

## **Board 433: Work in Progress: Improving Students' Decision-Making Behavior in Choosing an Engineering Pathway**

**Ashley Y. Tran, University of Illinois Urbana-Champaign**  
**Debapratim Ghosh, University of Illinois Urbana-Champaign**

Graduate Student in Statistics

**Samuel Harford, The University of Illinois at Chicago**  
**Prof. Houshang Darabi, The University of Illinois at Chicago**

Dr. Houshang Darabi is a Professor of Industrial and Systems Engineering in the Department of Mechanical and Industrial Engineering at the University of Illinois at Chicago. Dr. Darabi's research focuses on the use of Big Data, process mining, data mining, Operations Research, high performance computing, and visualization in improving educational systems and students' learning. Dr. Darabi's research has been funded by federal and corporate sponsors including the National Science Foundation, and the National Institute of Occupational Health and Safety.

**Dr. Jennifer R Amos, University of Illinois Urbana-Champaign**

Dr Jenny Amos is a Teaching Professor in Bioengineering at the University of Illinois Urbana-Champaign. She is an AIMBE Fellow, BMES Fellow, ABET Commissioner and Executive Committee Member, two-time Fulbright Specialist in engineering education. Amos has over a decade's worth of experience leading curriculum reform implementing robust assessment strategies at multiple institutions.

# **Academic Major Selection: Determining Influential Factors on Undergraduate Students' Choice of Engineering Majors**

## **Introduction:**

The choice of academic major is a critical juncture in a student's academic and professional journey, however, this selection is frequently made uninformed and under uncertainty, leading to some declared major students having an increased risk of attrition when compared to undecided students<sup>1</sup>. A major decision is often a multifaceted and intricate process that is heavily influenced by different behavioral, sociological, and economic factors such as personal interests, familial background, and financial considerations<sup>1</sup>. The process is further complicated by a lack of quality, reliable resources that are easily accessible to all communities.

To address these concerns, we aimed to better understand the decision-making process of engineering students when selecting their academic major. Some studies have identified career advancement potential and future job opportunities as crucial factors when deciding on a major<sup>2</sup>. Other studies highlighted how students often chose majors that supported their personal value systems<sup>1</sup>. Despite these findings, a gap remains to explore the reasons behind undergraduate engineering students' choice of a particular engineering major. This research paper looks to identify the selection patterns of engineering undergraduate students and the main factors that impact their academic major decisions. The findings will allow us to better understand students' perspectives as they go through the critical process of choosing an academic major.

## **Methods:**

This study seeks to gain insight into the factors that influence academic major selection for engineering students across two large public land-grant universities. The study utilizes a mixed-methods research design, which combines both quantitative and qualitative data. Quantitative data was collected via an online survey and qualitative data was obtained through semi-structured interviews.

We have previously reported on the development of our survey and presented descriptive statistics from the first cohort<sup>3</sup>. In Fall 2022, we distributed our survey to around 2,000 undergraduate students at both universities who were enrolled in an introductory engineering program. The survey focused on identifying the cognitive factors and contextual influences that affect academic major selection for STEM students<sup>3</sup>. At the end of the survey, students were given the option to leave their contact information for the possibility of being interviewed for a future study. Results were analyzed and compared across various categories such as home location, ethnicity, and major as well as analyzed using various descriptive and inferential statistics, such as correlation and regression analysis<sup>3</sup>. The results of the quantitative surveys motivated the questions posed in the interviews, to help provide explanations for some of the results.

From the students who opted in for the interview, possible participants were selected using purposive sampling criteria with race, major, and gender all being considered. After obtaining approval from the Institutional Review Board (IRB), these individuals were contacted for

interviews through email invitations. After gaining informed consent from all potential participants, we interviewed 10 undergraduate students enrolled in various engineering programs (Bioengineering, Mechanical Engineering, and Computer Engineering). Three students identified as cisgender men and seven identified as cisgender women. The semi-structured interviews were conducted virtually through Zoom, with all interviews lasting between 30 and 45 minutes. The interview questions were designed to explore each participant’s specific major selection process. These questions focus on three overarching themes; participants’ personal experiences of their major, specific factors that influenced their choice, and what sources were used to help inform their decision. Occasionally, follow-up questions were asked to elicit further details or to clarify responses. At the end of each interview, the students were asked if there was any additional information they would like to add about their respective major choice.

