Major Decisions! Exploring Student Pathways to Engineering Majors as Markers of Identity

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ABSTRACT

CONTEXT

The process of selecting an engineering major is a pivotal decision for students that can impact their sense of belonging, professional identity and academic success. This decision is often influenced by various factors, such as personal interests, academic aptitude, career objectives, and familial or societal expectations. A choice of major is essential to establishing a strong foundation for professional success, as it allows the student to align their career objectives to develop a meaningful professional identity.

PURPOSE

The motivation behind this study is to understand the various factors that influence students' decisions when selecting an engineering major. By capturing the motivations behind this decision-making process, the study aims to identify the most common reasons why students choose specific engineering majors and to highlight the significance of these factors in shaping students' academic and professional identities.

APPROACH

Interviews were conducted in May – July 2022 with 30 students and early career engineers who were completing or who had completed a four-year Bachelor of Engineering degree. The interviews explored their university experiences and the influences impacting their professional identity development including their pathway to their chosen engineering major. Thematic analysis of the transcriptions was then used to identify key factors and mechanisms that influence engineering students' decision-making process in selecting or switching their field of engineering study.

OUTCOMES

Participants identified a range of factors that had contributed to their engineering major selection. These included choosing what they perceived to be an 'easier' major, the influence of family members who had studied the same major, and predetermined interest. It was also common for participants to retrospectively identify a limited understanding of the breadth and depth of their specific majors. The timing of when students selected their engineering major decisions varied based on their self-identified level of professional identity. Those who had a strong engineering identity more often decided during their university studies, while participants without a strong engineering identity predominantly chose their major before university.

CONCLUSIONS

The utilisation of this information enables a more comprehensive understanding of the student's initial perceptions towards engineering majors, and the underlying factors that govern their decision-making process and the significance of these factors when selecting a major. Engineering majors are a key aspect of an individual's engineering identity and ensuring students are equipped to choose the major most suitable is crucial for ensuring better retention, academic success and enjoyment of an engineering course.

KEYWORDS

Professional identity, engineering education, major selection, engineering major, identity development

Introduction

Choosing a major is a critical decision for undergraduate students, as it sets the foundation for their academic and professional trajectory (Main et al., 2021; Paulson et al., 2016). In the field of engineering, students are faced with a wide array of specialised disciplines and the process of selecting a major becomes even more complex. The choice of an engineering major not only shapes students' academic experiences but also has long-term implications for their career prospects and overall professional identity development (Theiss et al., 2016). Understanding the factors influencing major selection is crucial for educational institutions and policymakers to better support students in their decision-making process and foster persistence in their chosen engineering discipline.

This paper aims to explore the relationship between engineering students' major choice and their self-identified engineering identity. Engineering identity refers to the extent to which individuals identify themselves as engineers and how this identity impacts their attitudes, behaviours, and career aspirations (Morelock, 2017; Tonso, 2014). Research has shown that a strong professional identity is closely tied to academic success, engagement, and persistence within the engineering profession (Huff, 2019; James et al., 2018; Stets & Serpe, 2013; Stryker & Burke, 2000). Therefore, understanding how major choice interacts with engineering identity can provide valuable insights into students' motivations, goals, and long-term commitment to their chosen field.

While several studies have examined the factors influencing major selection in engineering (Paulson et al., 2016; Theiss et al., 2016), there remains a gap in understanding how these decisions relate to the development of engineering identity. By delving into this relationship, this study seeks to contribute to the existing literature and identify key factors which foster a strong engineering identity during their major selection process. To address this need, this study centres on the research questions: (1) *what motivations for students exist in choosing their engineering major and (2) how are these related to engineering identity?*

