ŌTAUTAHI CHRISTCHURCH AOTEAROA NEW ZEALAND
35TH AUSTRALASIAN ASSOCIATION FOR ENGINEERING EDUCATION ANNUAL CONFERENCE
8-11 DEC 2024
THE ENGINEER AND THE WORLD

Aligning Expectations: Student and Academic Perspectives on Engineering Professional Identity Development

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CONTEXT
Professional identity encapsulates the multifaceted development of engineers, including personal values, industry work, technical knowledge, peer connections, and engineering experiences. A strong professional identity correlates with professional progression and retention and is pivotal in engineers' success and longevity in their careers. Professional identity development is intricately intertwined with university and professional experiences and is developed by a myriad of influences on the journey towards becoming an engineering professional.

PURPOSE
University educators play a significant role in fostering the development of students' professional identity, as they impart knowledge, provide mentorship, and create environments which facilitate the path to engineering careers. However, educators' understanding of professional identity may differ from student expectations of their identity development and recognising the shared beliefs and identifying the differences may allow for more holistic and reconciled identity development. In response, this study focuses on the research question: *How do engineering academics understand engineering professional identity, and how does this compare to student perspectives?*

APPROACH
A workshop was held during the Australian Association of Engineering Education conference in December 2021 with seven engineering academics. This 90-minute online workshop involved three short activities and group discussions related to academic perspectives of student professional identity development. These activities were centred around defining professional identity, identifying how students develop their professional identity, and discussing methods for facilitating professional identity development through curriculum and classroom activities. Jamboards were used and then collated and thematically analysed to identify themes across responses. Student perspectives were gathered as part of a PhD study, provide a benchmark to compare academic perspectives against.

OUTCOMES
Engineering academics identified traits such as problem-solving and a sense of belonging as being central to professional identity development. Academics discussed the influences such as networking and in-school programs and emphasised the importance of mentors and professional experience. Student engineers also identified the importance of professional experience and noted that external recognition and individual values are key drivers of their identity development.

CONCLUSIONS
By bridging the gap between academic understanding and student expectations, educators can better facilitate a holistic approach to identity development within engineering education. This work can contribute to a more transparent dialogue between students and academics and assist academics to develop a better understanding of professional identity from a student perspective.

KEYWORDS
Engineering academics, engineering education, professional identity

INTRODUCTION

Engineering professional identity encompasses how engineers perceive themselves as professions within the industry and is shaped by education, work experiences, personal values, and peer relationships (Lakin, Wittig, Davis, & Davis, 2020; Morelock, 2017; Nadelson et al., 2017; Young, Dawes, & Senadji, 2024). It provides a sense of purpose, direction, and sets standards and expectations for behaviour and work (Godwin, Potvin, Hazari, & Lock, 2013). As students transition into professional engineers, developing a strong engineering identity becomes crucial. It involves recognising oneself as an engineer, feeling a sense of belonging to the engineering community, and adopting engineering values and practices (Kapoor & Gardner-McCune, 2019; Pierrakos, Beam, Constantz, Johri, & Anderson, 2009). This identity fosters motivation, engagement, effective communication, and networking skills and significantly influences educational and professional persistence, impacting job satisfaction and career commitment (Morelock, 2017; Rodriguez, 2018).

Engineering professional identity is crucial for retention and job satisfaction within the industry (Nadelson et al., 2017) . A strong sense of professional identity not only aligns engineers with the values and norms of their profession but also fosters a deeper connection to their work (Morelock, 2017; Nadelson et al., 2017). When engineers identify strongly with their profession, they are more likely to feel a sense of belonging and purpose, leading to higher job satisfaction (Groen & McNair, 2016). Furthermore, engineers who feel a strong sense of professional identity are more likely to remain committed to their careers, leading to higher rates of retention within the field (Godwin & Lee, 2017; Groen & McNair, 2016). Proactively building professional identity for students requires academics to have a nuanced understanding of the beliefs they share with students as well as recognition of differences, paving the way for a more comprehensive and holistic approach to identity development.

