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Understanding the Ethical Implications of Using GenAI in Engineering Education: A Pilot Study With Engineering Education Academics

Zachery Quince^a, Kathy Petkoff^b, Sasha Nikolic^c, Scott Daniel^d and Ruby N. Michael^e
Southern Cross University^a, Monash University^b, University of Wollongong^c, University of Technology Sydney^d, Griffith University^e
zach.quince@scu.edu.au

ABSTRACT

BACKGROUND & CONTEXT

The integration of generative artificial intelligence into engineering education is accelerating, raising new ethical considerations for educators and institutions. Tools like ChatGPT and Copilot are now used in teaching, assessment, research, and industry practice, creating both opportunities and challenges. Despite the presence of professional codes such as the Engineers Australia Stage 1 and 2 competencies, there is limited guidance on how to navigate the ethical complexities of GenAI use.

PURPOSE

This study aimed to explore the ethical implications of GenAI in engineering education as perceived by engineering academics and assess whether current professional frameworks adequately address these concerns.

METHODOLOGY

A focus group workshop involving 15 engineering academics was conducted at the 2024 Australasian Association for Engineering Education (AAEE) Conference. Participants engaged with four purpose-built GenAI case studies covering academic, student, research, and industry scenarios. Data were collected through facilitated discussions and thematic analysis was conducted using Braun and Clarke's methodology.

OUTCOMES

Participants identified 21 distinct ethical considerations, which were subsequently mapped against an existing 32-point ethical implications framework. All concerns were accounted for within the framework, validating its comprehensiveness. However, several themes were only loosely defined, prompting the proposal of ten broader thematic categories to improve interpretability and cross-domain application.

CONCLUSIONS

Engineering academics recognise both the benefits and ethical risks of GenAI. While current professional standards provide a useful foundation, they require clearer guidance and contextualised interpretation to be effective. This study contributes a revised thematic framework to support ethical decision-making and practical application in engineering education settings.

KEYWORDS

Generative AI, engineering education, ethics, thematic analysis.

Introduction

The rapid emergence of generative AI (GenAI) tools, such as ChatGPT, Copilot and Gemini is transforming higher education practice. Notably, in engineering education, there is a current call-to-action to ensure graduates of professional engineering programs are equipped with professional skills such as self-agency and feedback-literacy (Lidfors Linqvist et al, 2025). Advanced use of AI systems is increasingly utilised to automate grading, assist in content creation, facilitate personalised learning experiences, and enhance student engagement through instant feedback and ideation support (Kasneci et al., 2023; Quince et al, 2025). This use is causing disruption to the field for educators to use in their own practice and also to equip students with digital literacy.

However, the integration of GenAI technologies into engineering education has also precipitated significant ethical challenges that educators, institutions, and professional bodies must urgently address (Quince & Nikolic, 2025). Prominent among these are concerns regarding bias, data privacy, intellectual property rights, the potential erosion of critical human skills, and the necessity of human oversight (Kasneci et al., 2023; Cotton et al., 2023; Rudolph et al., 2023; Quince et al, 2025). Bias in AI systems, resulting from training on unrepresentative datasets, raises fairness issues, potentially exacerbating existing educational inequities by disproportionately disadvantaging specific student populations. Data privacy concerns involve the unauthorised collection and misuse of student information, presenting substantial risks to confidentiality and trust within educational settings (Holmes & Tuomi, 2022).

Moreover, intellectual property complications and plagiarism risks are inherent in GenAI-generated content. Students utilising AI for coursework can obscure originality, complicating traditional plagiarism detection and raising questions of academic integrity and authenticity (Cotton et al., 2023; Quince et al., 2024). Equally concerning is the risk of over-reliance on GenAI, which could undermine essential engineering competencies, including critical thinking, problem-solving, and reflective practice, thereby negatively impacting long-term student development (Holmes & Tuomi, 2022; Rudolph et al., 2023; Quince & Nikolic, 2025). To mitigate these risks, continuous human oversight and clearly articulated institutional guidelines are increasingly advocated, ensuring ethical standards and maintaining educational integrity (Rudolph et al., 2023; Quince et al., 2024).