Background

Over the past decade, the popularity of different engineering majors among domestic students in Australia has undergone notable shifts as shown in Figure 1.
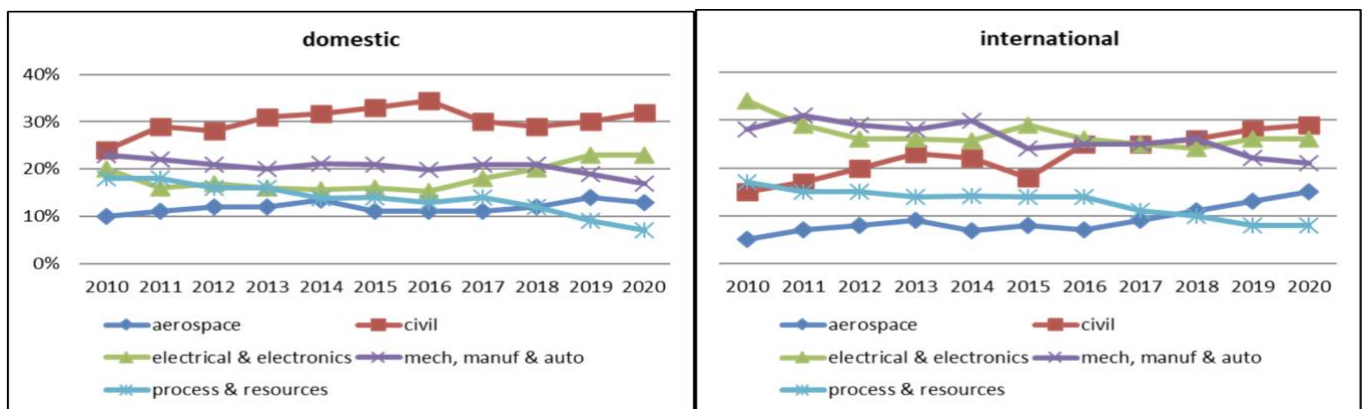

Figure 1: Indicative distributions of bachelor degree (3-year and 4-year) awards by broad areas of engineering, 2010-2020 (ACED, 2022)

Data from the last decade indicate that the proportion of civil engineering graduates has seen a significant increase, reaching a peak in 2020 (ACED, 2022). This rise in popularity can be attributed to the growing emphasis on infrastructure development, urbanisation, and sustainable engineering practices (Main et al., 2021). This has since decreased across all Australian states and more students are following a path to mechatronics and software engineering. In contrast, the field of electrical/electronic engineering has shown stability, with the proportion of graduates remaining relatively consistent. A decline, however, exists in the proportions of graduates in the process and resources discipline (ACED, 2022). This downward trend may reflect changing industry and technological needs, which have led to a decreased demand for graduates in these specific engineering fields. However, the motivations behind students' selections of these majors forms a vital puzzle piece in understanding these trends and fluctuations.

Understanding the factors driving students' major choices and the popularity of different engineering disciplines in Australia is vital for educational institutions to provide relevant and effective guidance to prospective engineering students and to support the future needs of the wider profession. There are various factors that influence students' choice of engineering major, such as prior academic performance, career goals, personal interests, and familial or peer influence (Main et al., 2021; Painter et al., 2017; Theiss et al., 2016). Some students may select an engineering major based on prior exposure or success in related coursework or activities, while others may choose a field that aligns with their long-term career aspirations (Painter et al., 2017). Personal interests and passions can also play a role in major selection, as some students may be drawn to a particular field due to a fascination with the subject matter or a desire to contribute to a specific industry or societal issue. Additionally, familial or peer influence can impact major selection, as students may receive guidance or pressure from family members or friends who work in or have studied engineering (Painter et al., 2017). Painter et al. (2017) summarised and categorised these motivations in a study of 390 first-year engineering students from a large university in the Midwest, United States. These are shown below and were used as the themes which the responses from the interview excerpts were initially coded against.

- Interest in a Subject Matter: Student in interested in a subject.
- Family Influences: Family is an engineer or encouraged them.
- Prior Experience: A prior experience influenced them.
- Nature of the field: Student perceives the field's opportunities positive.
- Career/Job Outlook: Student's perceived future career paths in field.
- Ability Level: Student's perceived ability level in subject.
- Social Influences: Being influenced by people outside of family.
- Love and Passion: Student loves or has passion for a subject.
- Financial Outlook: Student believes the financial outlook is good.
- Helping Society: Student believes choice will help society.
- Engineering as Means to an End: Program used as a steppingstone.
- Desire for a Challenge: Student's desire of a challenge.