BACKGROUND

Educators serve as fundamental supports for students' professional identity development within higher education. Their roles extend beyond imparting technical knowledge to encompass mentorship and the creation of environments conducive to students' identity journeys. As students navigate the complexities of shaping their professional identities, educators provide guidance, share experiences, and offer valuable insights that facilitate this developmental process. The dynamic interplay between educators and students brings forth a multifaceted perspective on professional identity. While educators offer mentorship and expertise, students actively engage in self-discovery and identity formation. This underscores the co-development of professional identities, where educators serve as mentors and facilitators, while allowing students to forge their own identity narratives.

Central to this process is empowering students to be in control of their identity trajectories. Recognising the importance of agency in identity formation, educators must create spaces that enable students to explore diverse experiences, values, and aspirations. By fostering a sense of ownership and autonomy, educators allow students to actively shape their professional identities in alignment with their personal values and career goals. Moreover, the convergence of educators' perspectives with those of students enriches the dialogue surrounding professional identity development. Thus, this study seeks to answer the research question: "*How do engineering academics understand engineering professional identity, and how does this compare to student perspectives?*

METHOD

Data collection

As part of a large research study, we held a workshop with seven engineering academics who had between three and 20 years of experience as an engineering educator. These academics were attendees at the 2021 Australian Association for Engineering Education (AAEE) conference and self-elected to attend the workshop.

Table 1 presents an overview of the key demographic information about the workshop participants, including institution and years of teaching experience.

Table 1 – Participant demographics

Participant ID	Institution	Years of Experience in Engineering Teaching Role
A	University of Technology Sydney	3 - 5 years
B	Charles Sturt University	5 - 10 years
C	Queensland University of Technology	5 - 10 years
D	Queensland University of Technology	5 - 10 years
E	Australian National University	5 - 10 years
F	University of Western Australia	5 - 10 years
G	Sydney University	10 - 20 years

The workshop, which lasted approximately 90 minutes, explored engineering academics perspectives on student identity development. This workshop was conducted in December 2021 and was led by both authors. The workshop was held via Zoom and 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, shown through the range of participant institutions, ultimately improving the overall diversity and inclusivity of the findings.

The workshop included discussions in response to three prompting questions:

1. What is professional engineering identity?
2. What influences student professional identity development?
3. How can we best implement identity building into teaching practice?

Throughout the workshop and by using scaffolded discussions, participants were allocated to breakout rooms and invited to respond to the above questions using Google Jamboards. This boards were then discussed as a group when participants returned to the main room and were exported for analysis. This research was approved by the Human Ethics Research Committee (approval number 2021000288).

Data analysis - academics

For each of the Jamboards created, a pile sort approach was used to categorise the data. The goal of pile sorting is to understand a group cognition or “what goes with what” by building groups around common themes (Lantz et al., 2019). At the conclusion of the workshop, both authors revised the Jamboards and collaboratively sorted responses into emergent categories. Any discrepancies were discussed as they arose and changes to categories were made as required. This process allowed for iterative discussion and development of categories based on the data rather than any preconceived perceptions.

Larger research study – students and ECE’s

Within the scope of a PhD project, interviews were conducted with 30 undergraduate engineering students in their third or final year at Queensland University of Technology (QUT) and early career engineers (ECEs) who had graduated from QUT within 1 to 5 years (Young et al., 2024). This selection of both students and ECEs as participants was motivated by their firsthand experiences and reflective position in the process of forming their professional identity, facilitating insights into their journeys and perspectives. Employing a semi-structured interview approach enabled participants to offer detailed and comprehensive responses pertinent to the research context (Longhurst, 2003) through the development of a journey map (Young et al., 2024). Carried out between May and June 2022, the interviews were facilitated by the first author. While in-person interviews were preferred whenever feasible (n=18), Zoom web-conferencing software was utilised for remote participants (n=12), with interviews recorded via video for transcription purposes. The subsequent analysis of these interviews resulted in a framework of identity influences, derived from student experiences into themes, ordered by significance of influence, and this is given in Table 2. This work is discussed further in Young et al. (2024).

