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Professional Engineering Skill Priorities of first year New Zealand Engineering Students & Academics

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ABSTRACT

CONTEXT

Traditionally, professional skills have been perceived by engineering students to have lesser importance than technical skills. However, the ability to demonstrate professional skills alongside discipline-specific skills for engineering graduates has an increasing importance. How the importance of these skills are perceived by students, is not yet well understood in alignment with professional skills frameworks.

PURPOSE OR GOAL

This paper presents details on how New Zealand engineering students and academics prioritise professional skills by using the newly developed COMPASS framework. The purpose of this study is to understand how these groups perceive the importance of professional skills to identify any gaps. The goal is to be able to use these gaps to enhance the relevance to the design of the curriculum to support professional development and emphasise the value of professional skills.

APPROACH OR METHODOLOGY/METHODS

This study uses a survey to capture how students and academics prioritise professional engineering skills. Students and academics were asked to prioritise the different skills from the COMPASS framework by responding to open ended questions and then asked to rank all skills in order from most to least important.

ACTUAL OR ANTICIPATED OUTCOMES

Preliminary findings indicate that *Defining and Analyse Engineering Problems, Design/Developing Engineering Solutions* and *Communicate Through Various Mediums* are mostly scored as "Very Important" by students. In the student ranking, defining and designing remains in the top two most important skills, whereas majority has ranked communication in the bottom four. It is also noted that *Apply Project Management Skills* and *Assess Suitable Engineering and Digital Tools* is perceived by students to have a lower level of importance than any other skills. For the student- ranking project management, remains the least important, with *Apply Ethical Practices* coming in 2nd least important despite being considered important in the individual ranking. There were differences in rankings between students and academics.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

By better understanding how student perceive professional skills allows for an informed scaffolding of curriculum to emphasise on skills currently underrated by students. This would allow for a more meaningful and targeted development of these skills to improve contents.

KEYWORDS

Professional Skills, Competencies, COMPASS

1. Introduction

Engineering is a dynamic and multifaceted discipline that continuously evolves to address the demands of an increasingly complex and interconnected world. Employers of graduate engineers expect these graduates to possess strong technical foundations and professional skills that enable effective collaboration within multidisciplinary teams, engagement with diverse stakeholders and responsiveness to sustainability challenges inherent in contemporary engineering problems (Nwulu et al., 2023; Bertel et al., 2023; Kaushal, 2016; Chadha & Heng, 2024). To thrive in this environment, future engineers must demonstrate technical expertise alongside a commitment to ethical principles, allowing them to navigate a constantly changing professional landscape. They are required to tackle complex, often unprecedented problems beyond their immediate discipline, employing innovative and agile approaches to develop responsible and effective solutions. These expanded expectations highlight the critical importance of integrating professional competencies alongside technical knowledge in engineering education and practice (Crosthwaite, 2021).

Engineering graduates across various disciplines consistently identify a core group of professional skills such as teamwork, communication, problem solving and data analysis as the most critical for their careers (Passow, 2012; Chadha & Heng, 2024). These competencies highlight the need for curricula to focus not only on technical knowledge but also on developing these key professional abilities. It also shows that there is a persistent gap between academic preparation and the realities of engineering practice a disconnect long recognised in engineering education (Pons, 2016). By addressing this, educators can better equip graduates to meet the complex demands of the profession.

Over the years, competency frameworks have been widely adopted to help structure and communicate the expectations placed upon engineering graduates. These frameworks attempt to capture the range of knowledge, skills and behaviours required to enter the profession and contribute meaningfully. International accords, such as the Washington Accord (International Engineering Alliance, 2021), subsequently integrated into graduate capabilities provide foundational benchmarks that inform curriculum development, accreditation and workforce readiness. To address the professional skills competencies, many frameworks have been established (Kemp, 1999; Meier et al., 2000; Sardana & Arya, 2003) including the most recent COMPASS framework (Quince et al., 2025) aiming to articulate the professional competencies necessary for engineering graduates. Developed through alignment with international standards and national benchmarks, COMPASS framework provides a structured taxonomy of ten high-level competencies and 35 detailed sub-competencies specifically for professional skills. The COMPASS framework represents a recent advancement in this effort, offering a structured and detailed articulation of professional competencies expected of graduate engineers.

