LEVERAGING AI FOR EQUITABLE LEARNING: INSIGHTS FROM ACADEMICS IN ENGINEERING

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ABSTRACT

Generative artificial intelligence is a hotly debated issue in the current landscape of educational research, with educators' abilities to utilise this powerful tool falling by the wayside as institutions focus instead on regulation. Current research on generative AI in engineering education, whilst in its infancy, places a large onus on studying students and how they use such services. Therefore, little is currently known regarding current and proposed uses of generative AI by engineering educators and academics. Its potential in enhancing educational methodologies often remains underexplored amidst regulatory concerns. This is especially true for the field of diversity, equity and inclusion where generative AI has been used in numerous ways to cultivate more equitable outcomes for engineering students. Our ongoing research aims to elucidate these current and proposed uses of AI to understand how it can be used to create equitable learning environments for undergraduate engineering students. This research aligns with CDIO Standards by investigating how generative AI can support active learning environments (CDIO Standard 8) and integrate diverse learning preferences into the engineering curriculum (CDIO Standard 7). Through a reflexive thematic analysis of six semi-structured interviews with academics from Monash University's Faculty of Engineering, the main themes of *Adaptive Integration, Balancing Efficiency with Deep Learning* and *Empowering Through Training and Resource Allocation* were discovered. Future research should centre around uncovering the mechanisms of algorithmic bias in the field of engineering, assessing the efficacy of generative AI powered pedagogical interventions in achieving equity, diversity and inclusion as well as the development of faculty scaffolded ethical guidelines and frameworks for the use of generative AI tools.

KEYWORDS

Equity, Diversity, Inclusion, Artificial Intelligence, Standards: 7,8

BACKGROUND AND MOTIVATION

Generative Artificial Intelligence (GAI) is not a new phenomenon but has entered almost all domains of common parlance due to its rapidly increasing sophistication in recent years. ChatGPT, one of the most prominent examples of GAI, represents this meteoric rise as it is now considered to be the fastest growing application in human history (Murugesan & Cherukuri, 2023). GAI, a technology that enables systems to 'think' and 'act' like humans, is not only defined by its ability to achieve goals and solve problems, but also embodies key advantages over other forms of artificial intelligence, such as its capacity for continual improvement of answers based on both current and previous user inputs (Akgün & Greenhow, 2022; Adamopoulou & Moussiades, 2020). With ever increasing catalogues of parameters within the LLMs that GAI interfaces are trained on, it is almost certain that GAI will touch most aspects of engineering education, revolutionising the field (Murugesan & Cherukuri, 2023; Johri, 2020; Bahroun et al., 2023). Within the community, calls have been made for initiative to be taken to both construct a knowledge base around its capabilities and use as well as documenting and shaping specific applications (Johri et al., 2023; Nikolic et al., 2023a).

In response, many tertiary institutions and researchers have immediately begun investigating concerns over academic integrity and engineering assessments, reflecting the broad interest and concern in this field (Nikolic et al., 2023a; Nikolic et al., 2023b; Abd-Elaal et al., 2022). Whilst this is critically important in ensuring the ongoing integrity of engineering assessments and by extension the quality of our future engineering graduates, this is not the first time that this tension has arisen. Necesal & Pospisil (2012**)** underscore a crucial decision for academics: one path involves prohibiting GAI tools, while the other entails integrating these tools into the educational toolkit. The latter being firmly in keeping with the philosophy of engineering wherein technological advances exist at its core, motivating the use of GAI tools in our learning and education into the future (Murugesan & Cherukuri, 2023). Consequently, GAI tools such as ChatGPT have been adopted in various educational settings with mixed results often overlooking their potential to enhance pedagogical strategies (Mollick & Mollick, 2023).

Implementation of GAI tools in engineering classrooms does not, however, come without just concerns. Issues of accessibility, bias, privacy and broader societal discrimination have been raised as such potential concerns due to GAI tools' abilities to widen already existing gaps (Akgün & Greenhow, 2022; Crutchley, 2021; Holstein & Doroudi, 2021; Menekse, 2023; Sun et al., 2023; Adamopoulou & Moussiades, 2020; Bobula, 2023**)**. The concerns raised have significant socio-cultural implications, particularly in terms of equity, diversity and inclusion thus necessitating investigations into how these challenges can be effectively addressed in engineering education. This study follows the lead of many prominent engineering education research on equity, diversity and inclusion (EDI) in understanding EDI not as the sum of its component parts but rather as interlinking components that are co-dependent, inextricable from one another and are central to ethical engineering (Hess et al., 2023). In order to understand the interplay between GAI and EDI in engineering education researchers must be paradigmatically critical of the widely espoused and problematic notions of GAI tools being morally superior to humans due to their purported objectivity, neutrality and lack of bias in decision making (Crutchley, 2021).

