graduation rates [9], [10]. Often cited reasons for students leaving engineering are students not feeling like they belong in engineering, an event reducing their motivation to study engineering, or even something that reduces their engineering self-efficacy [11], [12]. Because these factors have been shown to decline after students have been denied admittance to a program or opportunity [13], we need to study the effect of students being denied entry into their first-choice major to better understand how to support students in this situation so we do not inadvertently push them away from engineering as a whole.

Background

In order to support students in making a decision about their engineering major when they do not get into their first-choice major, it is important to understand what factors affect their decisions and how they gain this information. Not all students come into this decision with the same background information, so engineering programs often include some opportunities for students to learn more about the majors through survey courses (e.g., [7]), engineering coursework and activities (e.g., [6]), and opportunities for students to explore each major (e.g., [14]), often in first-year engineering courses. While these opportunities help to even out the accurate information students have about the majors, students also learn about them outside of formal courses, ultimately combining the information they have to form perceptions of each major. Using these perceptions and their own desires for their future career, students then select an engineering major.

Universities use different types of matriculation processes for students to enter a major, such as direct matriculation into a major or a common first-year program with an application to a major. Additionally, not all universities use the same type of engineering major application process, where students may be automatically accepted by meeting certain criteria, applying to individual majors separately, or even applying through a common application across all engineering majors. Because these processes differ, students traversing them may need supported in different ways or at different times, so it is important to better understand what students need as they navigate

these processes and if they do not get into their first-choice major, what factors they consider when deciding their next steps. At [University] at the time of this study, engineering students must complete a common first-year engineering sequence while also taking prerequisite science and mathematics courses. After meeting the minimum requirements to apply to a major (which differ by major), students could then apply to up to three engineering majors, ranked in their preferred order.

To investigate student experiences after not getting into their first-choice major, we used Attribution Theory as a theoretical framework [15]. Attribution theory focuses on connecting what people attribute as a factor of some outcome and them examining how these attributions affect their motivation in the future [15]. In this framework, each attribution is broken down into three dimensions: locus of causality, controllability, and stability [15]. By using this theoretical framework, we were able to examine what factors participants believed affected them not getting into their first-choice major and then look at how their motivation to persist in engineering was affected.

Methods

The subset of findings discussed in this Research Brief help answer the following research questions:

RQ 1: What factors do students attribute to not getting into their first-choice major?
RQ 2: How do students describe their next steps and motivation after not getting into their first-choice major?

While this study included additional findings that answer these research questions, the qualitative findings specific to students' beliefs about their applications and next steps are discussed in this paper. The data considered for this article was collected through semi-structured interviews of 12 students who did not get into their first choice of engineering major. Each interview was performed virtually using Zoom and led by one researcher, however an additional person joined each interview to help take notes and ask follow up questions. The interviews were focused on asking participants questions about their experience about not getting into their first-choice engineering major, including why they believed they did not get in and what their next steps were. After all of the interviews were completed, the data was analyzed using causation coding to connect the causes, effects, and reasons they related to the outcome of not getting into their first-choice major. These codes were used to make causation maps that visually connected each of the causes that affected the result of their major application, and these maps were examined using thematic analysis to identify themes relating to their approach of the engineering major application and their next steps. While each participant had a unique story and perspective, it appeared that we reached saturation because we did not observe any new themes or experiences in the last few interviews [16].

Results

Using the causation maps, we identified themes in what participants believe affected them not getting into their first-choice major and how this outcome affected their motivation to persist in

engineering. This Research Brief focuses on three of the identified themes that help illustrate the participants' approach to the application and what affected their outcome. Each theme includes a few quotes or phrases from participants to provide examples of how their experiences match each theme.

Theme 1: Students did not know the best strategy for taking classes to create a strong application for their first-choice engineering major

One common experience participants discussed was not knowing how to strategically take courses and schedule classes in ways that improved their application success. During the interviews, they pointed to examples of taking hard courses too soon, causing their GPA to drop before the application. While each program does have a GPA requirement to stay in it, this requirement is much lower than the average GPA students needed to be competitive in these applications. Because their GPA was a significant aspect of their application, if they had waited to take these hard courses until after they got into their major, they would not have to worry about it dropping later as long as they kept it high enough to stay in the program. One student pointed out that other students took "really easy-A courses first or second semester" to improve their GPA before the application, and another student discussed regretting taking a higher-level math class before they needed to because if they had waited to take it, they would have had more time for their other courses and believe they would have "gotten in with flying colors."

These participants described strategies they believe would have helped improve their chance of getting into their first-choice major, however they did not receive advice regarding the application so did not think of these strategies until later. They often attributed this lack of strategy to external factors, as they acknowledged that there was some strategy on the timing of their courses to improve their chances of getting into their first-choice major, but that nobody shared this advice with them so they were caught off guard. Because these attributions were stable (a better strategy would usually lead to more success) and controllable (someone could share these strategies with them), the participants believed that adopting a better strategy could help future students, however they had already taken these harder courses and received lower grades, they were likely locked in and would be unlikely to be able to enter their first-choice major if they decided to apply again. This theme helps us identify how we can better prepare students for similar processes so they can more clearly identify their goal and design a path that helps them increase their odds of getting into their preferred major.