The stage at which students select their engineering major has also been considered in this study in relation to professional identity. Existing literature (Main et al., 2022) utilised life stages as a framework for these stages; (pre-high school, high school, and early university). Pre-high school encounters predominantly drew upon familial contributions, while during the high school period, role models and participation in engineering activities were most prevalent. Upon entering university, the influences extend to encompass academic advisors, professors, and fellow students. These life stages emphasise the necessity of adapting and developing different strategies to ensure alignment between career support offered to students and potential job prospects.

Method

Data Collection

As part of a large research study, we conducted interviews with 30 undergraduate engineering students who were in their third or final year of study at QUT, as well as with early career engineers (ECEs) (1 to 5 years post-graduation) who had completed an engineering degree at QUT. We selected both students and ECEs as the primary stakeholders because of their frontline experience and firsthand knowledge in the process of choosing a major. This enabled us to gain insights into the decision-making process and the key factors involved.

To recruit student participants, we advertised in engineering undergraduate courses and targeted two core units offered to third and final year students, which are taken by all engineering students. Additionally, we posted advertisements on several engineering student club social media pages. ECEs were contacted through professional contacts of the research team using LinkedIn and through QUT Alumni.

Table 1 presents key demographic information about the interview sample, including the participants' engineering discipline, gender, and self-described professional identity as an engineer. It is worth noting that 63% of the participants identified as female however, previous studies have shown that undergraduate research often has an overrepresentation of female participants (Dickinson et al., 2012), however this is

observed as a limitation of this study as this is not representative of the typical male dominated engineering cohort.

Civil engineering was also the most represented major, followed by mechanical which is generally representative of overall enrolment trends. During the interviews, participants were asked whether they self-identify as an engineer or not, and although analysis of this questions falls outside the scope of this paper, this has been included in the demographic data to frame further discussions around identity.

The results are also separated via two distinct groups, participants who have a self-described strong professional identity and those who did not. This was identified through the final interview question which asked participants "Do you identify as an Engineer?". This allowed the participants to self-identify themselves as engineers or not, and thereby whether they identified with a strong engineering professional identity or not.

Table 1: Participant demographics

	N	% of sample
Education		
Student Engineer	18	60%
Early Career Engineer	12	40%
Gender		
Male	11	37%
Female	19	63%
Engineering Major		
Civil	16	53%
Mechanical	6	20%
Medical	3	10%
Mechatronics	2	7%
Electrical	1	3%
Chemical Process	1	3%
Computer and Software	1	3%
Do you identify as an Engineer?		
Yes	19	63%
No	11	37%

The interviews, which lasted approximately 45 minutes, aimed to explore participants' university experiences and the influences they perceived as important in their professional journey. We utilised a semi-structured interview style to allow participants to provide detailed and expansive responses relevant to the research context (Longhurst, 2003). The interviews were conducted between May and June 2022 and were led by the first author. Whenever possible, interviews were conducted in person (n=18), but for remote participants (n=12), we utilized Zoom web-conferencing software, recording the interviews through video and generating transcripts from the audio component. Although qualitative research favours in-person interviewing for data richness and rapport building (Johnson et al., 2019; Shapka et al., 2016), the flexibility of online interviews meant a larger pool of participants could be reached, ultimately improving the overall diversity and inclusivity of the findings.

This study focuses on participants' responses to two specific interview questions related to their choice of engineering major. These questions aimed to enhance our understanding of how professional identity is shaped through the process of major selection. The questions were, "(1) When did you choose your engineering major, and (2) how did you make this decision?"

Ethics approval for this study was obtained from the Queensland University of Technology's Human Research Ethics Committee.

Data Analysis

The thematic analysis of the interview transcripts was conducted using NVivo software. Structural coding was employed to identify specific sections of the interview transcripts where participants discussed their major selections, following the approach outlined by Guest et al. (2012). Thematic analysis was applied to

allow patterns to emerge from the data through the lens of categories developed by Painter et al. (2017). This approach however did not strictly code to these categories and allow additional codes to be developed based on participants' explicit descriptions of their experiences, rather than only interpreting their responses within the existing framework.

