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Using journey maps as a holistic, reflective approach to capture student engineering identity experiences

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ABSTRACT

Engineering identity has been repeatedly linked to the retention and success of engineering students, however, the current methods for understanding identity may not capture the holistic engineering identity journey. This study reviewed the method of utilising journey maps as a new approach to capture student engineering identity experiences. Interviews were conducted with 30 engineering students and early career engineers in which the participants responded to semi-structured, open-ended questions through the creation of their individual journey map. These maps were then thematically analysed to identify the key influences of engineering identity and the stage of their university journey when these influences occur. We determined that participants who strongly identify as engineers more often discussed and valued social identity experiences in the mid-year and final years of their degree, in contrast to participants who did not feel like engineers. We found that utilising journey maps as a tool for understanding identity allowed for a retrospective correlation between experience and impact, provided the participants space for authentic reflection and honoured the individuality of identity development. This method of journey mapping could be used to inform engineering education research in the further exploration and understanding of student identity development, reflective experiences and narrative storytelling.

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Engineering identity; journey maps; professional identity

Introduction

Engineering identity refers to the perception and understanding that engineers have of themselves as professionals (Morelock 2017; Tonso 2006). This is a type of role identity that students develop during their experiences in engineering (Stets et al. 2013; Stryker et al. 2000), and is shaped by factors such as their education, work experience (Nguyen et al. 2018), personal values, and ethical principles (Kim-Prieto et al. 2013). Having a strong engineering professional identity enables engineers to understand their place in the industry and the impact they can have in society. It helps to provide a sense of purpose and direction in their careers, and to set standards for their behaviour and work (Morelock 2017).

Engineering identity development is an essential aspect of a student's journey towards becoming an engineer. It involves the process of recognising oneself as an engineer, developing a sense of belonging in the engineering community, and embracing the values, attitudes, and practices

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associated with engineering (Huff 2019; James et al. 2018a; Paretti et al. 2012). A strong engineering identity helps students stay motivated and engaged in their coursework, research, and professional development. It also enables them to communicate effectively with other engineers and non-engineers, build a professional network, and navigate the challenges and opportunities in the engineering field. Ultimately, engineering identity development is crucial for the success and satisfaction of individuals pursuing a career in engineering. Engineering identity is also crucial for long term retention as it fosters a sense of belonging and purpose within the profession, leading to greater job satisfaction and career commitment (Sheppard et al. 2015).

Engineering identity has been found to be a strong predictor of educational and professional persistence (Morelock 2017; Spencer et al. 2018; Springer et al. 2020). These studies of engineering identity have centred on the characteristics that students say are necessary to be an engineer as well as whether students think of themselves and identify as engineers. Other research has concentrated on the dialogue that students use to define and identify as practising engineers (Nadelson et al. 2015; Villanueva et al. 2017). Students use this discourse to create their engineering personas through internal and external dialogue.

Capturing professional identity development for undergraduate engineers is complex. The process of professional identity development is highly individual and so too are the influences that impact this journey. Research methods selected to appropriately capture this development need to consider this individuality. Further, as the development of professional identity is non-linear, and evolutionary, these methods also need to reflect this nature. Various research methods and approaches have been used to capture the development of engineering identity and help educators and institutions support their students' professional growth. Within the realm of professional identity research, the primary tools of data collection are surveys, classroom tasks and assessments and semi-structured interviews (Morelock 2017; Nadelson et al. 2015). While these methods have provided results with respect to professional identity development, they may not fully support the nature of professional identity development as described above.

The purpose of this paper is to propose and adapt Journey Maps as a method that we believe is better suited to capture the complex and individual nature of identity development in undergraduate engineering students.

Journey maps are tools for data collection that provide a structured way to gather and organise information about an individual's experience. By mapping out the various touchpoints and interactions that a student has during university, journey maps help to identify areas where and when these influences occur and the degree of impact on identity development. These influences can include classroom experiences (Chen et al. 2019; Gwynne-Evans 2018; Ofori-Boadu et al. 2019; Svyantek et al. 2015), relationships with academics (Interiano et al. 2019; Park et al. 2018), WIL (Male et al. 2014; Spencer et al. 2018) and other key positive and negative experiences. Journey maps also provide a visual representation of the student journey, making it easier to analyse and interpret data, and to identify trends and patterns.

The concept of journey maps stem from the lifeline approach which emerged from two research traditions, namely life course and life events (De Vries 2013) research. Life course research highlights the significance of examining people's lives in historical and biographical contexts, considering the impact of time and place (Elder et al. 1998). On the other hand, life events research focuses on significant occurrences and situations and their resulting life changes, which have generally been regarded as intrinsically stressful (Dohrenwend 2006). The foundational work of (Holmes et al. 1970) is a prominent example of this approach, where individuals report the normative life events that have happened over a given period, and scores are interpreted as an index of social stress. Although the association between stress scores and mental and physical well-being has been empirically validated, studies have shown that the timing, nature, and context of life events play a more significant role in their consequences (de Vries et al. 1995; de Vries et al. 2001). Rather than objective life events, the focus is on the subjective meaning of those events to individuals who experience them (Jang et al. 2002; Lazarus and Folkman 1984). Consequently, researchers have shifted away

from scalar assessments and event recognition towards more narrative descriptions of events, which integrate an event-based perspective with a personal life course narrative (de Vries and Suedfeld 2005; de Vries and Watt 1996).

In this paper, we propose to adapt Journey Maps to the context of professional identity development. We illustrate its use in the context of Engineering students and graduates and propose a framework that can be extended to capture professional identity development beyond Engineering. This paper first discusses the current approaches used in engineering education research to explore professional identity, and journey maps are further explained with examples given from research in grit and resilience. The theoretical framework applied is then discussed, followed by a detail description of the methodology undertaken to apply journey maps in our study. Finally, some initial results of the study are provided as well as reflection discussion about the application of journey maps.

Methods for capturing professional identity

We have reviewed numerous methods which explored professional engineering identity in the engineering education research space over a five-year time span (2018–2022). Methods prior to 2018 were considered by Morelock (2017) who conducted an extensive systematic review of identity studies prior to this and captured methods used before 2018. His work found that most of the methods used were qualitative (26 of the 46 methods reviewed), mainly using interviews and surveys short answer responses. Out of the twenty other methods captured by Morelock (2017), eight used surveys, five studies used mixed methods, combining qualitative and quantitative approaches, and seven were historical analyses or literature reviews.

The studies included in our review were those which explored undergraduate engineers' professional identity development, were published during 2018–2022, and described their methods of data collection and the methods summarised by the research team, have been summarised in Table 1 (Supplementary Material).

Of the 37 research papers captured in Table 1, several methods were utilised including surveys (16 studies), student work (including classroom activities) (4 studies), a combination of surveys and interviews (6 studies), interviews (3 study), focus groups (1 study), narratives (1 study), student work in conjunction with interviews (1 study), surveys in conjunction with academic transcript and resumes (1 study) interviews and observation (1 study), a combination of surveys, focus groups, student work and observations (1 study) and a combination of surveys, observations, and interviews (1 study).