This research, therefore, aims to understand the perspectives of engineering academics with regards to their readiness and willingness to incorporate GAI tools in their classes to support the principles of equity, diversity and inclusion. The subsequent reflexive thematic analysis is the product of six semi-structured interviews with engineering academics from a range of

departments and experience levels at Monash University. Ultimately, this research seeks to answer the following research question:

What are the current perspectives of engineering academics regarding their readiness and willingness to adopt GAI tools to help achieve equity, diversity and inclusion in their classes?

LITERATURE REVIEW

The past year has seen a dramatic increase in the adoption of GAI tools both within engineering education and more generally (Murugesan & Cherukuri, 2023). Correspondingly, the body of literature on GAI in the field has followed a similar trend (Bahroun et al., 2023). This has understandably led to constraints on time for research to be published, leaving numerous unexplored and overlooked gaps in the current body of literature. This study aims to address a number of these gaps: it examines the integration of GAI into teaching pedagogies, highlights the need for academics and educators' perspectives in GAI discourse, investigates the benefits of GAI as an educational tool and addresses concerns about Equity, Diversity and Inclusion (EDI) in the context of GAI use.

Applications of GAI have been seen to, or have been espoused to have the potential to support the learning of students through various uses (Akgün & Greenhow, 2022). Potential benefits include the enhancing of personalised learning experiences, improvement of student engagement, autonomy and overall learning and achievement (Fatahi et al., 2023; Menekse, 2023; Mollick & Mollick, 2023; Nikolic et al., 2023b; Qadir, 2023). These benefits may be achieved through reducing the time delay and social barriers to receiving feedback, virtual simulations, low-stakes testing, improved writing skills as well as customised problem sets and learning opportunities (Fatahi et al., 2023; Menekse, 2023; Mollick & Mollick, 2023; Murugesan & Cherukuri, 2023). There is undeniable potential to transform students' learning through these practices, however, they are largely completed by students in isolation without being formally adopted by academics and scaffolded through their delivery of content and teaching pedagogy. This has the potential to be problematic for students' learning for many reasons such as the need for GAI outputs to be evaluated and curated by engineering educators to ensure their veracity (Menekse, 2023). Such scaffolding can free up time for educators to connect and engage with students on more complex engineering concepts with proposed areas of research also including the construction of lesson plans with the assistance of GAI tools (Murugesan & Cherukuri, 2023; Menekse, 2023; Budhwar et al., 2023). Academics are, however, largely overlooked in this process. Before the implementation of pedagogical interventions aimed at achieving the aforementioned espoused benefits of GAI tools, the academics who will bear the brunt of practically carrying out these actions must be consulted. This research primarily focuses on understanding how ready and willing academics and educators are to implement GAI tools in their classes.

There is a distinct lack of rich, qualitative inquiries focused on the views and lived experiences of key stakeholders involved with GAI adoption at the coalface of engineering education delivery, namely engineering education academics and educators. Much of the current body of research is focused on delineating the technical capabilities of GAI tools, investigating issues of academic and assessment integrity or theorising more philosophically on the concerns over how GAI tools will impact our future (Nikolic et al., 2023a; Nikolic et al., 2023b; Menekse, 2023; Murugesan & Cherukuri, 2023). In order to develop and improve the educational experiences and outcomes of our engineering graduates into the future we must however investigate how and why GAI tools should be adopted as well as who will be

responsible for these changes (Longo, 2020). It is for these reasons that this research focuses on engineering academics who will ultimately find themselves at the nexus of research and practice when it comes to GAI tools and engineering education. Deductive GAI tools currently lack the capacity to effectively interpret and utilise a swathe of nuanced qualitative information (Budhwar et al., 2023). Thus, further underscoring the importance of investigating the interactional relationship between humans and GAI tools, the complexity of which, is predicated heavily on deeply subjective and human forms of understanding. These centering around the readiness and willingness of engineering academics and educators to adopt GAI tools in their classes for the purposes of this research.