To further enhance validity, two researchers (the first and second authors) independently engaged with the data and conducted an initial round of coding (Walther, Sochacka, and Kellam, 2013). The researchers then collaborated to discuss their preliminary findings and iteratively grouped codes into broader themes. Throughout this iterative process, codes and themes were revised as new insights emerged (Walther et al., 2013). The final themes that emerged from this analysis are summarised in Table 2. Additionally, Table 2 provides information on the frequency of themes and factors to give readers an idea of how often these ideas were referenced by participants. As a result of this comparison, a new influence of "**Lack of Understanding: Student has limited comprehensive of available majors**" was proposed. It should be noted that the three themes present in Painter et al. (2017); Financial Outlook: Student believes the financial outlook is good, Engineering as Means to an End: Program used as stepping stone and Desire for a Challenge: Student's desire of a challenge, all recorded zero responses and thus were removed from this discussion.

Results

The analysis revealed a strong consensus among participants regarding the influence of personal interests and limited awareness of other majors on their decision-making process. Many participants reported that their choice of major was primarily driven by their genuine interest and passion for a specific field of engineering: '*I was interested in the transport side of planning and saw civil engineering did this*'. Additionally, a significant number of participants mentioned a lack of understanding or exposure to alternative engineering disciplines, which contributed to their decision; '*Didn't understand much about each different major*'. These outcomes are expanded upon in this section with the support of excerpts from the interview transcripts.

Table 2: Summary of final themes from analysis of interview transcripts including frequency of occurrence based on professional identity.

Motivations based on Painter et al. (2017)	Strong Engineering Identity		No Engineering Identity	
	N	% of sample	N	% of sample
Interest in a Subject Matter: Student is interested in a subject	9	47%	8	73%
Family Influences: Family is an engineer or encouraged them	4	21%	1	9%
Prior Experience: A prior experience influenced them	3	16%	1	9%
Nature of the field: Student perceives the field's opportunities positive	4	21%	4	36%
Career/Job Outlook: Student's perceived future career paths in field.	1	5%	1	9%
Ability Level: Student's perceived ability level in subject	7	37%	0	0%
Social Influences: Being influenced by people outside of family	3	16%	4	36%
Love and Passion: Student loves or has passion for a subject	3	16%	0	0%
Helping Society: Student believes choice will help society	3	16%	1	9%
Lack of Understanding: Student has limited comprehensive of available majors	5	26%	2	18%

Note: The responses were often coded to more than one category of motivation, hence the number of recorded instances does not always correspond to the number of participants which recorded this motivation.

Interest in a Subject Matter: Student is interested in a subject

The most frequent response among participants, regardless of their level of professional identity, was "Interest in a Subject Matter". This finding was consistent among those who identified as having a strong professional identity (47%) as well as those who did not (73%). It suggests that a genuine interest in a specific subject within the field of engineering played a central role in participants' decision-making process when choosing their major. This finding underscores the importance of passion and intrinsic motivation in driving students' academic and career choices, irrespective of their self-described strength of identification

with the engineering profession. However, the skew to students without a professional identity may suggest that this decision is founded heavily on interest rather than consideration for some of the other significant factors. This would require further exploration. Some examples of this include:

Already interested in civil, liked how broad it is so went with it.

I really liked maths and physics and chemistry at high school so thought I might want to go into mechanical or civil engineering.

Chose robotics as minor as it was new aged and cool, also chose advanced electrical as this was my initial engineering interest.

Ability Level: Student's perceived ability level in subject

Another influential factor that held significance among participants, was "Ability Level". This factor was however reported as influential by 37% of participants with a strong professional identity and 0% of participants without a strong professional identity. This suggests that participants considered their perceived competence and skills in a particular subject matter as a determining factor in their choice of major. However, as this finding skews to participants with a strong professional identity, this may suggest a level of self-efficacy present which may set students up for success by choosing a major they are more confident and therefore more comfortable in.

A significant finding, however, emerged from the analysis indicating that the discussions surrounding 'ability level' were only negative. Participants expressed self-doubt and a perceived lack of proficiency in certain subjects, leading them to believe that they were not good enough or that specific majors were too challenging for them. This negative perception of their own abilities influenced their decision-making process, causing them to potentially overlook majors they were genuinely interested in due to feelings of inadequacy. Examples include:

Chose mechanical because sucked at electrical.