Table 2 – Framework of influences to engineering professional identity

Theme	Influence
Engineering Experiences	Work and industry experience
	Engineering major selection
	Career trajectory
Design Learning Experiences	Participation in real world problems and projects
	Capstone course or thesis project
	Design learning projects and experiences
	Short, intensive challenge projects
Individual Attributes and Values	Motivation for studying engineering
	Alignment of course with individual values
	Pre-course perception of engineering
	Pre-course exposure to engineering
	Minority personal identity
	Proactive approach to learning
Classroom Activities	Hands-on and practical learning experiences
	Case studies and ethical challenges
	Self-reflection and autoethnographic portfolios
	Group work and collaboration
	Learning mode (online versus face-to-face)
Peer Connections	Pre-existing relationships to peers
	Relationship to peers developed in course
Technical Knowledge	Acquisition of engineering skills
	Learning with authentic knowledge
	External recognition of technical knowledge and skills
	Personal competency with course content
Co-curriculum Experiences	Participation in student clubs
	International exchange
	Leadership and professional development programs
Educators and Academics	Educator enthusiasm and engagement
	Relationship to faculty
	Thesis and capstone project supervisor
Mentors	Peer mentor
	Academic mentor
	Industry mentor or connections
Academic Results	Academic achievement

Positionality

Both authors offer a unique perspective as engineering educators and engineers who have navigated their own professional identity development. With firsthand experience as students in higher education, engineers in industry, and educators in academia, they have a deep understanding of the challenges and opportunities in shaping engineering identities. This enhances the analysis of the results and provides a nuanced understanding of the similarities and differences between academic and student perspectives on professional identity development. These perspectives enrich the research, offering a comprehensive exploration of this vital aspect of engineering education.

RESULTS

How student and academics understand professional identity

Workshop participants were first invited to share their understanding of professional engineering identity. This was done prior to any facilitator explanation of engineering identity to reduce influencing participant responses. Based on the responses, it is evident that academics' understanding of professional identity and what is means to be an engineer, is multifaceted and dynamic. Participants offered a spectrum of perspectives, highlighting various dimensions of this identity. Some

underscored the technical proficiency inherent in engineering, emphasising skills such as problem-solving, investigative acumen, and adeptness with engineering language.

To me being an engineer is being investigative and wanting to know more about how things work.

Identify problems and identify potential solutions.

Able to handle new problems and find potential solutions.

Being 'fixers'

Feeling competent as an engineer - having relevant experience, skills required for the role.

Confidence in using your engineering judgement.

Workshop participants' varied views on professional engineering identity aligned highlighted its multifaceted nature and the significance of technical proficiency, problem-solving, and engineering judgment. Conversely, other academics placed greater emphasis on personal attributes and ethical comportment, citing the importance of belonging to the profession, possessing confidence in one's engineering judgment, and readiness to uphold ethical and professional standards.

Feeling competent as an engineer - having relevant experience, skills required for the role.

Ready to be an engineer both ethically, professionally and all other aspects.

Feeling like you belong to the profession.

Seeing the world through engineering eyes.

The emphasis placed by some academics on personal attributes and ethical comportment in professional engineering identity echoes findings in existing literature (Loui, 2005; Nadelson et al., 2017). This underscores the broader discourse surrounding the holistic understanding of professional identity, encompassing not only technical proficiency but also ethical awareness and a sense of belonging within the engineering community (Morelock, 2017).

It was also noted that professional identity is often subject to contextual nuances, as evidenced by participants who tailor their descriptions of engineering based on the audience. This adaptability underscores a recognition of the diverse stakeholders and communication requirements within and outside the engineering community.

I give a different definition [of engineering] to whoever I talk to - i.e., technical people get my technical definition, but relatives get a very vague description.

The observation of contextual nuances in professional identity aligns with studies highlighting the adaptability of individuals in tailoring their self-descriptions based on the audience (Davis, 1996; Male, Bush, & Murray, 2009). This reiterates the dynamic nature of professional identity construction within the engineering community and its interaction with broader societal contexts.

Furthermore, there was acknowledgment of the continual growth inherent as an engineer, with some participants viewing themselves as perpetual learners rather than as static experts.

Seeing oneself as an engineer in training rather than a glorified high school student.

Malleable and flexible.