Theme 2: Students are motivated to select another major to avoid wasting time, credits, effort, or money and not fall behind in their academic plan

Another common experience participants discussed was being motivated to select another major to reduce waste in time, credits, or even money. While some participants had multiple majors in mind and were fine their second or third choice, many of them felt very strongly about their first-choice major. However, they also recognized that while they could turn down another major to reapply to their preferred major the following semester, they may be wasting time by delaying their graduation, which could also lead to taking additional courses they would not need and paying extra because of the extended timeline. Participants discussed accepting another major so they could "keep up with everything" and not get behind, finish sooner because they were

already worried about their student loans without taking additional semesters, and possibly putting in “a lot of effort to go through for nothing” if they reapplied to their first-choice major later. These experiences highlight the complex decision they have to weigh between if they want to reapply to their first-choice major again later (and risk not getting in again) or move on to a new major and not lose more time, effort, or even money.

These participants discussed an interesting idea that regardless of if their outcome could change in the future, that they had external factors that affected their motivation to apply again. Specifically, despite having a better understanding of the process and what they need to do to increase their likelihood of getting into their first-choice major, they faced limitations in time, money, or even effort as they considered having to retake courses and extend their projected graduation. Even if they could get into their first-choice major if they tried again, they may be delayed a whole year, increasing the time needed to graduate while also increasing the cost of finishing a program. Many of the participants decided that they would rather finish a different program on time, causing them to decide not to reapply and seek a different outcome. This theme may help us identify that the process is more complicated for students than just trying again, which we can keep in mind in designing future processes or supporting students that do not get into their preferred major.

Theme 3: Students consider how they can engage with their first-choice major-related interests & goals without being in the major

Many participants identified that even if they could not major in a specific type of engineering, they could still engage with that engineering type in ways outside of their chosen major. Some participants talked about how they could accept a different engineering major but still be able to take technical electives in their first-choice major to gain experience in it. Another participant discussed how the two majors were “the same thing, but with a different name,” allowing them to focus on overlapping skills between their preferred major and actual major. This theme was most salient for participants who accepted the major offered to them without planning on reapplying, suggesting that these students were comfortable connecting with their preferred engineering type without majoring in it. These participants identified a few ways they could still engage in their preferred type of engineering, including taking classes related to their first-choice major as electives and working jobs and internships related to their first-choice major. By still learning about and gaining skills related to their preferred major, one participant pointed out that they could sell themselves as whatever engineering type potential employers were looking for.

These participants identified what factors were internal to them and controllable by them that would allow them to engage with their preferred type of engineering. While they believed that many factors of process were out of their control and unlikely to change for them personally, they focused on new factors in their control, such as gaining experience and taking technical electives in their preferred major even if they selected a different major. By recognizing that they had alternative routes to access and connect with what they wanted to do after graduating, these participants displayed motivation to complete a different program, despite it not being the program they intended to study. This theme helps us to identify how we can help connect students to what they want to study, even if they cannot major in it.

Discussion and Future Work

The themes identified in this Research Brief illustrate some of the themes we identified in this study in student experiences as they apply to and do not get into their first-choice major. When applying to their first-choice major, students identified how the process may have turned out differently had they received advice on the order in which to take their classes. If they had decided to take a harder course after the application, they may have received the same grade in the course but still had a stronger application due to the grade not affecting their application, or even because they would have had more time to put into their other courses. In this situation, the timing in which they take their courses can matter because after they get into a major, their GPA can drop from future courses without affecting their major as long as they meet the minimum requirements set by their department or college. Identifying this theme can help us to see how we can support students experiencing a similar situation regarding applying to an engineering major and preparing for this process.

Not all students may get into their first-choice major, but some themes identified here also help us understand how students make a decision about whether they should extended their graduation timeline to reapply to their first-choice major, accept a different engineering major, or even leave engineering. These experiences help us understand what factors students weigh when considering reapplying or not, which can be used to have discussions about these topics with students if they do not get into their first-choice major. Additionally, the themes identified also look at ways in which students can connect to or gain experience in a specific engineering discipline, even if they do not major in it. By mentioning these options to students when we have these discussions with them, we can help them identify alternate routes to a dream career or position, which they may not realize if they think they have to have a specific major to get there.

These themes were identified across a range of students with varying backgrounds and experiences before attempting to enter their programs. While we were able to identify what decisions they made about their next steps and what factors contributed to that decision (such as minimizing time to complete their degree or ability to engage with their major in other ways), our sample size was too small to examine how these themes differed by student characteristics, such as previous experiences in engineering, first-generation status, or socioeconomic backgrounds. In future work, additional data could be collected to help examine how these characteristics relate to what students decide after not getting into their first-choice major.

While this Research Brief discusses only some of the themes identified in a larger, mixed-methods study that further delves into these experiences and decisions, the themes identified here are the most actionable for better recognizing how students can approach these types of applications or having conversations with them afterwards to help them realize they have more options than they think. We may not be able to guarantee that all students get to study their first-choice engineering major, but we should be better prepared to give them advice before and after they navigate these types of applications so they can align their preparation to their career goals and have known alternative options in mind while making this tough decision.

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