This spread of data collection favours surveys and interviews. Surveys provide tools for high representativeness, ease of accessibility for participants and can create good statistical significances, however, they are also limited by their inflexibility of responses (Creswell et al. 2018). This is especially relevant when discussing professional identity development as it is highly unique to

Table 1. Focus group participant demographic.

	Count
Education	
Student Engineer	17
Early Career Engineer	8
Gender	
Male	7
Female	18
Engineering Major	
Civil	16
Mechatronics	3
Mechanical	2
Medical	2
Chemical Process	1
Computer and Software	1

each student and thus any survey tool should include some degree of open-endedness to allow for student driven responses. Interviews were utilised solely or in conjunction with other data collection methods for 12 studies and, conversely to surveys, allow participants to direct their responses, elaborate and clarify their thoughts and discussions (Creswell et al. 2018) around their individual identity journey. However, traditional research methods may not fully capture the nuanced and individual nature of professional identity development, and using journey maps could offer a more comprehensive and effective approach to studying this complex process.

Journey maps

Journey Maps, which are also referred to as 'lifelines', 'life maps' or 'timelines' (Neale 2017) present visual illustrations of participants' lives. They are a participatory approach, meaning the data is commissioned by the researcher and jointly constructed or self-generated by the participant in a relatively unmediated way. These journey maps are constructed in a fluid, personalised, intuitive and creative way, integrated within an interview which allows ample space for discussion.

The exercise involves drawing a life journey map, with participants indicating key milestones, events, transitions, or turning points that occurred along their path. The links between these personal events and unfolding life experiences can be represented on the map as well. These drawings are not limited to reflecting past experiences; they can explore a person's entire life or segments of it and may also delve into the future (Gordon et al. 2005; Neale et al. 2012; Thomson et al. 2002). This is typically done in chronological order across a linear x-axis (Nelson 2010). Researchers have utilised journey maps as a method of illustrating biographical interviews across a span of methodological and theoretical perspectives (Adriansen 2012; De Vries 2013; Gramling et al. 2004). Journey maps are ideal tools for biographical data collection as they improve the participants' accuracy when recalling chronology, details of events and timing (Glasner et al. 2009; Hope et al. 2013). They provide participants with a visual tool to reflect on events, influences and turning points throughout their lives and thus elicit participant reflexivity within collaborative research (Neale 2017).

Within the engineering space, journey maps have been used to map the experiences of academic staff and explore grit and resilience of participant (Direito et al. 2021). Similarly, to identity development, the latter explores personal development experiences. Figures 1 and 2 provide two examples of journey maps which were developed in a study by Dagg et al. (2019). It should be noted that these maps provide an overview of experiences over a lifetime whereas the maps created in our study were confined to the experiences just prior to, just after (if applicable) and inclusive of the university journey only.

By using the journey map method, the researchers were able to maintain an analytical separation between the 'life as lived' and 'life as told' while jointly reconstructing participants' life experiences

Figure 1. Example of journey map from Dagg et al. (2019).

Decade	1950s	1960s	1970s	1980s	1990s	2000s	2008 Crisis	2010s	2015 Rescue
Economic trend	Stagnation	Growth	Growth	Recession	Growth	Growth	Recession	Stabilisation	Growth
Age range	0-5	6-15	16-25	26-35	36-45	46-55	About 55	56-60	About 60
Larry	Childhood	Adolescence. Awareness of family problems.	Leaves school. Apprenticeship. Marriage. First Child.	Moves to civil service occupation. Three children born.	Dealing with childhood memories. Separation. Moves to commuter town.	Builds house in rural area. Meets second wife.	Birth fifth child.	Austerity cuts. Retires. Sixth child born. Critical financial difficulties.	Struggling to accept decision to sell house and moves in wife's family.

Figure 2. Example of journey map from Dagg et al. (2019).

and perceptions (De Vries 2013; Gramling et al. 2004). Through the reflexive lifeline interview, Dagg et al. (2019) were able to investigate resilience as a process in which participants rewrote their pasts and reimagined their futures (Neale 2017). This approach also gave the researchers an unexpected opportunity to practice reflexivity as researchers, challenging some of their preconceived notions about resilience. They also believe that the reflexive lifeline method has the potential to be used in a wide range of biographical research topics. However, since it creates a 'feedback loop between participant narratives and research data', it requires a high degree of ethical sensitivity (Dagg et al. 2019). One of the challenges of biographical research in the social sciences is that it may appear to individualise topics such as resilience, emphasising contingent events, agency, and individual characteristics, while ignoring the determining effects of broader socio-historical contexts and structural limitations. However, within this study, by utilising thematic analysis to review all 30 journey maps, common influences and themes could be identified across participants. Finally and most significantly, the reflexive lifeline or journey map approach captures what Abbott (2005) refers to as the 'historicality of individuals' and helps to reveal the 'reflexive competences' (Caetano 2015) that people use to address critical life events. Both layers of interpretation and analysis would be applicable for a biographical understanding of engineering identity.

Journey maps serve as a valuable tool to rejuvenate conversation or to facilitate communication about sensitive topics and life (Guenette & Marshall 2009; Worth 2011). These maps can provide an external reference point and a tangible representation of a participant's life, allowing for a focus on the discussion. They can be revisited, refined, and elaborated upon during the interview process as participants further reflect on their life events and processes, often leading to intriguing visual connections (Glasner et al. 2009). Journey maps are especially useful for reflecting the fluidity of temporal processes, as the construction of these maps conveys subjective understandings of the life course. The accompanying commentaries offer rich insights into how participants discern the flow of time and the salience of particular events and processes. Life maps take on various forms, such as mind maps, horizontal or vertical lines, parallel lines, zig-zagging or criss-crossing paths, or circular, spiral, and flowing pathways, depending on the individual's preference and the aim of the research (Worth 2011).

Theoretical framework

To facilitate the analysis of our journey maps, we drew upon the underpinnings of role identity as framed in psychological and sociological literature as well as the application of this theory in science education.

Role identity is the meanings that the individual attaches to the context of a social and cultural role. An individual has as many selves or identities as he or she has groups of people with which he or she interacts. Some identities become more salient based on the particular context and social situation in which an individual is immersed (Stryker et al. 2000). This framing of identity comes from social identity theory and symbolic interactionism. Symbolic interactionism is the meanings that

individuals develop and rely on as a part of social interaction. In this key sociological theory, when a person has claimed an identity, he/she acts on the basis of that identity, and he/she attempts to fit their actions with others in that community to accomplish their goals (Gibson et al. 2018; Husin et al. 2021). There are different emphases in identity theory that focus on how individuals define themselves in relation to social structures, how individuals' internal dynamics influence behaviour, and how identities are maintained and manifested in face-to-face interactions.

For engineering students, the journey to identifying as an engineer is intertwined through their academic (Fagan 2016) and personal development (Fagan 2016; Hinojosa 2018), retention (Springer et al. 2020), and incorporation into the larger engineering profession (Interiano et al. 2019; Park et al. 2018). In their process of engineering identity development, students must negotiate the roles they play within the community of engineering as a discipline, in groups with their peers, during internships and work experience, and within the classroom. Engineering students must author individual identities that map to the group identity of an engineer. The development of an engineering identity requires legitimate participation and recognition within that social sphere. This consideration emphasises the need for individual and social identities to be considered interwoven with engineering identity and reaffirms the application of journey maps as tools for exploring these individual identities.