However, having a framework is not the same as having shared understanding or consistent application. One of the persistent challenges in engineering education is the misalignment between what students, educators and industry consider to be the most important skills for graduate engineers (Fleming et al., 2024; Craig et al., 2018). This divergence is not arbitrary, it often stems from differing experiences, priorities, institutional roles and expectations. Academics, deeply embedded in curriculum design and institutional mandates, tend to focus on accreditation-aligned outcomes, such as professional body standards (Souppez, 2023). In contrast, students may prioritise what feels most immediate or intuitive based on their academic experience, public perceptions of engineering or self-motivation (Kirn & Benson, 2018) which often underestimating broader strategic competencies. These differences reflect distinct perceptions where academics interpret competencies through pedagogical and regulatory lenses, while students bring lived and personal concerns that may not yet be shaped by industry realities. At the same time, industry perspectives are often driven by commercial outcomes, client demands and the need for engineers who are both technically competent and professionally adaptable (Craps et al., 2022; Munir, 2022). When these views are not aligned, it can result in a disconnect between what is taught, what is learned, and what is expected in the workplace. Addressing this misalignment is essential for developing responsive and future-oriented curricula that prepare graduates to navigate the full scope of professional engineering practice.

The COMPASS framework seeks to bridge that gap by offering a clear and inclusive language for identifying and developing professional capabilities. The COMPASS framework outlines ten key graduate engineering competencies. These include: (1) the ability to define and analyse engineering problems, (2) design and develop engineering solutions, and (3) methodologically investigate engineering problems. It also encompasses (4) the ability to assess engineering and digital tools, and (5) solve complex engineering problems with a focus on responsible and sustainable outcomes. Ethical considerations are addressed in (6), the ability to apply ethical practices, while interpersonal and teamwork skills are captured in (7), the ability to work independently and collaboratively. Communication is highlighted through (8), the ability to communicate through various mediums. The framework also includes (9) the ability to apply project management skills and (10) the ability to engage in ongoing learning and professional development. The effectiveness of the COMPASS framework depends not only on what it includes but also on how it is interpreted. Accordingly, the paper aims to evaluate the extent to which the COMPASS framework high-level competency descriptors sufficiently capture the complexity of real-world engineering work, or if more detailed sub-competencies are required to accurately reflect the full scope and depth of professional skills. The resulting insights gained will support ongoing efforts to improve the alignment between educational programs, accreditation requirements and the practical realities encountered by engineers in the workplace.

2. Methodology

This study uses a mixed-method approach to investigate the perceptions of skills required by graduate engineers, as viewed by students and academics within a New Zealand tertiary engineering education context. This paper presents the preliminary results drawn from selected sections of a larger survey. A limitation of this study is the small sample size, as the data was collected from the initial round of the survey, as such may not be representative of the population. The survey was designed, validated and launched as part of the 2024 AAEE Project '*Identifying Professional Skills Development and Alignment with Industry Demands: A Multi-institutional, Trans-Tasman Study'*. The analysis combines qualitative thematic analysis of open-ended responses with a quantitative comparison of how participants ranked the high-level professional skills, as outlined in the COMPASS framework.

The participant sample comprised 13 undergraduate engineering students and 7 academic staff from a New Zealand university. Student participants were enrolled across multiple years of an engineering program, while academic staff represented diverse teaching and industry experiences within engineering. Participants were recruited via a targeted invitation, and all participants provided informed consent to participate in the study. Data was collected using an online survey, using Qualtrics, where the current results details three open-response items and one structured ranking task. Participants were first asked to respond to the following questions: 1. *What skills do you believe are important for a graduate engineer? (Please list as many as you wish)", 2. Why do you think these skills are important?", 3. Which skill from the list you provided above is the most important in your opinion?"* In the later section of the survey, participants were instructed to rank the ten predefined graduate competencies, based on the COMPASS Framework's high-level skill descriptors, from 1 (most important) to 10 (least important).