In response to these ethical considerations, professional bodies such as Engineers Australia emphasise the critical role of ethics and professional accountability through their established Stage 1 and Stage 2 competency frameworks (Engineers Australia, 2019). These frameworks explicitly require adherence to ethical standards and awareness of intellectual property issues. However, they lack specific guidelines addressing the nuanced ethical challenges posed by GenAI, creating interpretative ambiguities that educators must navigate independently (Quince et al., 2024; Holmes & Tuomi, 2022).

Current literature highlights that while there is extensive examination of GenAI's potential impacts on student learning and institutional policies, limited research specifically investigates engineering educators' perspectives regarding the ethical dimensions of GenAI (Holmes & Tuomi, 2022; Zhai, 2022; Quince et al., 2024). Given their pivotal role in curricular integration and pedagogical adaptation, understanding educators' perceptions is critical. This insight is vital for developing informed, responsive policies and instructional strategies that balance technological innovation with ethical responsibility. As such, this pilot study explores the questions: "What are the ethical considerations that engineering academics identify with higher education case studies?" and "Are the current competency and ethics documents comprehensive enough to capture the use of GenAI?" by capturing educators' insights in an immersive workshop environment.

Methods

Participants

This pilot study included engineering education academics attending the Australasian Association for Engineering Education (AAEE) Annual Conference, held in Christchurch, New Zealand, in December 2024. Sixteen academics participated in the ethics workshop, with 15 completing the survey instrument and all contributing to the focus group discussions. Participants represented a range of Australian and New Zealand universities, teaching disciplines, and academic career stages, from early-career academics to senior education researchers. This diverse participant pool offered a breadth of perspectives on GenAI adoption and ethical concerns. Participants were recruited through the conference program by registering for the workshop. There was no participant lists provided to the research team.

Data Collection

Each group was assigned one of four short case studies that illustrated potential uses of GenAI in academic, student, or industry contexts. The groups consisted of four workshop attendees each, based on their seating position. They were intentionally created to be short and packed with information that was designed to spark debate. The case studies were carefully crafted to embed multiple ethical dimensions, including issues such as data security, intellectual property, bias, human labour displacement, and environmental impact. Each group was given 20 minutes to discuss their assigned scenario. Discussions were semi-structured, guided by a set of prompting questions, but participants were encouraged to pursue emergent lines of inquiry. A nominated group spokesperson summarised the discussion outcomes in a plenary session following the small group work. Group discussions were audio-recorded (without video) using Zoom Workplace and subsequently transcribed for thematic analysis. Table 1 documents the four scenarios and the ethical considerations that were used by the focus groups to identify alignment with the ethical consideration framework. Participants were also asked the following question “Are the current Engineers Australia code of ethics and professional competencies (Stage 1 and Stage 2) comprehensive enough to cover the ethical usage of GenAI?” and asked to expand on their binary response.

Table 1: Four case studies (scenarios) for the focus group assessment

Case Study Topic	Case Study
Case study 1 – Academic use of GenAI in Learning and Teaching	In a forward-thinking engineering department, Professor Johnson adopts generative AI to streamline assessment processes. The AI swiftly designs detailed marking rubrics tailored to assignment requirements, ensuring fairness and clarity. Students submit their work digitally, and the AI autonomously evaluates and scores each submission against predefined criteria. Post-assessment, the AI generates personalised feedback messages, pinpointing strengths and areas for improvement with precision.
Case study 2 – Student use of GenAI in Learning	In an engineering studio, students leverage generative AI to ideate a design assessment. The AI generates diverse concepts based on input criteria, sparking innovative ideas. With AI assistance, students draft intricate CAD files, refining designs with precision and efficiency. As the project progresses, the AI aids in compiling technical reports, structuring findings and analyses into cohesive narratives.
Case study 3 – Industry use of GenAI in the Workplace	In structural engineering firms, engineers adopt generative AI to swiftly compute internal shear forces in bridge designs. The AI automates complex calculations, ensuring rapid and accurate assessments. However, concerns arise as some engineers rely solely on AI outputs without verifying underlying mathematical checks. Despite this,

	engineers confidently sign off on calculations, trusting AI's consistency and precision.
Case study 4 – Academic use of GenAI in Research	In a bustling engineering research lab, Dr. Lee harnesses generative AI for comprehensive data analysis. The AI swiftly crunches vast datasets, extracting trends and anomalies crucial for ground-breaking research. Dr. Lee then employs AI-generated advanced machine learning algorithms, custom-tailored to optimise experimental outcomes. As results unfold, the AI seamlessly compiles findings into a technical journal manuscript, drafting cohesive sections and integrating complex data visualisations.

