Diversity across Engineering Disciplines: Factors that Influence Student Engineering Major Choice

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Introduction and Background

Although initiatives and programs designed to broaden participation in academic institutions have generated many positive changes, the proportions of women, African American, Hispanic, and Native American students have not seen commensurate increases in engineering fields. Diversifying the undergraduate engineering population has important consequences for our nation's ability to meet the increasing demands for a larger technological and scientific labor force. While diversifying engineering in the aggregate is both timely and critical, it is equally important to consider the level of diversity within each engineering discipline (e.g., Mechanical, Civil, Electrical, Chemical). When engineering disciplines are disaggregated, it is clear that some disciplines are less diverse than others. 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. Thus, this research examines the causes and consequences of the demographic variation across engineering disciplines.

This research study applies a mixed methods approach to focus on a critical decision juncture—selection into an engineering major. Using organizational demography (Wharton, 1992) and social cognitive theory of self-regulation (Bandura, 1991) as theoretical frameworks, the following research questions are addressed:

- Which demographic characteristics are associated with engineering major choice?
- Why do students choose engineering?

Data and Methods

The data include over 20,000 individual student-level data from a large, Midwestern research university. The students matriculated in the College of Engineering between 2001-2015. Logit regression was applied to identify factors that influence student selection into a particular engineering major. Explanatory variables include gender, race/ethnicity, U.S. citizenship, number of Science, Technology, Engineering, and Mathematics (STEM) Advanced Placement test credits, high school grade point average, SAT verbal and math scores, and first-year college engineering grade point average.

For the qualitative analysis, 39 interviews were conducted in Fall 2015 with first-year engineering students using a semi-structured interview protocol. Approximately 44% of the student interviewees were women, and 5% African American, 2.6% Native American, 15% Hispanic/Latino, and 26% Asian/Asian American. The students represented a number of engineering disciplines, such as Mechanical, Civil, Electrical, Chemical, Industrial, Biomedical, Environmental. The interviews were analyzed using thematic analysis of 39 with a focus on the major selection process.

Results

Research findings indicate that women are more likely than men to choose Chemical engineering, whereas Hispanic/Latino students are more likely to choose Electrical or Industrial engineering versus other majors, all else equal. African American students are more likely to

choose Chemical or Electrical engineering compared to other majors. Table 1 summarizes the logit regression results.

Table 1. Likelihood of Entering Civil, Chemical, Electrical, Industrial, or Mechanical Engineering.

	MAJOR CHOICE				
Major	**Civil**	**Chemical**	**Electrical**	**Industrial**	**Mechanical**
Female	**-0.0590*** **	**0.163** **	**-0.0816** **	0.0250	**-0.102** **
	[0.0200]	[0.0632]	[0.0324]	[0.0318]	[0.0513]
AfricanAm/Black	**-0.0419*** **	**0.0486** **	**0.100*** **	**-0.0242** **	**-0.0477** **
	[0.00859]	[0.0195]	[0.0277]	[0.0115]	[0.0226]
Hispanic/Latino	-0.00318	-0.00260	**0.0420** **	**0.0242***	**-0.0653*** **
	[0.0101]	[0.0116]	[0.0183]	[0.0134]	[0.0160]
Asian	-0.0396***	-0.0147**	0.106***	0.0195**	-0.0515***
	[0.00527]	[0.00705]	[0.0122]	[0.00855]	[0.0104]
Other Race	-0.00394	-0.0344***	0.0573***	0.0215*	-0.00637
	[0.0101]	[0.00846]	[0.0171]	[0.0130]	[0.0165]
International	-0.0385***	-0.0159***	0.117***	0.0913***	-0.0513***
	[0.00461]	[0.00601]	[0.00920]	[0.00815]	[0.00835]
STEM AP Test	-0.00796***	0.00292**	-0.00528***	-0.00556***	0.00327*
	[0.00142]	[0.00117]	[0.00148]	[0.00136]	[0.00189]
High School GPA	0.00561	0.0290***	-0.0466***	-0.00332	-0.0252*
	[0.00815]	[0.0104]	[0.0106]	[0.00856]	[0.0144]
SAT Verbal	-0.000188***	-1.31e-05	-6.61e-05**	-5.74e-05**	-0.000229***
	[3.08e-05]	[3.16e-05]	[3.37e-05]	[2.83e-05]	[4.74e-05]
SAT Math	-0.000157***	-8.62e-05**	0.000269***	-0.000156***	0.000123**
	[3.87e-05]	[4.12e-05]	[4.53e-05]	[3.59e-05]	[6.22e-05]
Engr GPA Year 1	**-0.0250*** **	**0.0466*** **	0.00123	**-0.0323*** **	**0.0406*** **
	[0.00443]	[0.00583]	[0.00536]	[0.00427]	[0.00768]
Female*EngrGPA	0.00861	**-0.0188***	-0.00282	**0.0194** **	0.0193
	[0.00954]	[0.00972]	[0.0148]	[0.00832]	[0.0205]
Non-Engr GPA Yea	-0.0387***	0.0278***	0.0306***	-0.0275***	0.0541***
	[0.00463]	[0.00597]	[0.00576]	[0.00458]	[0.00800]
Female*NonEngrG	**0.0176***	0.000718	0.0145	-0.0120	-0.0151
	[0.00984]	[0.0102]	[0.0159]	[0.00866]	[0.0199]
Observations	20,619	20,619	20,619	20,619	20,619

Notes: *** p<0.01, ** p<0.05, * p<0.1; Standard Errors in Brackets

Table 2. Reasons Students Choose to Major in Engineering

Reason	# Respondents	Percentage
STEM Subject Interest	31	79%
Family Influence	29	74%
Career Prospects	23	59%
Academics - Pre-College & College	23	59%
Peers	14	36%
Extra Curriculars	13	33%
Exposure to Industry Professional	11	28%
Hands On Opportunities	9	23%

Consistent with previous literature, students indicate the following reasons for majoring in engineering: (1) STEM subject interest, (2) parental/family influence, (3) professional aspirations, (4) high school and college curriculum and programs, (5) peers, and (6) hands on opportunities. The reasons provided and the associated frequencies are summarized in Table 2.

Future Work and Implications

Our next steps include identifying the influence of peer and instructor effects on student major choice, as well as a grounded theory analysis of the 39 individual student interviews to develop a conceptual model of engineering major choice. While previous studies focus on major choice with engineering in the aggregate, this work will expand the literature by examining the differences and nuances across engineering disciplines.

Research findings provide important context and information for various potential applications to increase discipline-specific diversity, such as developing new strategies/interventions to support success among underrepresented students, identifying overlooked areas in classroom environments, providing critical information for the development of surveys and larger-scale studies for investigating diversity across engineering. University administrators, faculty, and stakeholders could use these findings to help develop strategies to encourage more women and underrepresented students to pursue engineering and to consider more fully the wide range of engineering disciplines available.

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