Open-text responses were analysed using an inductive thematic coding approach (Braun & Clarke, 2006) to identify frequently mentioned skills. These codes were then deductively mapped onto the ten high-level competencies of the COMPASS framework. Where a response did not align with any existing COMPASS framework descriptors, additional categories were created to capture the emerging themes. The frequency of each theme was tallied separately for students and academics. Responses were only themed to the closest fitting competency.

Rank data were analysed descriptively. For each group, the mean and median rank positions of each competency were calculated for all ten competencies. This enabled the generation of a rank-order profile for both students and academics. Results were visualised through bar charts and comparative tables to identify the areas of consensus and divergence across groups. The use of rank-order analysis is well established in educational research for understanding stakeholder prioritisation (Cohen, Manion, & Morrison, 2018). A triangulation approach (Denzin, 1978) was used to compare and integrate findings across the qualitative and quantitative data. This allowed for validation of themes observed in open-text responses against the rank-based data and supported the identification of competencies that were either over- or under-represented in participants' prioritisation.

3. Results and Discussion

3.1 Thematic Alignment: Themes Not Mapped in COMPASS Framework

There were several codes that did not align with the existing themes from the COMPASS framework. These codes were categorised into five themes as follows: (i) Technical Skills, (ii) Cultural and Social Awareness, (iii) Mathematics and Scientific Knowledge, (iv) Practical Skills and Hands-on Experience, and (v) Transferable Skills and Professionalism.

3.1.1 Technical Skills

Codes such as *Technical skills, Discipline Skills* or *Discipline Knowledge* were considered under the theme Technical Skills (not mapped in COMPASS). In the design of the COMPASS framework, technical skills and discipline knowledge were intentionally excluded as an explicit competency, as they were considered foundational engineering skills. The rationale is that while technical skills are required to contribute to the engineering discipline, professional skills enable engineers to apply that expertise effectively and responsibly in real-world contexts. This framing was not provided to participants undertaking the survey to deliberately investigate how their perceptions aligned or misaligned with the framework's underlying assumption about technical skills. The Engineering 2035 report is currently tasking engineering educators to shift away from the notion that technical knowledge alone defines engineering competence.

3.1.2 Cultural and Social Awareness

Cultural and Social Awareness was another emerging theme that was not mapped to the COMPASS framework. One participant emphasised the importance of diversity: "I think understanding different cultures, backgrounds, and personal identities is the first big thing." which although this may be considered as Apply Ethical Practices, putting it as a distinct theme highlights a gap in how higher-level competencies are defined within the COMPASS framework.

Within this emerging theme, one student's response stood out by explicitly identifying biculturalism as a critical graduate attribute. This student highlighted the importance of understanding cultural backgrounds and identities in professional engineering practice: *"Understanding biculturalism and different identities is very important when interacting with people and companies in New Zealand. The mindset is basically just being a good person, and of course the practiced approach to engineering problems is just what you need to learn to become an engineer."* When asked to identify the most important skill, the same student responded: *"Definitely biculturalism, as New Zealand is slightly different from the rest of the world in which we have Te Ao Māori to consider and work with."* This response is both timely and significant, particularly in the context of Aotearoa New Zealand, where the principles of Te Tiriti o Waitangi and bicultural engagement are central to professional and educational practice (Engineering New Zealand, 2025).

3.1.3 Mathematics and Physics, Practical Skills and Hands-on Experience and Professionalism
Mathematics and Physics were often explicitly mentioned separately from technical knowledge/skills, as such, led to a new theme of Mathematics and Scientific Knowledge. A similar pattern was observed for Practical Skills and Hands-on Experience (Not mapped in COMPASS), where the participants distinctly listed these as stand-alone skills alongside the others. Transferable Skills and Professionalism (Not Mapped in COMPASS) is a theme that emerged from a broader set of attributes listed by participants. Given that participants could list an unlimited number of skills in the open-responses, many included qualities such as flexibility, professionalism, and people skills, along with mindset-oriented statements like “unafraid to make mistakes.”