Using journey maps to explore engineering identity

Stage 1: developing the semi-structured interview questions

After an extensive review of literature around engineering identity and prior to conducting the journey map interviews, we held focus groups to confirm and validate the previously identified identity influences found in literature (Morelock 2017). This allowed us to determine the most frequently identified influences and determine any additional influences we wished to further explore. Seven focus groups, with a total of 25 participants, were conducted in September 2021 at the Queensland University of Technology (QUT), Australia. Participants included undergraduate engineering students in their third or final year of study at QUT and early-career engineers (ECEs, 1–5 years post-graduation) who have completed an engineering degree at QUT. Table 1 presents key demographic information from the focus groups, including the participants' education, gender, and engineering discipline. It is worth noting that 18 of the 25 participants identified as female, which deviates from the typical male-dominated engineering cohort. However, previous studies have shown that undergraduate research often has an overrepresentation of female participants (Dickinson et al. 2012).

These groups covered eleven open-ended questions and averaged a length of 51 min. Ethics for this research study (includes focus groups and journey map interviews) was approved by Human Research Ethics Committee at QUT, approval number 2021000288.

The results of these focus groups culminated in approximately 350 min of audio recordings. These recordings were transcribed and resulted in approximately 60,000 words of data collected. These transcriptions were then analysed using structural coding within NVivo to confirm and validate the previously identified identity themes and influences and identify any additional influences. Throughout the coding process, careful attention was paid to maintain consistency in interpreting and applying codes to segments of text. To further enhance reliability, an iterative coding process was followed, where the researchers engaged in regular discussions to resolve any discrepancies, refine codes, and ensure a shared understanding of the themes. This collaborative approach not only increased the reliability of the analysis but also provided a platform for critical reflections on the findings. To address potential researcher bias, efforts were made to maintain reflexivity by documenting researchers' thoughts, assumptions, and interpretations throughout the analysis process. This transparency allowed for an ongoing assessment of the potential impact of researchers' perspectives on the analysis outcomes, thus enhancing the validity of the findings.

Engineering experiences was the most frequently identified theme, specifically the influence of academic and industry experience. This was expected as the impact of work integrated learning

on identity is well documented within engineering (Dominguez et al. 2019; Jackson 2017). Design projects, and specifically design learning experiences and real-world projects were also well represented. The clash between personal gender identity to the typical engineering male identity, was discussed as barrier to identity development for participants. Through this analysis an additional theme was observed around co-curriculum experiences. This was not previously captured as a theme, however, does incorporate key aspects of numerous other themes i.e. peer connections, design projects, mentors, engineering experiences, and technical knowledges. This theme included the influences of student clubs and societies and international exchanges. This influence has not been well linked to identity development and provides an important aspect of better understanding the student identity journey. This analysis informed the development of ten key themes (below) which were used to develop the semi-structured interview questions which were then used in the journey map interviews.

1. individual attributes and values,
2. peer connections,
3. classroom activities,
4. design learning experiences,
5. educators and academics,
6. mentors,
7. engineering experiences,
8. technical knowledge,
9. academic results and,
10. co-curricular activities.

The insights garnered from the focus groups exerted a profound impact on reshaping the research team's perception of the engineering identity framework adapted by Godwin (2016). Initially, our literature review laid the groundwork by identifying established influences on engineering identity. However, it was the focus group discussions that illuminated the nuanced interplay of these influences within the context of real-world experiences. The data-rich interactions within these groups revealed unexpected dynamics, prompting a revaluation of how personal identity and social identity are fundamental to developing an engineering professional identity. This will be discussed further in Stage 4.

These themes played a pivotal role in shaping the trajectory of the subsequent journey map interviews. With each theme representing a facet of the intricate identity development process, they provided a structured and comprehensive framework to guide our line of inquiry. These themes served as the building blocks upon which the interview questions were constructed. The questions were designed to elicit participants' reflections on their experiences related to each theme, thereby capturing the interplay between these influences in their personal journeys of engineering identity development. By anchoring the interview questions in these themes, we ensured that the conversations during the journey map interviews were purposeful, insightful, and aligned with our overarching research objectives. It is important to note that these themes represent a wide range of experiences and thus it was important to ensure the questions were reasonably open-ended and provided room for participant interpretation and space to explore their own personal experienced. The themes formed an integral bridge, connecting the insights gained from the focus groups to the in-depth exploration undertaken in the journey map interviews, culminating in a holistic understanding of the multifaceted dynamics of engineering identity formation.

Stage 2: data collection

The journey map interviews were conducted with 30 participants including undergraduate engineering students in their third or final year of study at QUT and ECEs (early-career engineers, 1–5

years post-graduation) who have completed an engineering degree at QUT. Student participants were initially identified through participants from the focus groups, and 19 participants from the focus groups went on to be participants in the journey map interviews. This overlap will be explored later to emphasise how journey maps were used to capture student experiences in a more comprehensive approach compared to focus groups. Additional recruitment was also done in engineering undergraduate courses. Two core units offered to third, and final year students were targeted with advertisements as these units are undertaken by all engineering students. Advertisements were also included on engineering student club social media pages. ECEs were contacted through professional contacts of the research team using LinkedIn and through QUT Alumni. Both students and ECEs were selected as students can provide a real-time and rich account of current experiences whereas ECEs can retrospectively reflect on their university experiences. Both groups of participants can add valuable and unique perspectives for this study.

The 60-minute interviews were designed to explore participants' experiences, including the influences they thought were important, and their perceived supports and barriers to becoming professional engineers. We used a semi-structured interview style as it allowed participants to give rich and expansive responses focused on aspects significant to them within the context of the research.

From these interviews we gathered 30 unique journey maps which represented the participants' experiences across a range of different styles. Some participants utilised mind map or road map type drawings, whereas others used timelines or lists. These were primarily done using pen and paper, however, some participants chose to use Microsoft Word or PowerPoint in which they created flowcharts, lists and slideshows during the interview. Excerpts of the collected journey maps are included as examples in Figures 3 and 4.