The recognition of continual growth and the perception of oneself as a perpetual learner within the engineering profession resonate with research highlighting the importance of adaptability and lifelong

learning in professional development. This perspective aligns to the evolving nature of professional identity and its dynamic interaction with changing industry demands and technological advancements.

The comparison between how student and academic understand professional engineering identity revealed intriguing insights. Academics, drawing from their expertise and professional engagement, highlight the technical skills required in engineering, such as problem-solving skills, investigative acumen, and confidence in engineering judgment. This perspective is evident in their characterisation of engineers as "investigative" individuals who excel in identifying problems and finding potential solutions. Furthermore, the emphasis on belonging to the profession and upholding ethical standards underscores their recognition of the broader responsibilities associated with professional engineering identity. In contrast, students approaching the concept of professional engineering identity often focus initially on acquiring technical skills and knowledge, reflecting their stage of development and immediate educational goals. Their descriptions frequently centre on mastering engineering principles and gaining hands-on experience through projects and internships. This emphasis suggests a foundational phase where students are building competence and confidence in their technical abilities, laying the groundwork for their future roles as engineers.

Drivers to identity development

The second stage of the workshop saw participants allocated to breakout rooms where they were asked to identify and discuss what they believed to be the contributing influences to professional identity development. Three categories of influences were posed to the participants based on Godwin, Potvin, Hazari, and Lock (2016) – individual influences, social influences and systematic influences. Their comments were once again collected on Jamboards to be shared and discussed with the wider session. These were then mapped against the findings from the student interviews from Table 2 to compare and contrast the findings.

The comparison between influences identified by student engineers and those acknowledged by academics reveals intriguing parallels and nuanced distinctions. While both groups recognise the significance of individual attributes, student engineers predominantly emphasise personal aspirations and the importance of self-representation within the engineering field. In contrast, academics highlight problem-solving mindset and innovative thinking, the ownership of skills and alignment with societal perceptions of engineering roles. Regarding social influences, both students and academics acknowledge the importance of peer connections, mentors, and participation in co-curricular activities. However, academics specifically place more emphasis on student teams and clubs, and professional networks and industry connections, indicating a shift towards broader professional engagement. Additionally, while students focus on classroom activities and technical knowledge, academics, highlight qualifications, industry experience, and the integration of learning with real-world applications. This comparative analysis suggests a progression from personal aspiration towards a deeper integration into the professional engineering community among academics, characterised by an increasing emphasis on qualifications, industry engagement, and leadership roles.

Practical supports for student identity development

The final component of the workshop invited the participants to consider practical strategies to support student identity development. This time, participants were asked to verbally discuss their thoughts and experiences and various strategies emerged. One participant emphasised the importance of authentic assessment, suggesting tasks mirroring real-world scenarios faced by first-year engineers, such as preparing reports for local government authorities. This approach not only grounds students in practical applications but also fosters engagement and responsibility within the curriculum (Godwin & Lee, 2017; Young et al., 2024). The involvement of local authorities as tutors was also discussed as a tool for valuable insights and guidance.

Another academic highlighted the significance of hands-on projects (Lakin et al., 2020; Young et al., 2024), such as investigating corroded steel around the city, to offer students a tangible experience akin to professional practice. Volunteering opportunities and increased accessibility to university-run events were noted as avenues to engage students who may not naturally seek out extracurricular

Table 3 – Comparison of student and academic professional identity influences

Student Engineers	Engineering Academics
Individual Influences	
• Individual attributes and values • Personal aspirations and self-representation	• Close contacts who are engineers • In-school programs / school outreach • National Youth Science Forum / STEM camps • Seeing yourself in what an engineer looks like and ownership of skills. • Problem-solving mindset • Wanting to be an engineer • Positive attitude and being encourage, even if you do not fit the accepted mould. • Innovative thinking
Social Influences	
• Peer connections • Educators and academics • Mentors • Co-curricular activities	• Networking and mentoring • Student teams • Student clubs • Peers - behaviour, intelligence, demographics • Real world projects within curriculum • Work experience • Counter-cultural areas of engineering (e.g., environmental, systems, humanitarian engineering) • Cultural/societal perception on engineering • Parents and culture • Mentors • Peers • Networking • Engineering clubs and societies • Different types of networks too - student to peers, student to industry • Discussion panels/guest lecturers
Systematic Influences	
• Classroom activities • Design learning experiences • Engineering experiences • Technical knowledge • Academic results	• Qualification • Available jobs • Linking their learning experience to real-world experience • Work experience - meeting people at that time, learning about engineering, meeting mentors, finding the social positives of engineering roles. • Professional experience

involvement. Further discussion pointed to the potential for faculty to take a more active role in organising career events, reaching beyond the limited scope of student clubs.