3.2 Important Skills for Graduate Engineers

In the first open-ended question, students and academics were asked to list skills they consider important for a graduate engineer. Figure 1 presents the responses from students and academics, thematically categorised against the ten higher-level COMPASS competencies (Quince et.al, 2025). Participants were able to provide an unlimited list of responses as such the frequencies are reported using percentages for the themed student responses (n=44) and academic responses (n=33). As multiple skills were able to be extracted, there is a higher number of responses to participants.

Collectively, all ten competencies were represented in participant responses, suggesting that the COMPASS framework encompasses competencies that are valued as important skills by both students and academics. However, some differences in emphasis emerged between the two groups. For example, students considered *2. Design and Develop Engineering Solutions* and *4. Assess Suitable Engineering and Digital Tools* as important, whereas these competencies were not prioritised by academics. In contrast, academics placed greater emphasis on *3. Methodologically Investigating Engineering Problems is an important skill that* was not identified by students.

The code *Problem Solving* was only mapped into the closest related competency *1. Define and Analyse Engineering Problems*; however, if codes were mapped across all related themes, this code could also be aligned with *3. Methodologically Investigate Engineering Problems* and *5. Solve Complex Engineering Problems with a Focus on Responsible and Sustainable Outcomes.* This would then suggest that all ten COMPASS competencies are covered by the student responses. *Problem-solving* was the most frequently mentioned code by students, but it was not identified at all by academics. This may indicate that academics consider problem solving as inherently linked to technical or disciplinary knowledge.

The results indicate that academics have three main recurring competencies that were reported as important with the responses of 15% or above. These were competency *8. Communicate through various medium* (most frequently included), *Technical Skills (not mapped in COMPASS)* and competency *7. Work Independently and Collaboratively*. On the other hand, students had competency *1. Define and Analyse Engineering Problems* as one competency which stood out as frequently reoccurring, much owing to number of occurrences of the code *Problem Solving*. A notable contrast between the two groups of participants is that students appear to have a broader view of important skills, whilst academics appear to have a clearer and distinct focus, particularly on the skills they considered in the top 3. This may reflect academics’ familiarity with the curriculum, competency standards, industry expectations or ongoing academic dialogue, hence collectively shape a more unified perspective. The broader and more varied view by students may, however, stem from more traditional views of what they know of engineering professions or reflect their exposure to a rapidly changing technology. An example of this is students’ inclusion of competency *4. Assess Suitable Engineering and Digital Tools,* which may be because they are often directly exposed to various digital tools across their studies. Although academic consensus provides structure and continuity, student perspectives may offer early insight into emerging demands that curricula must begin to address.