Reflecting on the use of journey maps for the identity interviews, it was clear that some participants were initially unsure of how to approach the mapping process, requesting clear directions for how their map should look. However, all the participants, after some encouragement from the

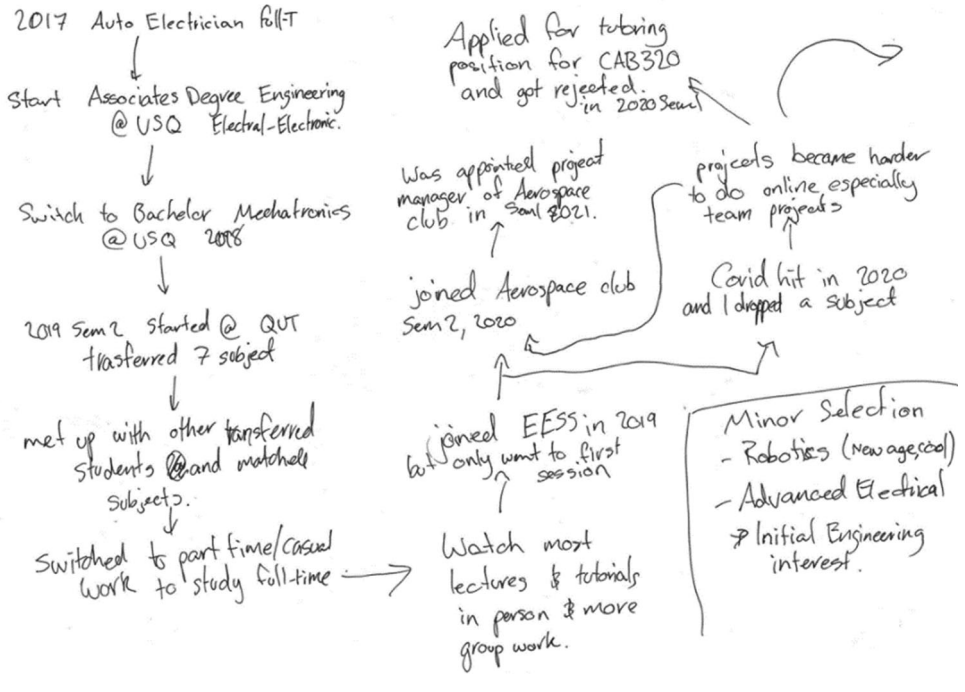

Figure 3. Example of student journey map (excerpt provided for anonymity).

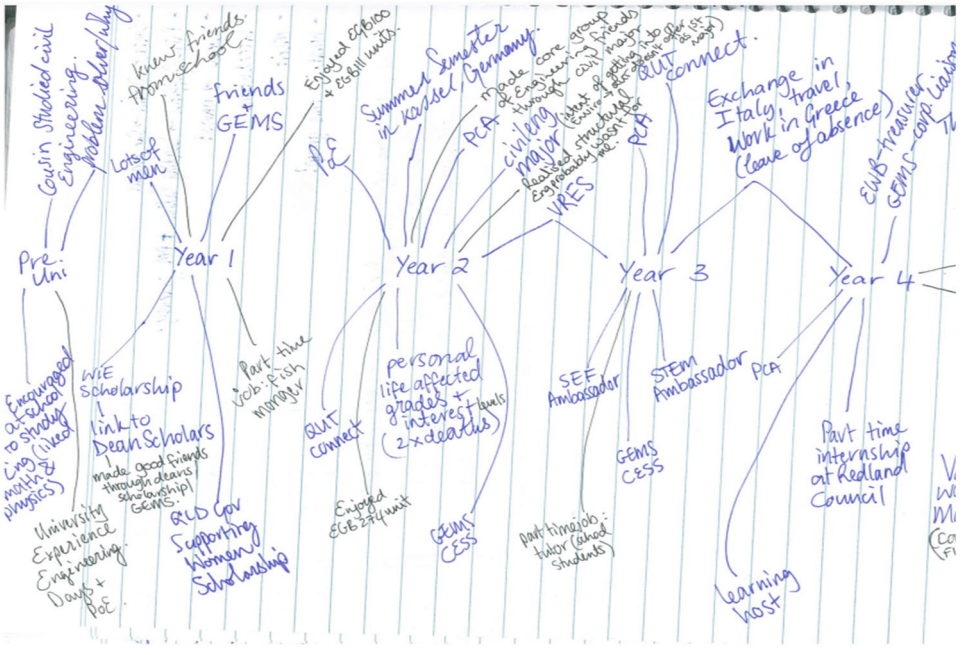

Figure 4. Example of student journey map (excerpt provided for anonymity).

facilitator, were able to begin and construct their maps in their own unique approach. This lack of structure didn't bind the participants to one method of mapping and rather resulted in numerous styles of journey maps including lists, mind maps and flow chats. This individuality is key to unpacking identity development.

Many participants found it to be a valuable and engaging experience. At the conclusion of the interviews, several participants expressed their enjoyment in reflecting on their journey and noted that they had not previously considered many of the experiences discussed. The fact that participants requested a copy of their journey maps also indicates that they found the exercise to be both valuable and meaningful.

When utilising journey maps as a research tool, the research team identified and was mindful of potential pitfalls, limitations, and ethical considerations. Journey maps, while providing a visual representation of individuals' experiences and identity development, inherently involve a certain level of subjectivity. Participants might unintentionally omit certain aspects or unconsciously reshape their narratives to align with their perceived expectations. Researchers must remain vigilant in understanding that journey maps offer a snapshot of an individual's perception, which can be influenced by memory biases and the desire for coherence.

Ethical considerations may arise when dealing with sensitive topics or personal narratives. Participants must be informed about the research purpose, their involvement, and the potential implications. Ensuring confidentiality and obtaining informed consent are paramount, as journey maps can unveil personal experiences that participants might not wish to disclose.

During the process of conducting the journey maps interviews, the research team become aware of the depth of reflection that this process offered, as both a research methodology and a personal development tool. Not only did they allow the researchers to gain insight into identity construction and experiences, but they also empowered students to reflect upon their personal development. By engaging in the process of creating and interpreting journey maps, students become cognisant of the intricate processes influencing their own growth and transformation. The desire of students to retain their maps underscores the impact of this introspective exercise in fostering self-awareness and reflection.

This distinctive duality of journey maps makes them an effective tool for both research and personal development, enriching our understanding of identity and enhancing individuals' self-awareness.

Stage 3: translating the maps

Due to the highly individual nature of the journey maps, the research team chose to translate the maps into a digital version. This conversion not only enhanced their readability but also facilitated a more streamlined and systematic analysis of the data. The digital format allowed for easier categorisation, comparison, and identification of overarching patterns, contributing to a more efficient and comprehensive analysis of the participants' unique identity journeys. This was done by transcribing the maps and ensuring that they captured all annotations on the maps including drawings and links between words. The team ensured that any timeframes indicated i.e. pre-university, first year etc. and the method through which their map was created were also accurately translated into the digital versions. It should be noted that although the maps were translated for the purpose of this investigation, the process of development, method of construction and the actual artefact are all valuable aspects of data which should be used to develop a holistic understanding of engineering identity and will be explored in a subsequent investigation.

In the process of translation, the audio recordings of the interviews were also reviewed, and additional annotations were made to most of the maps. During the interviews, it was noted that participants often did not include details of an event that they discussed with the facilitator on their map, and as such the research team felt some key details were omitted. Any annotations by the research team that were not transcribed by the participant on the original journey map were clearly highlighted to differentiate them from the original maps. An example of this is shown Figure 5 in an excerpt of a translated map below where the additional notions made by the research team are highlighted in green text.