A third participant shared a project-based approach where student engaged in design consultancies, promoting collaboration and accountability among peers. This method not only aligns with engineering competencies but also nurtures a sense of unity and accomplishment within student cohorts (Morelock, 2017; Nadelson et al., 2017). The integration of professional engagement units and work-integrated learning (WIL) opportunities underscores the importance of bridging academic learning with industry practice, preparing students for the realities of the engineering profession (Rodriguez, 2018). This emphasis on WIL and industry partnerships was echoed by another participant who noted that the transition to online learning posed challenges in this regard, highlighting the need for

innovative approaches to maintain experiential learning opportunities and foster student identity development.

Another academic advocated for diversity in educators and course offerings (Male et al., 2009), enabling students to pursue their interests and engage in contextual, real-world learning experiences. Finally, one participant underscored the importance of hearing from recent graduates, who can offer valuable insights into the realities of the engineering field and facilitate mentorship opportunities for current students.

Findings from interviews with both student and early-career engineers identified several key strategies for proactively building professional identity. Student participants emphasised the significance of early exposure to real-world engineering, advocating for partnerships with industry professionals to facilitate hands-on experiences and interdisciplinary learning opportunities (Morelock, 2017; Young et al., 2024). Extracurricular involvement, such as design competitions and industry visits, was highlighted as pivotal in reinforcing classroom learning and fostering practical skills. Moreover, educator engagement through inclusive teaching methods and mentorship programs was deemed essential for holistic student development. External recognition of skills through industry partnerships and peer connections within inclusive communities emerged as crucial components in solidifying students' professional identities (Young et al., 2024).

The comparison between the suggested supports by academics and the insights gathered from student and early-career engineers' perspectives highlights both consensus and disparities. While academics emphasised practical strategies such as authentic assessments mirroring real-world scenarios and hands-on projects to foster student engagement and responsibility, students and early-career engineers underscored the importance of early exposure to industry through partnerships and extracurricular involvement. Both groups recognised the significance of educator engagement and mentorship programs in supporting holistic student development. However, the emphasis on diversity in educators and course offerings, as advocated by academics, suggests a broader perspective on fostering inclusivity and contextual learning experiences. By acknowledging shared beliefs and understanding differences in how students understand professional identity, educators can tailor their support to meet the diverse needs and aspirations of students. This approach fosters a more inclusive and holistic environment for identity development, where students feel empowered to forge their own career pathways with confidence and purpose and feel guided and supported by engineering educators.

CONCLUSION

In conclusion, this study has emphasised the multifaceted nature of professional identity, encompassing technical proficiency, personal attributes, ethical comportment, and a sense of belonging within the engineering community. While academics play a significant role in fostering identity development through curriculum design, mentorship, and experiential learning opportunities, students bring their lived experiences, aspirations, and diverse perspectives to the table. The evaluation between academic perspectives and insights from students and early-career engineers reveals both alignment and nuanced differences in understanding professional identity development. While academics emphasise practical strategies such as authentic assessments and hands-on projects, students and early-career engineers stress the importance of early exposure to industry and extracurricular involvement. Both groups recognise the significance of educator engagement and mentorship programs, yet academics advocate for diversity in educators and course offerings to foster inclusivity and contextual learning experiences. Although this is positive progress, academics may be preparing students for to become engineers in an ideal world which does not yet exist, and thus current and ongoing industry involvement is vital.

By acknowledging these shared beliefs and understanding differences, educators can tailor their support to meet the diverse needs and aspirations of students. Ultimately, students must be stewards of their own identity narratives, supported by academics who provide guidance, share experiences, and create learning environments conducive to professional growth and development.

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