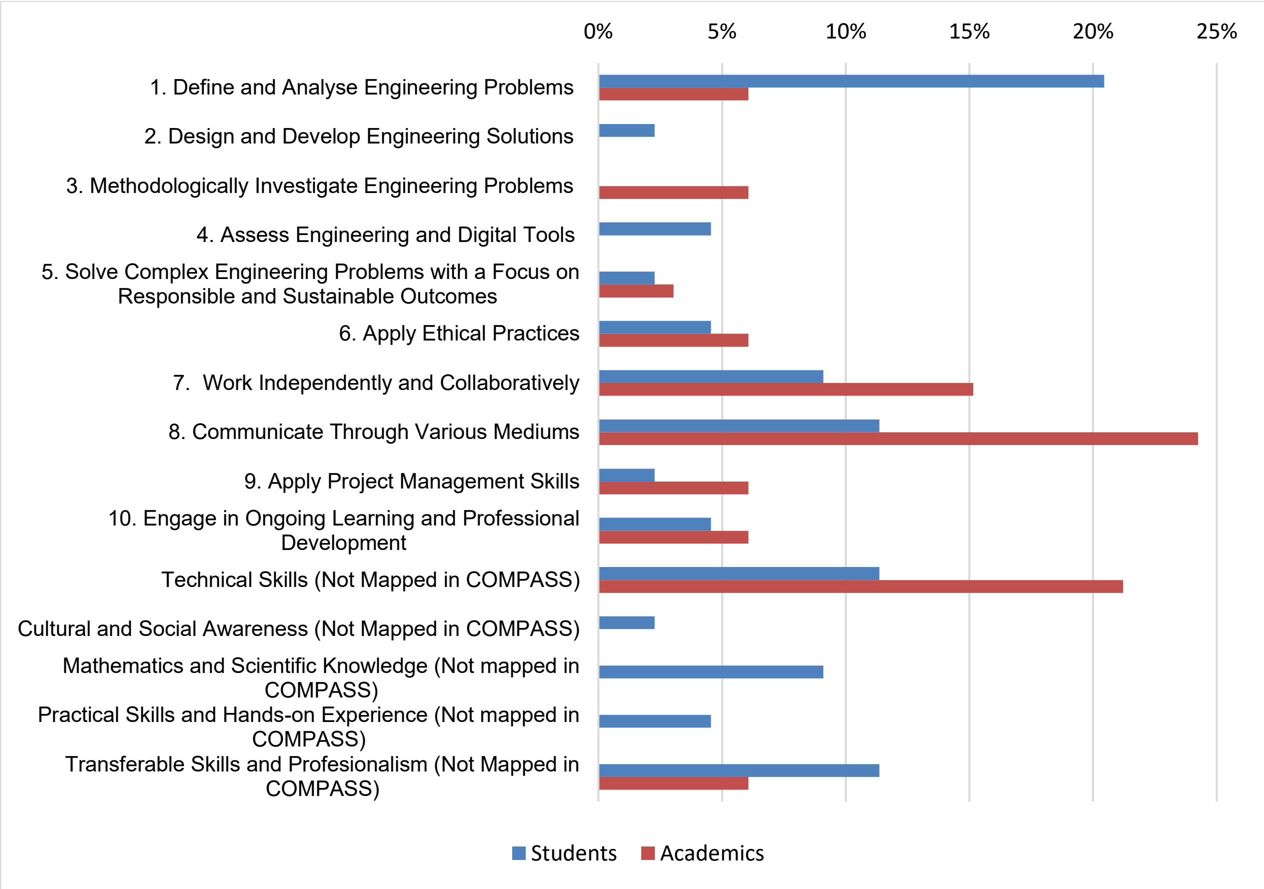

Figure 1. Comparison of Student and Academic Perceptions of Important Graduate Engineering Skills Categorised by COMPASS Competencies (n=44 students; n=33 academics)

3.3 Justification of Important Skills for Graduate Engineers

When asked to justify why the skills they identified were important for graduate engineers, both academic and student participants consistently emphasised the value of combining technical and professional skills. Their responses demonstrated a holistic understanding of what it means to be a competent engineer in today's complex and interdisciplinary environment.

Academics frequently noted that technical proficiency alone is no longer sufficient in the modern engineering profession. They stressed the importance of interpersonal and communication skills in effectively applying technical knowledge. As one academic explained, "We create graduates who are at the start of their careers. Industry expects baseline technical competency and has told us repeatedly that soft skills like communication are really important." Others highlighted the need for balance, arguing that both skill sets are essential for impact: "Without solid technical skills, an engineer cannot contribute meaningfully to product development, operations, or problem-solving. But without soft skills, teamwork, communication, etc., an engineer is unlikely to have a significant impact."

3.4 The Most Important Skills for Graduate Engineers by Students and Academics

In Figure 2, the most important skills as reported by students (n=13) and academics (n=7) indicate a notable level of consensus. Academics maintain a relatively high consensus of the three top skills from section 4.2 as being the most important. With competency *7. Work Independently and Collaboratively* at 14%, competency *8. Communicate through various medium* with 29% and Technical Skills (not mapped in COMPASS) with the majority of 57%. This further supports that academics have a more unified view, likely owing to their familiarity with curriculum, competency standards, industry expectations, and ongoing academic dialogue.