It is important to note that this newly constructed translation does not capture every minutiae present in the original journey maps. For example, it may not capture each instance where a participant wrote about an experience at a point in time and then scribbled it out. However, this translation

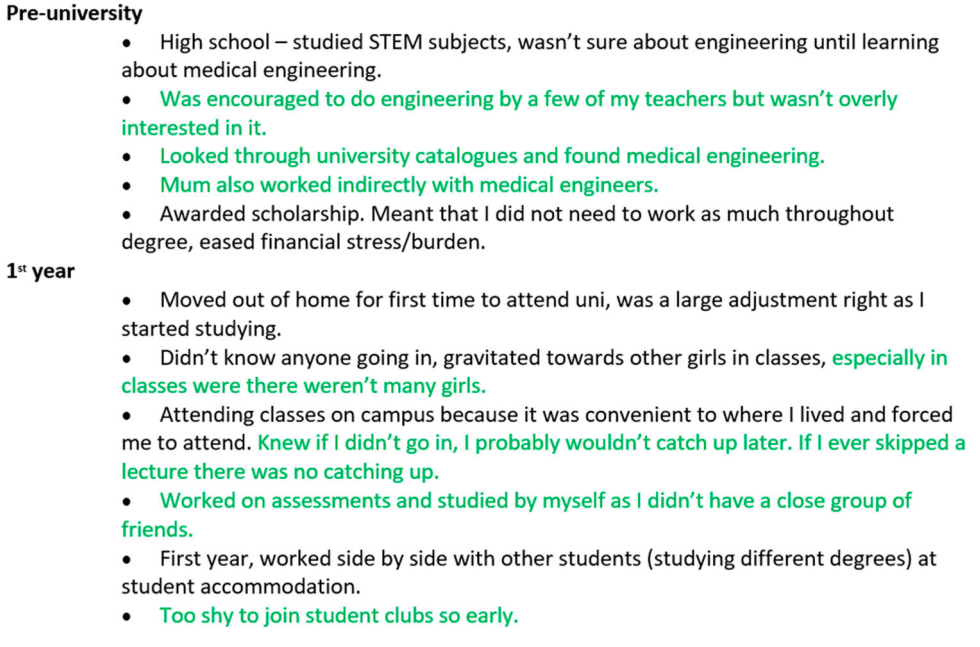

Figure 5. Example of translated and annotated student journey map.

process serves to bring to light certain aspects that might have been less discernible before. Additionally, the digital format notably streamlines the journey maps, making them more accessible and conducive to in-depth analysis. While this translation offers advantages in terms of visibility and analysis, there are inherent trade-offs. The transition to a digital format may inadvertently omit some intricate details present in the tangible paper maps. Balancing the benefits of enhanced clarity and ease of analysis with the potential loss of certain nuances is a critical consideration that underscores the complexities of this stage.

Stage 4: data analysis

Once the maps were translated, structural coding was then used to isolate the parts of the journey maps where participants note experiences and influences which were related to their engineering identity development. To promote validity, the three researchers independently engaged with the one of the journey maps and completed an initial coding round. The researchers then discussed their preliminary findings and collaboratively worked to group codes into larger themes over multiple iterations. This ensured consistency across the data analysis and clarity in the findings.

Engineering identity framework

Using Gee (2000)'s foundation, Hazari et al. (2020) developed a quantitative measure of physics identity. Additional work has been conducted by Godwin (2016) to expand this original quantitative instrument to measure engineering identities. Within this model, the measures of students' subject-related role identities are comprised of three constructs including students' perceptions of their own: performance/competence beliefs (i.e. self-efficacy beliefs), interest in the subject, and feelings of recognition (i.e. beliefs that they are seen as a good student in the subject by peers, parents, and teachers) as being the type of person that can do a particular subject. This framework for students' identification with engineering, forms the basis of evaluating the use of journey maps to capture students' self-reported engineering identity. This framework is shown below in Figure 6.

Adaptation to Godwin (2016)'s framework

Our original ten themes which were developed from the focus groups, prioritise the impact of student individual attributes and values and peer connections to engineering identity development.

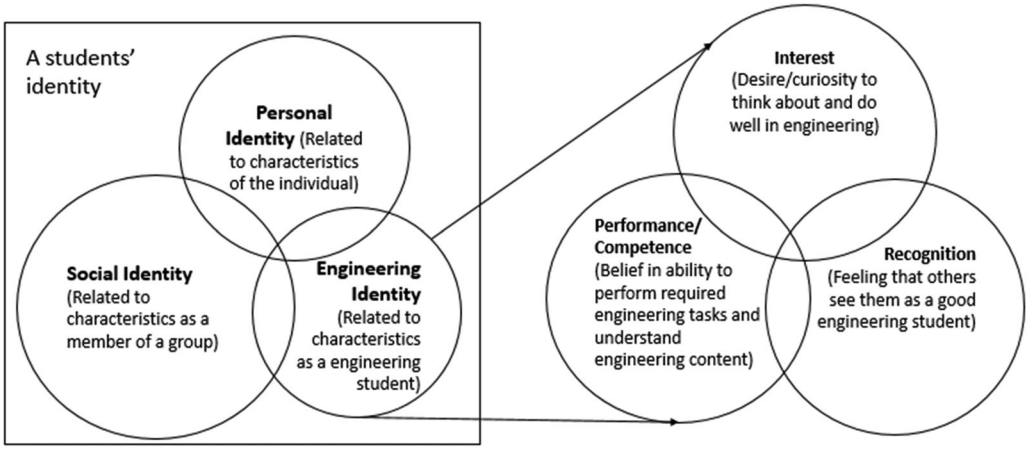

Figure 6. Framework for students' identification with engineering adapted by Godwin (2016).

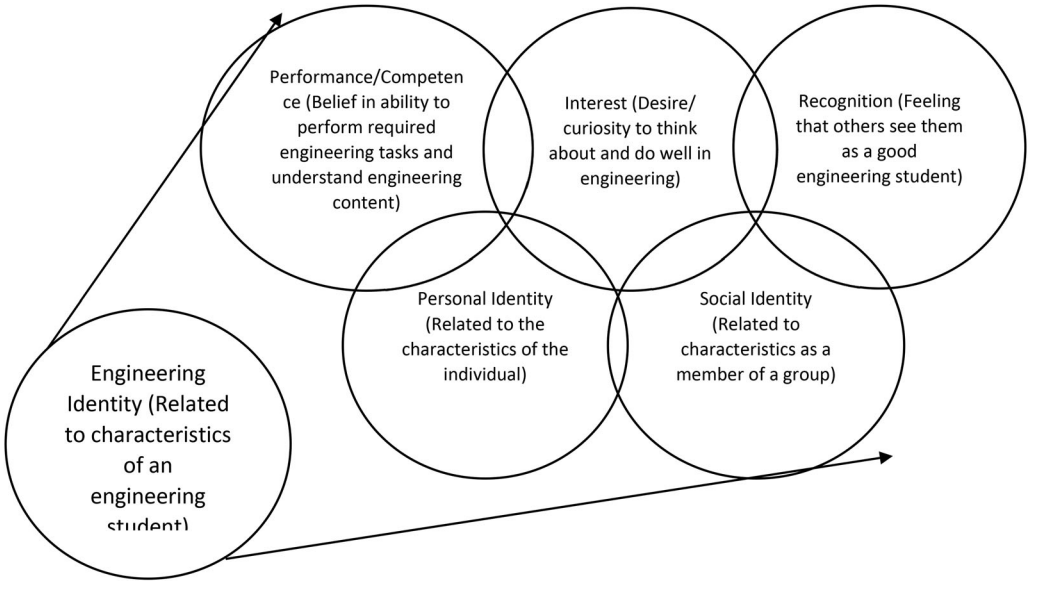

Figure 7. Framework for students' identification with engineering adapted to include person and social identity within engineering identity.