a. Personal experience questions	b. Influential factor questions	c. Informative source questions
Please tell me about your major.	Do you feel like your family or your peers view you as a future [insert major occupation]?	How prepared did you feel when choosing your major?
Did you ever change your major?	Is there anything about your friend group or upbringing that you think influenced your major choice?	Did you attend any orientations or sessions to explore career options?
Would you say you feel confident about your major?	Did finances or job security play a role in your major choice? How?	Did you look into specific career opportunities for your major? What did you find?
What is something that you wish you knew about when you were choosing your major?	Do you think that your performance in foundational STEM courses affected your major choice? How?	

All interviews were audio-recorded; they were then transcribed using Zoom’s automated transcription service<sup>4</sup> and revised manually for further analysis.

The qualitative data obtained through the interviews were analyzed using thematic analysis<sup>6</sup>. This thematic analysis involved identifying patterns and themes within the data and coding them into sub-themes. To ensure the validity of the data analysis, three different coders analyzed and coded the same transcripts for inter-rater reliability. The reliability of the codes was assessed using Cohen’s Kappa statistic, which was found to be above 0.8, indicating high inter-coder agreement<sup>6</sup>. The Kappa Statistic between the different coders is provided in Table 2:

	Rater 1	Rater 2	Rater 3
Rater 1	1	0.8	0.81
Rater 2	0.8	1	0.87
Rater 3	0.81	0.87	1

## Results:

Through thematic analysis of the interviews, five major themes were determined that influence undergraduate students' decision-making process when choosing an engineering major. These themes are discussed in order of importance and prevalence throughout all participants' interviews, with supporting examples given from participants' quotes.

1. *Personal Interests and Passions* (21% or n=66): Personal interests and passions were found to be the most significant factor in choosing an engineering major. For example, many students pointed to how a hobby they enjoyed led them to choose a particular engineering major that aligned with those interests: "It was very early on that I started being interested in robotics...by my sophomore year, I had cemented that I was going to be [a mechanical engineering major]." Other participants indicated that certain foundational STEM courses led them to realize their passion for a specific major: "[STEM courses] have somewhat shaped my [academic major] decision because I learned through those foundational courses that I am very interested in biology and chemistry."

2. *Family and Peer Influence* (18% or n=55): Family and peer influence were found to also have a moderate impact on participants' decision-making process. For example, some participants mentioned how their parents urged them to select an engineering major over other non-STEM majors: "Specifically engineering was like a lot of push from my mom...[my major options] would be doctor or engineering." The academic major interests of a participant's friends or peers also played a role in some students' major choice, with one participant stating "My one other friend wanted to become a bioengineering major...after she mentioned that [bioengineering] was something she wanted to study, I looked more into [that major]."

3. *Career Prospects and Financial Considerations in Engineering* (18% or n=54): Participants also considered the career prospects and financial considerations associated with choosing an engineering major. Many participants indicated that they chose an engineering major because it offered better job prospects and higher salaries compared to non-engineering majors. For example, one participant said, "I chose computer science because I know there are plenty of job opportunities in this field, and I want to be financially stable in the future." Another noted financial considerations had heavily swayed their major choice away from a non-STEM major, stating, "I'm very art driven...but once I sat down and really thought about what I want in my future, which is financial safety...I realized I should probably go into a STEM field." Some participants worked backward, identifying a career option they found appealing or interesting and choosing the engineering major that best aligned with the skills required for that job: "I ended up talking to engineers from US Steel...one of them was a mechanical engineer who mentioned they do a lot of problem solving so I decided to apply for [mechanical engineering]."

4. *Pre-University Experiences* (13% or n=40): Pre-university experiences, such as exposure to engineering subjects in high school or working in engineering-relating internships before college, were also found to play a significant role in influencing participants' choice of engineering majors. Participants who had prior experience in a particular field of engineering were more

likely to choose that as their major. For example, one participant said, “I did an internship in civil engineering before starting college, and that’s when I knew that’s what I wanted to study.”