The code *Problem Solving* resulted in the 30.8% share for competency *1. Define and Analyse Engineering Problems* in the student responses. If viewed as a subset of technical skills, as often considered by academics. The 23.1% share of Technical Skills (Not mapped in COMPASS) along the 30.8% share for competency *1. Define and Analyse Engineering Problems* in the student it would make up a 53.9% share, which more closely correlates with the academics view on the most important competency. In a similar way, students also value competency *8. Communicate through various media (23.1%);* however, do not consider competency *7. Work Independently and Collaboratively*.

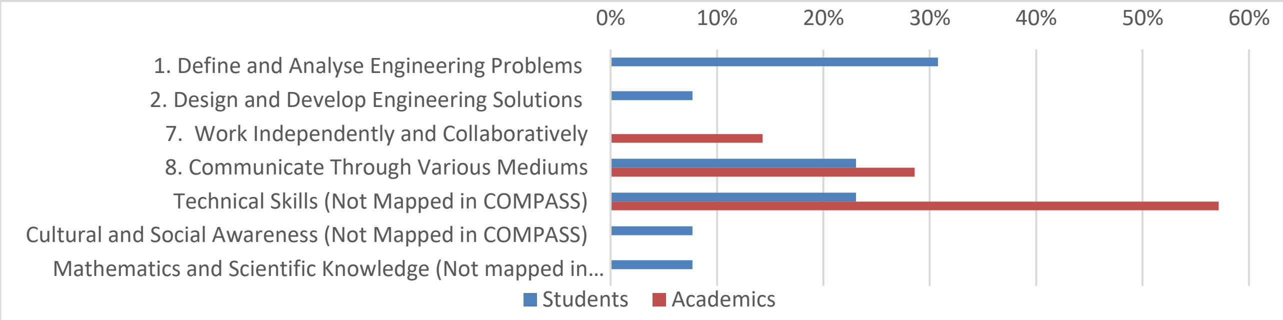

Figure 2. Comparison of Student and Academic Perceptions of the most Important Graduate Engineering Skills Categorised by COMPASS Competencies (n=13 students; n=7 academics)

3.5 Importance Ranking of COMPASS Competencies with Triangulation to Qualitative Data.

A triangulated analysis was conducted to compare student and academic perspectives across both qualitative and quantitative datasets. Table x. shows the ranking order of the COMPASS competencies based on the averaged ranking made by the individual students (n=13) and academics (n=7). Additionally, the analysis presented in sections 4.2 and 4.4 was used to validate and contextualise these rankings, excluding any skills that were not mapped on the COMPASS framework.

Both students and academics ranked competency *1. Define and Analyse Engineering Problems* as the most important competency. This shared perspective aligns with the responses to the open-ended questions discussed in Sections 4.2 and 4.4. Students frequently reported this competency, whereas academics only mentioned it briefly in 4.2. The shared ranking may stem from the close association of this competency with Technical Skills (Not Mapped in COMPASS), which, like Problem Solving, could be mapped across multiple COMPASS attributes. A similar pattern can be observed for 2*. Design and Develop Engineering Solutions*, which was ranked second by academics, but not mentioned in 4.2 or 4.4. This may suggest that while design is a highly valued conceptually, it may be embedded in academic expectations of technical skills which are not commonly articulated explicitly. In contrast, students mentioned design more directly, which is likely reflected more distinctly in their learning experience. Despite this alignment, several competencies showed significant differences in perceived importance between students and academics.

The most significant divergence was observed in the ranking of competency *5. Solve Complex Problems with a Focus on Responsible and Sustainable Outcomes*, which was ranked second by students and seventh by academics. One explanation is that students probably consider the *problem-solving* aspect of the competency, while academics may have placed greater emphasis on responsible and sustainable outcomes. However, it is also possible that students value responsible and sustainable outcomes more, perhaps influenced by broader societal and generational concerns. A similar pattern appeared for *Apply Ethical Practices*, which students ranked fifth compared to academics' lower ranking at eighth.