Focus group transcripts were analysed using Braun and Clarke's (2006) six-phase framework for thematic analysis. An inductive coding approach was adopted to allow for the emergence of themes from the data itself, without imposing pre-existing theoretical constructs. The analysis process involved:

1. Familiarisation with the data through repeated reading of transcripts.
2. Systematic generation of initial codes related to ethical considerations.
3. Collation of codes into potential themes based on conceptual similarities.
4. Review and refinement of themes to ensure coherence and distinctiveness.
5. Definition and naming of final themes.
6. Selection of representative quotations to illustrate thematic findings.

Ethical Approval

Ethical approval for this study was obtained from the Monash University Human Research Ethics Committee (Approval Number: 44849). All participants provided informed consent prior to participation. Focus group recordings were anonymised, and transcripts were redacted where necessary to ensure confidentiality and prevent identification of individual participants.

Limitations

This study has several limitations. Firstly, the sample size was relatively small and drawn from a specific group of engineering education academics attending the AAEE 2024 Annual Conference, which may bias the ethical considerations that were discussed due to overfamiliarity with GenAI. The focus group discussions, while rich in detail, were time-constrained to 20 minutes, potentially limiting the depth of exploration into the scenarios. Furthermore, the thematic analysis was inductive and qualitative, meaning that the identified themes are interpretative and may be influenced by the researchers' perspectives. While efforts were made to ensure objectivity through iterative coding and validation against the dataset, complete elimination of subjectivity is challenging. Finally, the integration of quantitative and qualitative analyses relied heavily on the alignment of survey results with thematic insights, which may oversimplify the complex relationships between themes and quantitative trends. Future studies with larger, more diverse samples and extended discussion durations would provide more comprehensive

Results and Discussion

When assessing the verbalised response from the participants for the question regarding EA competencies and code of ethics, two key themes were extracted. The first is that some agreed that the code of ethics specifically is comprehensive enough however, interpretation is needed. The second is that we need institutional/governance in how to apply the current ethical documentation to the complex ethics of GenAI. One response noted that

"Plenty of other technologies are not mentioned by name".

This comment refers to the Stage 1 competencies where a sub-section requires a graduate to be able to use engineering tools and keep up with technological advancements. Some argued that

“The ethical dimensions of GenAI are complex and require consideration of aspects that may not be common knowledge and which have not previously been considered”.

As expected from the divergence in responses to the verbal responses which had 7 indicate that the current EA frameworks were comprehensive enough to capture GenAI, 8 indicated they were not.

The thematic analysis across the four scenarios reveals several important trends that highlight both the opportunities and challenges of integrating GenAI into academic, student, industry, and research contexts. Each scenario brings unique concerns while overlapping in broader themes such as dependency, ethical data practices, and the balance between efficiency and oversight. From the responses of the groups, the excerpts were extracted and assigned a code. The codes were then grouped together and refined into the themes. An example of scenario 1 of how the key excerpts and codes were extracted is shown in Figure 1, with the final coding and themes for all four scenarios presented in Table 2. The coding process was undertaken by a single reviewer due to the limited sample size. The overall thematic analysis process was discussed and refined by the research team to provide reliability to the analysis.