5. *Access to Resources and Information about Majors* (12% or n=37): The availability of resources and information about different engineering majors also played a role in participants’ decision-making process. Participants who had easy access to resources such as websites, campus tours, brochures, or guidance counselors were better informed about different engineering majors and could make more informed decisions. For example, one participant stated, “I spoke to my guidance counselor, and she gave me some brochures about different engineering majors. That’s how I learned about environmental engineering and decided to major in it.” Several participants who did not utilize or were unable to access additional resources stated they wish they had more sources “I wish I’d gotten the opportunity to talk to more [engineering] students who are still like, in the early or final stages of their degree, just so I could see like, okay, what’s the courseload about.”

### **Discussion:**

The qualitative findings in this study were compared to the quantitative results from the online survey<sup>3</sup>. While the survey focused mostly on comparing major selection behaviors across different student categories, both the study and the survey indicated that a lack of easily accessible and informative resources hindered some students’ ability to learn about their chosen major<sup>3</sup>. The survey also highlighted the value that personal interest played in major selection for some students, specifically racial and ethnic minorities. However, the survey displayed some results that were not identified in the interview study. Specifically, electrical engineering students and domestic in-state students were observed in the survey to have a lower inclination for career exploration<sup>3</sup>.

The study results provide valuable insights into the factors that influence undergraduate students when choosing an engineering major. Thematic analysis identified students’ personal interests as the most prevalent factor, with participants citing their love for a particular STEM subject or engineering-related hobby as the main driving force behind their decision. This finding aligns with previous research that has identified personal interest as a critical factor in academic major choice<sup>1</sup>.

In addition to students’ passions, the study found that family and peer influence also played a significant role in students’ decision-making process for academic major selection. These findings highlight the importance of considering the social and cultural factors that shape a student’s decision-making process. By recognizing the significance of family and peer influence, universities and guidance counselors can offer students a more personalized experience regarding career and major exploration by providing access to specific resources that can help them make informed decisions.

Furthermore, the identification of financial considerations and pre-university experiences as aspects that impacted major selection emphasizes the need for universities to provide transparent access to various resources that provide information on these factors. To eliminate the feelings of uncertainty regarding the college major selection for high school students, universities could

provide easy access to each engineering major's curriculum as well as career prospects in each major like salary data, enabling these students to explore different career paths in different majors as well as skills that would be gained through that major's courses. This information should be made available clearly and concisely so that students can make informed decisions. More efforts should also be placed in exposing pre-university students to various engineering disciplines, whether that be through providing more informational opportunities (e.g., info meetings, brochures, tours) or greater integration of engineering courses into high school curriculum.

### **Limitations and Future Directions:**

There are limitations within this study that must be acknowledged. Firstly, the sample size of 10 interview participants is small, and may not accurately represent the full population of undergraduate students surveyed. Secondly, the students who opted for interview through the initial online could be deemed to be generally more "confident" in speaking about their given major and therefore could be interpreted as being more confident in their choice of major. This might effectively lead to selection bias in the sample, which might skew the results taken from the thematic analysis.

Future studies could address some limitations outlined in this study by using a larger sample size of undergraduate students and or using other means and methodologies to select participants. Future scholars should also consider different avenues regarding similar research. While our study consisted of diverse participants, future research could be done aligning with the survey results by conducting interviews with undergraduates who are a part of specified populations (e.g., changed majors, first-generation, international) to determine if factors differed across various populations.

Additionally, the next stage of this proposed work will leverage these findings in the design of a new portal that will allow students to rank the importance of information and values to guide them toward major exploration.

### **Conclusion:**

Selecting an academic major is an important point in many college-bound students' lives as it often acts as the first step towards reaching their academic and professional goals. Through this study, several sociological, economic, and personal factors were determined as being crucial to a student choosing to major in an engineering discipline. By identifying these elements, we can gain a more comprehensive understanding of students' decision-making processes and behaviors when selecting their engineering major. The results and understandings obtained from this study could prove to be fruitful as we explore ways to ensure college-bound students are making the most informed college major decisions possible.

### **Acknowledgements:**

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