On the other hand, academics placed greater importance on *Work Independently and Collaboratively*, which was ranked fourth compared to eight by students. This is likely reflected in the large bodies of work that has gone in to emphasising the value of collaboration and teamwork by institutions due to industry demands. Students, however, may not yet fully appreciate the complexity of collaborative dynamics in professional settings.

In section 4.2, *8. Communicate through various mediums* mentioned, was frequently included, whilst also considered the most important by both students and academics in section 4.4. However, when ranked against the other competencies, this competency ranked seventh by student and sixth by academics. This suggested a divergence in opinion when presented with a variation of competencies to weight against. In a more detailed analysis, it was found that only one academic and one student ranked communication at first place, with many suggesting this competency as low as ninth place. The two lowest-ranked competencies showed complete alignment between students and academics. These competencies are 9. *Apply Project Management Skills* and *Engage in Ongoing Learning* and *10. Professional Development.* This suggests a shared perception that these skills are less important compared to others.

Table 1: Ranking of COMPASS competencies (1=most important) by Students and Academics.

COMPASS Skill	Student (S) Rank	Academic (A) Rank	Difference (S - A)	Triangulation with Qualitative Data
1	1	1	0	Reported as most frequently mentioned by students in 4.2 and 4.4; briefly mentioned by academics in 4.2.
2	3	2	1	Moderately mentioned by students in 4.2 and 4.4; not mentioned by academics.
3	4	3	1	Mentioned by academics in 4.2; not mentioned by students.
4	6	5	1	Mentioned by students in 4.2; not mentioned by academics in 4.2.
5	2	7	-5	Briefly mentioned by both students and academics in 4.2.
6	5	8	-3	Briefly mentioned by both students and academics in 4.2.
7	8	4	4	Frequently mentioned by students in 4.2 and 4.4; frequently mentioned by academics in 4.2 and 4.4.
8	7	6	1	Frequently mentioned by students in 4.2 and 4.4; very frequently mentioned by academics in 4.2 and frequently in 4.4.
9	10	10	0	Briefly mentioned by both students and academics in 4.2.
10	9	9	0	Briefly mentioned by both students and academics in 4.2.

4.0 Curriculum Implications and Future Directions

This study highlights the importance of aligning engineering curricula with both analytical problem-solving and evolving professional competencies. While students and academics agree on the significance of defining and analysing engineering problems, students value sustainability and ethics more, likely reflecting broader societal concerns. Academics, meanwhile, prioritise communication and collaboration, aligning with industry needs and institutional goals.

Both groups acknowledge the ongoing tension between technical and professional skills, emphasising the need for curricula that balance these domains. Students' diverse views may stem from their adaptation to changing technological environments, offering early insight into future priorities for the field. The mention of bicultural awareness signals the growing importance of cultural competence in engineering education, especially in contexts like New Zealand. This presents an opportunity to embed cultural responsiveness and Indigenous perspectives more intentionally in curricula. To ensure programmes remain relevant and effective, integrating student input alongside academic and industry expertise is crucial, making curricula responsive to societal changes while maintaining professional standards.

5. Conclusion

This study highlights the imperative to align technical and professional skill development within engineering education. Both students and academics recognise the value of analytical problem-solving, yet their perspectives differ regarding priorities such as sustainability, ethics, communication, and collaboration. These preliminary results indicate that although curricula must retain robust technical content, they should also adapt to meet evolving professional and societal expectations including cultural competence and adaptability. To ensure curricula remain relevant and effective, it is crucial to integrate input from students, academics, and industry stakeholders. Strategically aligning educational outcomes with real-world requirements will equip future engineers to address complex challenges efficiently and ethically. Future work will incorporate a larger dataset to strengthen the findings and enhance generalisability.

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