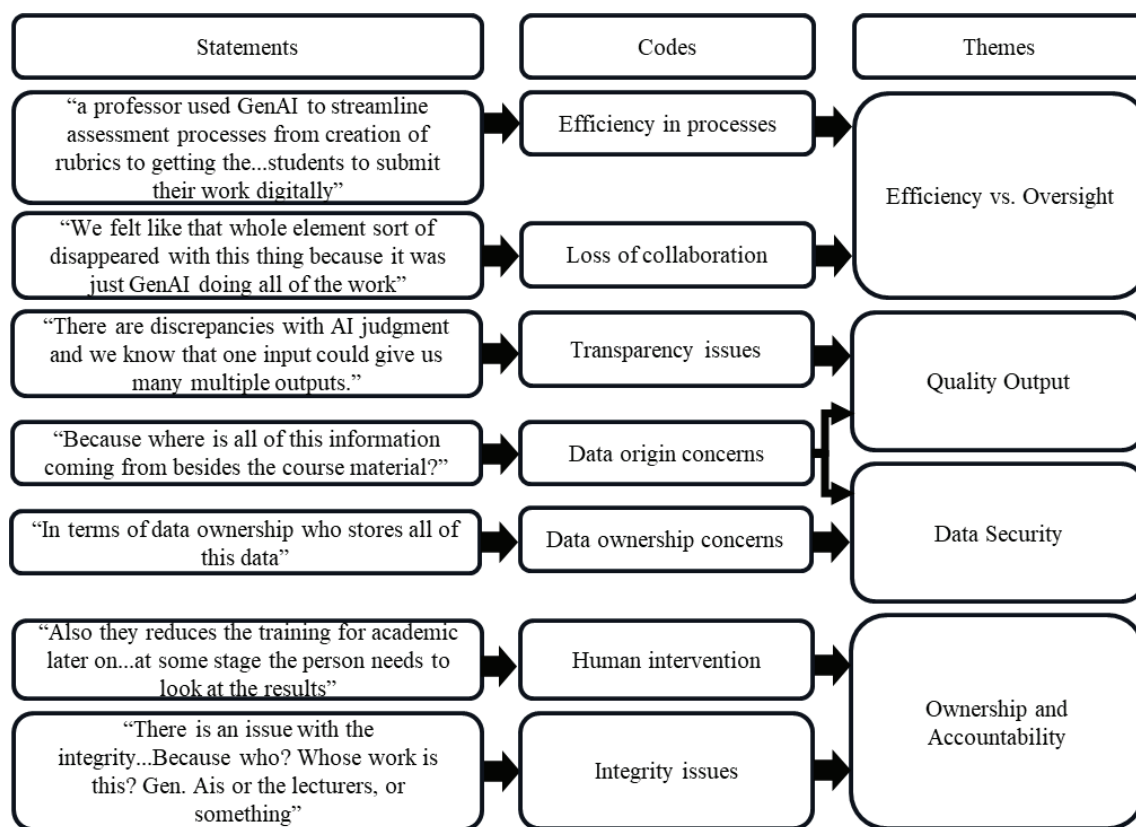


Figure 1: Statement extraction, coding and thematic assessment of scenario 1.

Table 2: Thematic grouping and coding from focus groups

Scenario 1 – Academics for Teaching Practice	Scenario 2 – Students use for Learning	Scenario 3 – Industry use	Scenario 4 – Academics for Research Practice

Themes			
• Efficiency vs oversight • Ownership and accountability • Data security • Quality output	• Learning and skill development • Dependency	• Competency and accountability risks • Environmental sustainability • Ethical data practices	• Environmental sustainability • Dependency • Data security • Quality output
Codes			
• Efficiency in processes • Data origin concerns • Loss of collaboration • Data ownership concerns • Integrity issues • Transparency issues • Human intervention	• Dependency on AI • Loss of skills (ideation and reflection) • Adaptation issues • Risk of reduced learning opportunities	• Automated processes accepted • IP and data origin concerns • Environmental impact • Integrity and accountability challenges • Loss of skills • Equity in computation (output)	• Dependency on AI • Environmental impact • data origin concerns • Integrity issues

In scenario 1, where GenAI is used by academics for academic purposes, the focus is on balancing efficiency in processes with adequate oversight. Codes such as "efficiency in processes", "data origin concerns," and "loss of collaboration" suggest an apprehension between the time-saving benefits of computerisation and the potential loss of human intervention in tasks like grading or assessment moderation. Similarly, scenario 3, dealing with industry applications, also emphasises the need for competency and accountability risks alongside quality control. Both scenarios underscore the importance of human intervention to maintain standards and integrity, illustrating a universal concern about automating complex decisions without human oversight.

Data security and ownership were central to the discussions in scenario 1, scenario 3, and scenario 4. These scenarios raise questions about where and how sensitive data is stored and used, as highlighted by codes like "data origin concerns," "integrity issues," and "transparency issues." For industry applications (Scenario 3), this extends to ethical data practices, particularly where safety and client confidentiality are vital. In academic research (scenario 4), dependency on AI for generating results further complicates accountability, as researchers risk delegating decision-making to AI systems without fully understanding or verifying their outputs.