I did doubt my abilities and doubt myself being capable of doing electrical or mechanical.

Hated the mechanical and electrical component – couldn't wrap my head around it.

This finding raises important concerns about self-perception and the impact it can have on students' major selection, highlighting the need for support mechanisms and interventions to address students' confidence and misconceptions about their abilities in different engineering disciplines.

Nature of the field: Student perceives the field's opportunities positively

Participants who identified as having a strong professional identity (21%) and those who did not (36%) commonly expressed the motivation of the "Nature of the field: Student perceives the field's opportunities positively." This response indicates that participants considered the potential opportunities and prospects within a particular field of engineering when making their major selection. They believed that certain engineering disciplines offered promising career paths, job prospects, and opportunities for growth and development. This finding suggests that participants' perception of the field's potential impact on their future careers played a significant role in their decision-making process, regardless of their level of professional identity. It underscores the importance of understanding the perceived opportunities and potential outcomes associated with different engineering majors when students are choosing their academic and career paths. This included excerpts such as:

Civil is broad, motivated by others.

I was fairly set on electrical engineering (renewable energy) and thought civil was a lot of site work and mechanical didn't seem very interesting.

Lack of Understanding: Student has limited comprehensive of available majors

A significant finding that emerged from this analysis, although not previously identified as a motivation, was "Lack of Understanding: Student has limited comprehension of available majors". This factor was reported by 26% of participants with a strong professional identity and 18% of participants without a strong professional identity. It suggests that a significant number of participants had a limited understanding of the various engineering majors available to them. This lack of comprehensive knowledge about the different disciplines could have potentially restricted their exploration and consideration of alternative options. This finding highlights the importance of providing comprehensive information and guidance to

students to ensure they have a clear understanding of the available majors, enabling them to make informed decisions that align with their interests and goals. Examples include:

Didn't know there were any other disciplines other than civil engineering.

Chose structural as a second major as didn't like construction and didn't know much about the others.

Chose civil engineering as this seemed like the easier choice

Social Influences: Being influenced by people outside of family

Participants who identified as having a strong professional identity (16%) and those who did not (36%) commonly mentioned the influence of "Social Influences: Being influenced by people outside of the family." This response indicates that participants considered the perspectives and recommendations of individuals beyond their immediate family when making their major selection. External influences such as friends, peers, mentors, or role models played a significant role in shaping their decision-making process. The opinions and experiences of these individuals influenced participants' perceptions of different engineering disciplines and their potential for success. This finding highlights the impact of social networks and interpersonal relationships on students' major choices, regardless of their level of professional identity. It emphasises the need to consider the broader social context in which students make decisions about their academic and career paths, and the importance of providing diverse and inclusive support systems that can guide students towards informed decisions.

Picked environmental as a second major based on discussions with older students

Choosing 2nd major was difficult but met [mentor] at [student club] event where she introduced me to the environmental side of things.

Family Influences: Family is an engineer or encouraged them

Participants who identified as having a strong professional identity (21%) and those who did not (9%) frequently mentioned the influence of "Family Influences: Family is an engineer or encouraged them." This response indicates that participants' family background and support played a significant role in their decision-making process when choosing a major. The presence of role models and the support provided by family members with engineering backgrounds contributed to participants' perceptions of the field and their confidence in pursuing an engineering major. This finding underscores the impact of familial influences on students' career choices and highlights the importance of fostering supportive family environments that promote interest and enthusiasm for engineering disciplines to build their professional identity.

I chose to study engineering based on advice from my cousin who was an engineer.

I vaguely knew about civil engineering because of my grandfather who worked in the field and my cousin who had just started studying it.

Timing of Decision

Within the question posed to participants, the timing of choosing their engineering major was also explored and results are shown in Table 3.

Table 2: Timing of major selection based on professional identity.