Across each theme, individual attributes and social connections were identified by participants as supporting this process and development. Recognising the interplay between personal and social identity, we introduced personal and social identity as essential themes alongside the three core components of engineering identity, interest, recognition, and performance. This refinement was based on the findings from the focus groups analysis where two of themes identified, individual attributes and values, and peer connections, were recognised as being significant to engineering professional identity development. This amendment is shown below in Figure 7.

Based on this prior work in science education and a symbolic interactionism approach to understanding engineering role identity, our methodology, is based on five measurable dimensions of students' beliefs about their performance/competence, the recognition they receive from others, and their interest in engineering, and their personal and social identities. These are not the only identities that an individual may hold, but they capture a students' subject related identity within engineering and the engineering profession. This framework forms the basis of this paper's understanding of identity development and the methodology which was used to conduct the research.

The ten themes developed by the research team from the focus groups was used as a guiding tool, however, these were later coded to Godwin (2016)'s framework for students' identification with engineering which the research team adapted to include person and social identity within engineering identity as shown in Figure 8. Although the ten themes may include experiences which fall across several categories of the framework i.e. receiving a commendation during an internship may fall into Recognition and Performance, we acknowledge this limitation and for this purpose, the category which most broadly captured the theme was used.

Stage 5: results and discussion

We separated the data into key demographic groups; early-career professionals and students. Within those categories we also separated the results of those who identified as engineers and those who did not as shown in Table 2. This categorisation was made by participants response to the question '*are you an engineer?*'. Participants who were unsure i.e. could not definitively say yes or no, were

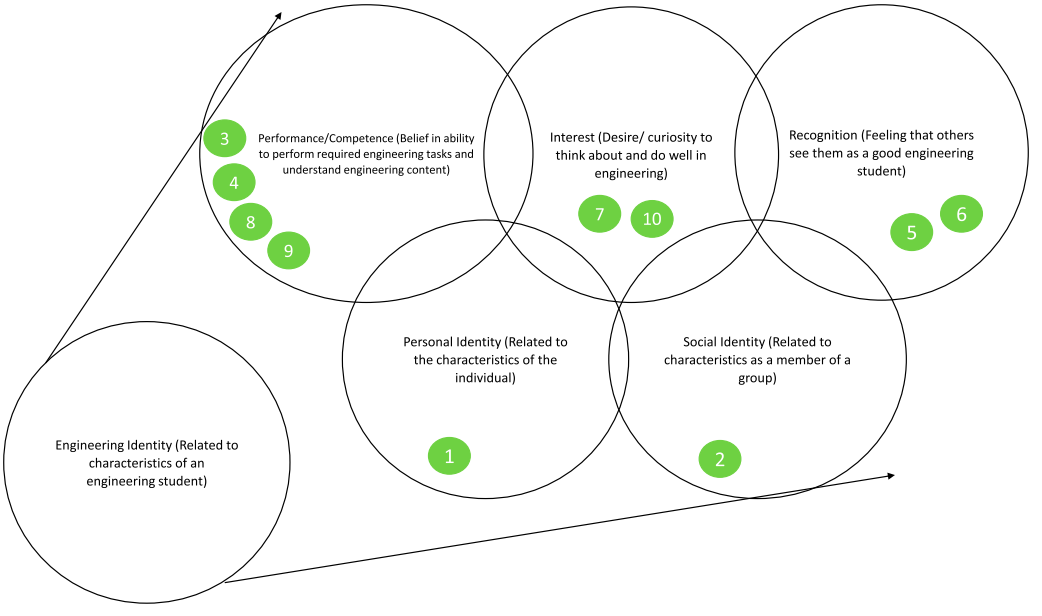

Figure 8. Framework for students' identification with engineering and ten key themes previously identified by the research team used for coding the data.

grouped with the latter as the research team agreed that this response did not align with a strong professional engineering identity.

Based on our data, 6 out of 12 student engineers and 3 out of 18 professional engineers do not identify as engineers at this point in time. Some of the reasons discussed by the participants for this trend included students not having finished their engineering studies and lacking real-world experience. Professionals noted not having the term 'engineer' in their job title, not working with other engineers, or still feeling inexperienced as reasons for not identifying as an engineer.

To further understand how engineering identity develops at university, we identified three key timeframes during university studies: first year, mid-year and final year. These timeframes were identified based on an initial review of the maps created in which the research team noted that significant influences were discussed during the first six – 12 months of their university experiences and in the final 6–12 months prior to graduation. Several participants also identified a similar trend of increased influences in the beginning of their engineering specialisation (generally occurring in second year). The research team found that although many studies explored engineering identity there was a clear gap of understanding when this development occurs within the engineering degree (Morelock 2017). Due to the nature of journey maps, establishing these timeframes was a significant benefit.

Once the timeframes were established, open-ended thematic analysis was used to categorise the experiences discussed into the ten overarching themes identified previously by the team. Examples of experiences and influences, and their respective themes, are given below. These excepts were chosen as they represent clear examples of each theme and offer insightful snapshots into the diverse array of experiences that participants shared. These excerpts provide a lens through

Table 2. Participants who identified as an engineer by demographic.

	Total no. of Participants	No. who identified as an engineer	No. who do not identify as an engineer
Student Engineer	12	6	6
Early Career Engineer	18	15	3

which the overarching themes come to life, vividly showcasing how individual stories align with and diverge from the broader patterns we observed. By selecting these particular excerpts, we aim to provide a well-rounded representation of the themes and their corresponding influences, highlighting the depth and complexity that characterise the process of engineering identity development.

Individual attributes and values:

> Language barrier with technical terms especially in lectures – felt isolated, people didn't talk to me in class because my English isn't good

> Considered leaving as I felt like an imposter as peers knew they wanted to do engineering since kids, but I was winging it

Peer connections:

> Struggled with the course content a bit so learnt to reach out to friends, older students who had done the unit or tutors

> I think working with other people on individual assignments, especially in first year when content and the assessment structure was so new, helped reassure me that I was on the right track and the confidence that I could do this course.

Classroom activities:

> I liked putting theories into practice e.g. concrete mixing and testing, truss building and testing, mortar mixing and sample creation

> I really liked the electrical subject in first year, mostly because of the practical section. I don't remember the tutorials as well, but I enjoyed learning with my hands and building the breadboard. Through the trial and error of this practical I felt like I learnt the most.

Design learning experiences:

> Enjoyed [unit] content – real world project and assessment and linked into work experience. Field trip made me feel like an engineer.

Educators and academics:

> Tutors were always good compared to lectures – enjoyed learning from tutors as they spoke about the content with a bit more context and understood what we didn't know.

> Teachers who were interested in teaching made the best impact.

Mentors:

> Met an industry mentor through a [student club] event – helped with how to deal with difficult industry situations.

> [Academic] was my mentor in final year through career mentor program. Appreciated the knowledge and experience he could share.

Engineering experiences:

> Two days at [engineering firm]. Like the company culture so looking forward to graduation program where it's on rotations.

> Fell into work as civil contractor. Stayed because it was well paid but long hours. Small company, learnt a lot and good variety of work. High turnover and limited mentorship.