Scenario 2 and scenario 4 share a notable emphasis on dependency on AI, with both contexts showing concerns about how reliance on GenAI might wear down critical human skills. In student project work (scenario 2), this includes a "loss of skills (ideation and reflection)" and a risk of reduced learning opportunities, as students may bypass essential stages of problem-solving. Similarly, in research contexts (scenario 4), codes like "dependency on AI" and "loss of skills" signal fears of researchers becoming over-reliant on GenAI, leading to a degradation of expertise and critical judgment.

Environmental concerns are particularly prominent in scenario 3 (industry) and scenario 4 (academic research). Both scenarios highlight the significant computational and energy costs of GenAI, as reflected in codes like "environmental impact." While these concerns are less pronounced in the other scenarios, they point to a growing awareness of the sustainability challenges posed by large-scale GenAI applications. Two different impacts were mentioned. The first was mining the resources necessary to continue the infrastructure manufacturing, and the second was the power required to generate the prompts.

Whether it's integrity issues in academic assessments (scenario 1), risks to equity in computation outputs (scenario 3), or challenges in ensuring ethical data practices (scenario 4), the need for clear guidelines and accountability mechanisms is evident. Each context

reflects a unique dimension of these ethical concerns, but they collectively highlight the broader societal implications of adopting GenAI technologies.

To validate a set of 21 identified ethical codes related to GenAI in education, each theme was mapped against an existing framework of 32 ethical implications. The codes were mapped to a recently published ethical considerations of use framework by Quince and Nikolic (2025), where all codes were able to be associated with at least one of the 32 implications. This not only demonstrates that there were no considerations mentioned in the groups that were explicitly missed by the framework, but also that the framework is comprehensive enough to translate across different domains. While some themes aligned directly with individual implications, others were only loosely defined within the framework. This suggests the need for a less structured and overarching list of ethical issues that can support practical application and cross-sector translation. In response, the following ten themes are proposed as a broader and more inclusive categorisation of ethical considerations:

1. Automated Processes
2. Bias and Intellectual Property
3. Collaboration and Ideation
4. Data Ownership, Security and Collection
5. Decision Making, Risk and Uncertainty
6. Environmental Impact
7. Equity and Accessibility
8. Human Labour
9. Integrity, Transparency and Accountability
10. Quality Output and Understanding of Subjects

These categories aim to capture the nuance and complexity of ethical risks and responsibilities emerging from GenAI use, especially in educational contexts, where both human development and technological integration are deeply interwoven.

Conclusions

This pilot study confirms that engineering education academics perceive generative AI as a powerful tool with significant potential for enhancing teaching, learning, research, and industry engagement. However, participants also expressed substantial ethical concerns related to data privacy, intellectual property, bias, dependency, and the diminishing role of human skills. While GenAI can streamline processes and support innovation, educators emphasised the importance of responsible integration that maintains academic integrity and upholds professional standards.

To validate the 21 ethical considerations raised during the workshop, each was mapped against a recently published ethical considerations of use framework by Quince and Nikolic (2025). All 21 codes aligned with at least one of the 32 established ethical implications, indicating that no ethical concern raised by participants was explicitly excluded. This mapping supports the comprehensiveness and flexibility of the existing framework, confirming its capacity to translate across educational and professional domains. However, the analysis also revealed that some participant-identified themes were only loosely represented, suggesting the need for a more accessible and thematically structured articulation of ethical considerations.

In response, a broader list of ten overarching themes was developed to support practical interpretation and application. These include automated processes, bias and intellectual property, collaboration and ideation, data ownership and security, decision making and risk, environmental impact, equity and accessibility, human labour, integrity and accountability, and quality of output and subject understanding. This revised thematic framework captures the complexity of GenAI's ethical challenges and provides educators with a more usable structure for evaluating and responding to them in context.

Overall, this study highlights the importance of expanding ethical literacy and institutional preparedness as GenAI becomes more deeply embedded in educational practice. While existing professional standards such as the Engineers Australia Stage 1 and Stage 2 competencies offer a foundational ethical guide, they may not be sufficient on their own to address the rapidly evolving challenges posed by GenAI. There is a clear need for sector-wide dialogue, updated governance frameworks, and targeted educator training to ensure that GenAI is implemented in ways that are pedagogically sound, ethically responsible, and aligned with the future needs of both students and the engineering profession.

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