	Strong Engineering Identity		No Engineering Identity	
	N	**% of sample**	**N**	**% of sample**
Before University	8	42%	7	64%
During University	11	58%	4	36%

The timing of when participants decided on their engineering major varied based on their self-described level of professional identity. Among those with a strong professional identity, the majority (58%) made their major selection during their university studies. This indicates that their exposure to different engineering disciplines and their experiences within the university environment played a significant role in shaping their decision-making process, specifically fellow students, academic advisors and educators (Main et al., 2022). On the other hand, for participants without a strong professional identity, the trend was reversed. A higher percentage (64%) of this group selected their major prior to university, suggesting that their decision was influenced by factors outside of the university setting, such as personal interests or external advice, engineering activities, family influences and role models (Main et al., 2022). These

findings highlight the diverse pathways and timing in which participants arrived at their engineering major decisions, underscoring the importance university supports during first year in shaping students' academic and career paths.

Discussion

The findings of this study shed light on the factors influencing undergraduate engineering students' decisions when choosing a major. One prominent theme that emerged from the analysis was the significance of Personal Interests in driving participants' decision-making process and this is commonly identified as a motivation for choosing a STEM pathway (Lyons, 2010). This highlights the importance of fostering a sense of passion and intrinsic motivation among students, as it can guide them towards majors that resonate with their personal interests and potentially lead to greater engagement and satisfaction in their academic and professional endeavours (Park et al., 2018). Participants expressed a strong alignment between their engineering major and their genuine interests; however, this was higher for participants who did not have a strong professional identity. This may emphasise the need for other motivations to be developed to ensure an engineering career presents a favourable career path outside of just personal interest and to continue to foster professional identity (Dawes et al., 2015).

Participants also highlighted the lack of comprehensive knowledge about the different disciplines which contributed to their exploration and consideration of alternative options. This emphasises the role of universities in providing comprehensive information and guidance to students to ensure they have a clear understanding of the available majors, enabling them to make informed decisions that align with their interests and to ensure the wider professional is supported by a wide range of future engineering majors (Badets, 2017; Bairaktarova et al., 2015). This underscores the pressing need for universities to address this issue and take proactive steps to enhance the clarity of information available to students regarding various engineering disciplines. Universities should prioritise the development of comprehensive resources, such as updated course catalogues, detailed program descriptions, and career guidance services, to empower students with the knowledge they need to make well-informed decisions about their majors.

Another influential factor that emerged from the analysis was participants' perceived ability level in the subject matter. Interestingly, the discussions surrounding this factor were predominantly negative, with participants expressing self-doubt and feelings of inadequacy in certain majors. This was only identified by participants with strong professional identities and suggests that students' self-perception of their abilities can significantly impact their major selection process, potentially leading them to overlook majors they are genuinely interested in due to a lack of confidence. Perceived natural talent was also established as a major driving factor in major choice in a study in a West Michigan college (Calvin College Center for Social Research, 2009).

The study also revealed the influence of social and family factors on participants' major choices. External social influences, such as friends, peers, mentors, or role models, played a significant role in shaping participants' perceptions of different engineering disciplines. Similarly, family influences, particularly when family members were engineers or provided encouragement, had a strong impact on participants' decisions. Similar reasons for students' decisions to study STEM have been highlighted in previous studies (Anlezark, 2008; Lyons, 2010), with the major influencers identified as teachers, parents, family, and peers.

The timing of participants' major decisions also varied based on their level of professional identity. Participants with a self-described strong professional identity more commonly selected their major during university studies, while those without a strong professional identity tended to decide before entering university. This suggests that university experiences, such as exposure to different engineering disciplines and the university environment itself, play a significant role in shaping major decisions for students with a strong professional identity. Conversely, participants without a strong professional identity may rely on pre-university factors, such as personal interests or external advice, when making their major selection. These findings highlight the diverse pathways and timing in which participants arrive at their engineering major decisions, underscoring the need for tailored support and guidance throughout the decision-making process during the first year of university (Long, 2022; Main et al., 2022).

Conclusion

In conclusion, this study provides valuable insights into the factors influencing undergraduate engineering students' major selection and the significance of these factors. The findings emphasise the importance of personal interests, perceived ability levels, understanding of available majors social and family influences, and the timing of major decisions. Understanding these factors can inform educational institutions and policymakers in developing interventions and support systems that enhance students' decision-making processes and facilitate informed choices aligned with their interests, aspirations, and capabilities. By addressing these factors, universities can better equip students to navigate the complex landscape of engineering majors and foster a sense of purpose and fulfillment in their academic and professional journeys.