Technical knowledge:

> I went to a small not very academic school. Was 1 of 7 in Maths B, and had to teach myself Physics by Distance Ed. Didn't do Maths C. I found [first year maths subjects] quite hard units, I relied a lot on [peer tutoring] to help me understand content.

> Enjoyed engineering hydraulics and advanced water – thoughts of potentially going further into water topics, no additional subjects which cover this.

Academic results:

> Marks were ok 5–6's

> Marks better again, mostly 7's. First class honours.

Co-curricular activities:

> Became more proactive on campus and attended club events. Helpful in finding a graduate job.

> I joined [student club] because the friend I knew from high school had also joined. The first few meet up events introduced me to other women in engineering. This was especially useful to meet other first years who I could sit with in lectures and tutorials. It was daunting walking into those first few lectures full of a predominately male population so having the comfort of at least knowing one person eased this stress hugely.

These themes were then mapped against Godwin's framework for students' identification with engineering within the previously discussed timeframes. This allowed the research team to then determine which component of the framework; performance/competence, recognition, and their personal and social identities, were discussed most often and at which stage of their degree. The translated journey maps were analysed using structural coding within NVivo. The maps were coded against the overarching themes identified within the focus groups, and then to Godwin's framework of engineering identity. These codes were also separated into the three key timelines as discussed above. This process allowed the research team to identify with aspect of the framework most often occurred at each stage of development.

These findings were plotted over radar graphs in Figure 9 as they provided a general picture of the trends within the framework and a relative measure of components to each other (Kickbusch et al. 2022; Seide et al. 2021). Radar graphs were used as they are able to condense multifaceted data into a visually comprehensible format, providing a quick and intuitive overview of complex patterns and trends. This unique structure enables the simultaneous comparison of each aspect of engineering identity. The journey maps were also separated into those who identified as an engineer and those who did not in order to explore the key differences between this development.

While the process of coding the journey maps and aligning the outcomes with Godwin's framework offers a systematic approach for analysing the data, it unavoidably involves a level of abstraction that might compromise the inherent richness of the original journey map interviews. However, this methodology serves as a structured framework that facilitates the systematic unpacking of the extensive data collected, enabling us to distil key insights and trends that might otherwise remain obscured. This trade-off between methodical analysis and preserving the depth of participant narratives underscores the necessity of striking a balance between systematic examination and maintaining the intricate fabric of personal experiences.

This analysis revealed several unexpected findings about the experiences and perceptions of engineering students and early career professionals across different stages of their careers. The results showed that students and professional engineers had similar experiences and priorities in their first and mid years, with a strong emphasis on social identity in the first year and social identity, performance, and recognition in the mid years. However, in the final year, there were some unexpected and notable differences between the two groups. Students were more likely to discuss the influence of social identity, performance, and interest, while professionals placed a stronger emphasis on recognition and interest.

These findings suggest that while there may be some commonalities in the experiences and priorities of engineering students and early career professionals, there are also important differences that emerge over time. The emphasis on social identity in the first year, for example, may reflect the importance of building a sense of community and belonging within the field of engineering (Verdin et al. 2019a; Wilson et al. 2008). As students progress through their studies and into their

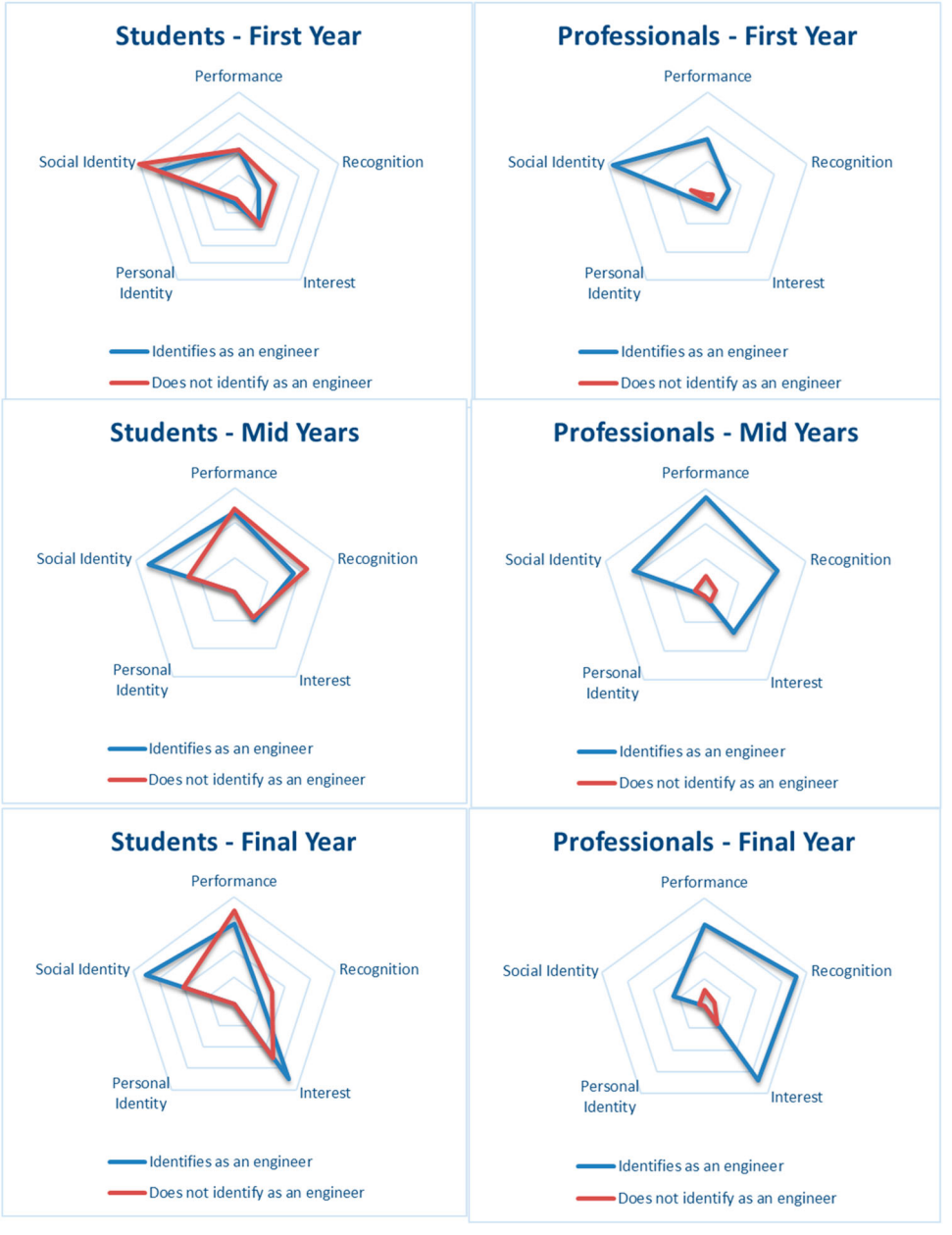

Figure 9. Findings from journey maps coded against the adapted model of engineering identity across first year, mid-years and final year for student and professionals.

careers, however, their priorities may shift towards factors such as performance and recognition, as they seek to establish themselves as competent and valuable members of the profession (Bliven et al. 2021; Patrick et al. 2018).

