A Conceptual Model for Engineering Major Choice

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Although initiatives and programs designed to broaden participation in academic institutions have generated many positive changes, the proportions of women and African American, Hispanic, and Native American students have not seen commensurate increases in engineering fields [1]. Focusing on diversity at the discipline level has important implications for the design of effective department level programs and curricular interventions to promote participation and persistence of a broad range of students. This research study therefore applies a mixed methods approach to focus on a critical decision juncture—selecting an engineering major—to identify the prevailing patterns of engineering discipline composition. This study focuses on why students choose to major in engineering as a function of gender, race/ethnicity, academic experiences, institutional programs, and future plans and goals. Data comprise 39 individual student interviews, as well as more than 20,000 student-level transcript data matriculating between 2001 and 2015 at a large Midwestern research university. A life course perspective [2] informs this convergent parallel research design, in which interview transcripts were analyzed using thematic analysis, and the factors that influence student selection and persistence in engineering majors were identified using regression analyses.

Research findings show that students indicate the following reasons for majoring in engineering: parental influence, high school teachers and programs, college curriculum and programs, professional/career-related aspirations, and desire to help society. Regression results show variation in likelihood of selecting certain engineering majors based on student demographic factors and first-year engineering GPA. Our quantitative results demonstrate the importance of academic achievement and demographic factors in the composition of engineers by major. In particular, high school academic achievement continues to play a role in student college major choice (beyond admission into the College of Engineering). Further, first-year engineering grades are also associated with major choice, such that students may be using their early college achievement to inform their relative fit in an engineering major, or such that they may be performing relatively better in the courses that they are most interested in. We synthesized the quantitative and qualitative findings to develop a conceptual model describing the process of major selection shown in Figure 1.

The conceptual model highlights the importance of social influence, as well as the desire to contribute to "impact and innovation," in engineering major choice across the life stages: pre-high school, high school, and college. This desire to contribute positively to society and to help develop "cutting edge" technological innovations were common themes that engineering students considered from pre-high school, through high school, to their early college years. Consistent with previous studies [3]-[5], math and science interest, participation in STEM-related activities and clubs/organizations, and career considerations and professional opportunities contribute to students' major choice decisions.

By examining the influences of student engineering major choice across life stages using the life course perspective, we found that the sources of influence can vary across time. While social influence is a common theme across the life stages, the source of the influence—the "who"—varies by life stage. At the pre-high school stage, family and school teachers play a relatively large role in helping encourage and inspire students to pursue engineering, whereas at

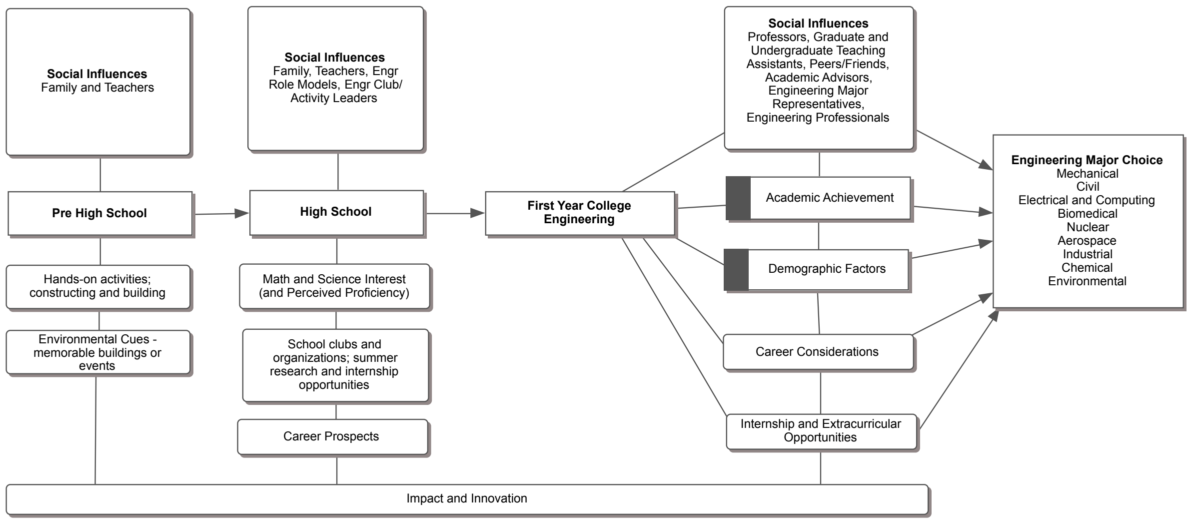

Figure 1. Factors influencing engineering major choice across the life course.

the high school stage, access to role models, such as practicing engineers, and individuals with engineering interests, such as through engineering clubs, also becomes important. At the college stage, the sources of social influence include a larger sphere of individuals, most notably peers and graduate teaching assistants (GTAs), who share experiences similar to the students' and are closer in age, life stage, and other dimensions. Instructors, academic advisors, and engineering professionals are also important influences. While the variation in source of social influence across the life stages is clearly correlated with the different individuals and roles that populate these different contexts, it is nonetheless important to indicate that not all students have similar access to these social networks and resources.

Our research findings highlight the importance of social influences and contextual support in the pursuit of engineering. Research findings suggest that establishing partnerships across the life stages (P-20)—between elementary schools, high schools, and colleges—may help provide potential engineering students with access to a wealth and sphere of social influences. Providing more opportunities to access engineering professionals at the pre-college and college levels could be a potential pathway to engage a broader range of students who may or may not have social networks that would connect them with professional engineering role models. Since graduate student teaching assistants and peers (classmates and team members) also played a relatively large role in student major choice, creating more opportunities for first-year students to interact with one another and to work with GTAs may provide them with greater access to information regarding the curriculum, culture, and career prospects of engineering majors. The prevailing desire of engineering students to have a positive social impact and to contribute to technological innovations suggests that sharing with potential students, particularly at pre-college levels, what they could potentially achieve or how they could positively impact society may help increase interest and participation across a broader range of students.

Disaggregating analyses by engineering major reveals discipline-specific information that could be leveraged by university administrators, academic advisors, faculty, students, and other stakeholders to help attract and increase participation in their respective fields. The life course perspective highlights the importance of influence from one life stage to another, such that it suggests that P-20 partnerships will be a critical force in diversifying and transforming the composition of engineering. University administrators, faculty, and stakeholders could use research findings to help inform their development strategies to encourage more women and underrepresented students to pursue engineering and to consider more fully the wide range of engineering disciplines available. Diversifying engineering education will require commitment and contributions from stakeholders across students' life stages.

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