References

Anlezark, A., Lim, P., Semo, R. & Nguyen, N. . (2008). *From STEM to leaf: Where are Australia's science, mathematics, engineering and technology (STEM) students heading?* Retrieved from http://www.industry.gov.au/skills/Resources/Documents/STEMtoLeafAustSciTechEnginMathHeading.pdf

Bairaktarova, D., et al. (2015). A project-based approach professional skills training in an undergraduate engineering curriculum. *International Journal of Engineering Education, 31*(1), 425-433. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84921878714&partnerID=40&md5=5a74fa80fe0eb7ea05090b0dda77ae17

Calvin College Center for Social Research. (2009). *Cultivating STEM: Why West Michigan college students select majors in STEM.* Retrieved from http://www.calvin.edu/admin/csr/weblog/files/Cultivating_STEM.pdf

Dawes, L., et al. (2015). *Why are students choosing STEM and when do they make their choice.*

Guest, G., et al. (2012). *Applied Thematic Analysis.* doi:10.4135/9781483384436

Huff, J. L. (2019). Identity in practice: Examining personal identities of engineering graduates in the transition to the workplace. *Emerging Adulthood Journal*, 359-368.

James, J. O., et al. (2018). A new facet: Building multifaceted engineering identity. *International Society of the Learning Sciences, 3*(2018-June), 1427-1428.

Johnson, D., et al. (2019). Beyond the In-Person Interview? How Interview Quality Varies Across In-person, Telephone, and Skype Interviews. *Social Science Computer Review, 39*, 089443931989361. doi:10.1177/0894439319893612

Long, S., Cunningham, Sam, Dart, Sarah, Whiteford, Chrystal, & Dawes, Les (2022). *Why do students choose to study engineering?: Insights from a large-scale institutional survey.* Paper presented at the In Proceedings of the 33rd Australasian Association for Engineering Education Conference (AAEE), Australia.

Lyons, T. Q., F. (2010). *Choosing Science: Understanding the declines in senior high school science enrolments.* Retrieved from http://simerr.une.edu.au/pages/projects/131choosingscience.pdf

Main, J., et al. (2021). Choosing an engineering major: A conceptual model of student pathways into engineering. *Journal of Engineering Education, 111.* doi:10.1002/jee.20429

Main, J., et al. (2022). Choosing an engineering major: A conceptual model of student pathways into engineering. *Journal of Engineering Education, 111*(1), 40-64. doi:https://doi.org/10.1002/jee.20429

Morelock, J. R. (2017). A systematic literature review of engineering identity: definitions, factors, and interventions affecting development, and means of measurement. *European Journal of Engineering Education, 42*(6), 1240-1262. doi:10.1080/03043797.2017.1287664

Painter, J., et al. (2017). *Why Engineering? Students' Reasons for Choosing an Engineering Major.*

Park, J. J., et al. (2018). Identifying Key Influencers of Professional Identity Development of Asian International STEM Graduate Students in the United States. *Asia-Pacific Education Researcher, 27*(2), 145-154. doi:10.1007/s40299-018-0373-6

Paulson, J., et al. (2016). *Examining engineering students' major selection: Developing baseline quantitative results to investigate major selection and change.*

Stets, J., et al. (2013). Identity Theory. *Handbook of Social Psychology*, 31-60. doi:10.1007/978-94-007-6772-0_2

Stryker, S., et al. (2000). The Past, Present, and Future of an Identity Theory. *Social Psychology Quarterly, 63*(4), 284-297. doi:10.2307/2695840

Theiss, A. H., et al. (2016). *Engineering Major Selection: An Examination of Initial Choice and Switching Throughout the First Year.*

Tonso, K. L. (2014). Student Engineers and Engineer Identity: Campus Engineer Identities as Figured World. *Cultural Studies of Science Education, 1*(2), 273-307. doi:10.1007/s11422-005-9009-2

Walther, J., et al. (2013). Quality in Interpretive Engineering Education Research: Reflections on an Example Study. *Journal of Engineering Education, 102*(4), 626-659. doi:https://doi.org/10.1002/jee.20029