The differences between students and professionals in the final year also highlight the importance of considering the unique perspectives and experiences of each group. While students may be more focused on their own interests and performance, professionals may be more attuned to the recognition (Godwin et al. 2016) they receive from others in their field and thus reflect on these influences more favourably.

Comparing the results of participants who identified as engineers versus those who did not, revealed interesting differences in the way they experienced and perceived their roles in the engineering field. Overall, both groups followed similar trends in their priorities and concerns across different stages of their careers, with a strong emphasis on social identity in the first year and a shift towards performance and recognition in the mid and final years.

However, there were some notable differences between the two groups. Mid and final year students and professionals who did not identify as engineers tended to focus less on social identity compared to those who identified as engineers. This may reflect a greater sense of detachment or ambivalence towards the engineering profession among those who do not strongly identify as engineers. Many countries, Australia included, have acknowledged that a significant percentage of qualified engineers – up to 40% – are not employed in engineering-related roles within three years of graduation. Furthermore, within 10 years, more than half of these engineers are working outside of their field (Palmer et al. 2018).

Although this framework provides a way to quickly assess and broadly understand engineering identity, Godwin (2016) notes that it does not 'replace the complex and nuanced narratives that students author as they navigate their engineering identities' and the totality of the journey map i.e. the process of development, method of construction and the actual artefact are all valuable aspects of data which should be used to develop a holistic understanding of engineering identity.

A total of 19 participants engaged in both the focus group discussions and the journey map interviews, providing a unique opportunity to compare and contrast the insights gleaned from these distinct methodologies. The integration of these two methods enabled a comprehensive examination of the participants' experiences, grounded both in the collective dynamics of focus group interactions and the introspective exploration facilitated by the journey maps. Notably, the journey map approach offered a personalised lens into each participant's journey, allowing them to delve into their experiences without external influence from fellow participants. The journey maps effectively served as individualised timelines, visually encapsulating their diverse experiences and milestones. This visual cue frequently prompted in-depth discussions during the interviews, fostering a reflective atmosphere that encouraged participants to share rich narratives surrounding their identity journey. The participant-centric nature of the journey maps was evident in their design, tailored to allow individuals to navigate their unique experiences and explore the facets of their identity development at their own pace. Through the journey map interviews, participants had the opportunity to explore their individual journeys in depth, unearthing additional experiences that might not have surfaced in a group setting (Dagg et al. 2019; Hope et al. 2013). The journey maps provided a unique space to highlight previously not discussed barriers, such as the impact of language proficiency on their engineering identity, or the complex interplay between their personal gender identity and the traditional perceptions of the engineering profession. These observations were confirmed by previous work into the use of journey maps in conducting life history research (Adriansen 2012) where it was noted that journey maps provide an opportunity to link the story within the wider social and environmental context during the interview.

What became evident through this integration was the nuanced evolution in participants' understandings of the engineering profession. The journey maps effectively captured pivotal shifts in their perceptions, where some individuals started with idealised notions that gradually transformed into more pragmatic and nuanced understandings. This shift often accompanied their exposure to real-world experiences within the engineering field. Lakin et al (2020) also found that real-world experiences and preconceived definitions can both inhibit and shift perceptions and understanding of the engineering profession. The journey maps, with their inherent flexibility and individual nature, enabled participants to unpack these shifts individually, without the pressure of external influences (Chen et al. 2019; Nadelson et al. 2015). This personalised approach allowed participants to critically engage with their own narratives, recognising the subtleties and nuances that collectively form their identity (De Vries 2013). This self-directed exploration facilitated a deeper and more holistic understanding of their identity development, empowering them to articulate the multifaceted dimensions

of their journey, thereby enriching both their personal growth and our research insights (Dagg et al. 2019; Bilgin et al. 2022b).

Stage 6: reflections and recommendations

Journey maps have proven to be a valuable tool for understanding the participant experience in a variety of contexts including engineering identity. They offer numerous benefits, including allowing for a retrospective correlation between experience and impact, providing a visual tool for reflection, and respecting participants' individuality. By mapping out the participant journey, individuals and facilitators can reflect on the experience and identify significant influences and timeframes. This allows researchers to identify key moments in the identity journey in which interventions and supports can be targeted to ensure positive identity development.

Journey maps are particularly effective at allowing participants to retrospectively identify gaps and influences in their journey. The visual nature of the maps and the ability to see their entire journey in one place allow participants to recall details that may have been forgotten, making them an invaluable tool for enhancing participant experience whilst deepening the scope and richness of the data collection. Additionally, journey maps respect participants' individuality, which is crucial for productive and meaningful research. Similarly, many of our participant stated that they enjoyed the process of creating a journey map and several requested copies of their maps, indicating that they find the exercise both engaging and useful. These benefits to the individual participants are just as valuable as the findings for the research team. Overall, journey maps are an effective and engaging tool for improving the participant experience and should be considered a valuable resource for research into engineering identity.

This paper offers a unique contribution to knowledge in documenting and evaluating the method of journey mapping engineering identity. By allowing engineers to reflect on their journeys and identify key experiences and influences, journey maps offer valuable insights into the complex processes of identity formation within engineering undergraduate courses in terms of both the influences to this development and the points in time in which they occur.

Limitations and future work

A limitation of this study is the sample used to collect the data. We only recruited participants who had studied or were studying at one university institution for interviews. Broadening the sample to include those in a wider range of academic institutions may provide alternative perspectives on the key influences to engineering identity. Similarly, the demographic sample was skewed towards female participants, and thus these findings may not accurately reflect the male-dominated engineering profession. The main purpose of the study, however, was to feature journey maps as a methodology for exploring engineering identity. Future work should focus on understanding how the significant influences identified using journey maps can inform engineering educators and the higher education sector to better support students in becoming engineers and in which stage of their learning these supports are most impactful. Although outside of the scope of this research, consideration could also be given to further exploring the importance and role of facilitation in the development of journey maps.

Conclusion

This study sought to review the process of using journey maps to better understand the influences of engineering professional identity for undergraduate students, given that current methods may lack the individuality necessary to holistically understand identity journeys and further explore the impact of experiences and relationships. This research will aid educators in fostering positive engineering identity experiences and in turn creating a sense of belonging and purpose in the profession,

promoting job satisfaction and career commitment, which are crucial for long-term retention. The journey maps of 30 undergraduate engineers and early career engineers were thematically analysed to identify the key influences to this identity development. Mapping of the themes to the adapted framework of engineering identity proposed by Godwin (2016) revealed that both groups (self-identified engineers and non-identified engineers) followed similar trends in their experiences and priorities throughout university, but notable differences include less emphasis on social identity among mid and final year students and professionals who did not identify as engineers. The process of using journey maps in engineering identity research resulted in benefits to the participant, highly individualised responses (aligned with the nature of identity) and rich artefacts which detail specific time points in which interventions and supports may best foster positive identity development. We argue that this novel methodology could be used to inform engineering education curriculum and research, specifically within the identity space but also across fields which require reflective and narrative storytelling.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Declaration of interest statement

The authors report there are no competing interests to declare.

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