The ethical and moral concerns shared by academics and researchers regarding the potential for GAI tools to exacerbate existing social inequalities raises questions regarding the principles of equity, diversity and inclusion. These concerns include privacy issues, systemic bias perpetuation, historical and institutionalised bias as well as misleading and incorrect information generation (Akgün & Greenhow, 2022; Crutchley, 2021; Holstein & Doroudi, 2021; Menekse, 2023; Mollick & Mollick, 2023; Murugesan & Cherukuri, 2023). Together, such concerns are often referred to as algorithmic bias wherein the LLMs associated with GAI tools are trained on current and historic datasets, in turn further perpetuating and reflecting inherent societal biases (Akgün & Greenhow, 2022). In essence, GAI tools are only as good as the data on which they are trained and if adopted in a haphazard manner have the potential to further cement biases such as socioeconomic status, gender and race at an increasing pace (Qadir, 2023; Johri, 2020). Such algorithmic bias is present in numerous examples such as the study conducted by Sun et al., (2023) in which the GAI image generator DALLE 2 was shown to underrepresent women in male-dominated fields whilst overrepresenting them in female-dominated fields when studying occupation-based outputs. Furthermore, women were disproportionately depicted with smiles and downward-pitching heads when compared to generated images of male professionals, further sounding alarm bells with regards to the overt and unquestionable representational and presentational bias inherent in GAI tools. Such examples help to abolish the misguided notions of GAI as the embodiment of neutrality, somehow impervious to 'human' attributes of subjectivity and bias. The additional concern with biased datasets relates to the fact that GAI tools do not operate in isolation but rather construct the very datasets which they are themselves shaped by, ultimately exacerbating existing bias in an uncontrolled manner (Akgün & Greenhow, 2022). It must be acknowledged that our current and historic datasets are indeed problematic, both in forms that we are aware of and ones that we are not, if we are to effectively address issues related to EDI in our field (Crutchley, 2021). Therefore, as a research community we must first understand the perceptions and readiness of academics in engineering regarding GAI, algorithmic bias, and EDI concerns. Such understanding is fundamental in fostering a more inclusive and equitable engineering community. This is especially vital given engineering's historical challenges with representation, marginalisation and cultural issues (Holstein & Doroudi, 2021, Davis et al., 2023; Garriott et al., 2023; Küskü et al., 2007; Lohan & Faulkner, 2004).

In order to address the identified literature gaps and understand engineering academics' readiness and willingness to incorporate GAI tools in their classes to support the principles of EDI, the study employed a qualitative, reflexive thematic analysis as described by Braun & Clark (2013).

METHODOLOGY AND METHODS

The methodological coherence and strength of any qualitative research is predicated on numerous factors including the clarity of the authors' epistemological and ontological stances which has been commonly overlooked in many engineering education research (Malmi et al., 2018; Bernhard & Baillie, 2013; Case & Light, 2011; Baillie & Douglas, 2014). This study applied a constructivist lens of enquiry in order to acknowledge the multiple, constructed and perceived realities of our study participants whereby there is no one objective and absolute truth to be discovered (Patton, 2002). In this sense, this study seeks to construct knowledge about the perceived reality of our participants rather than constructing reality itself (Patton, 2002). Our constructivist epistemology is consequently underpinned by an ontologically relativist stance wherein research participants are co-constructors of multiple subjective realities (Charmaz, 2014; Denzin & Lincoln, 2005).

The application of our stated epistemological and ontological paradigms motivated the use of semi-structured intensive interviews with participants. Such interviews firmly ground the interviewer within the process of constructing and co-constructing understandings generated from these interviews and acknowledge the interviewer as a valid instrument in the process (Charmaz, 2014). Intensive semi-structured interviews offer the researcher flexibility in following hunches during interviews to follow up on unanticipated avenues of inquiry, ultimately creating an interactional space that enables participants to effectively relate their experiences (Vander Linden & Palmieri, 2023; Charmaz, 2014).

The authors conducted 6 such interviews that were limited to approximately 45 minutes each due to constraints on participants' time. The interview questions focused on exploring the integration and impact of generative AI in educational settings and structured to encourage detailed responses. They covered a range of topics including the use of AI in teaching roles, its potential to enhance fairness and inclusivity in education, and the role of AI in creating and modifying educational content to address biases. They allowed the interviewees to reflect on their personal and professional growth, challenges faced in their academic careers, and their vision for the future of education.

Maximum variation sampling was carried out to select these 6 study participants. This is a non-probability sampling method that seeks to engage participants who vary on certain characteristics or traits in order to embed complexity within the study through eliciting multiple perspectives (Creswell, 2014). Such a method of sampling intends to represent the study population itself rather than being immediately and widely generalisable (Cohen et al., 2007). As such we selected a number of academics from a range of departments, levels of teaching experience and types of classes taught as can be seen in table 1 below.

Table 1. Summary of Study Participants

	Department	Position
Academic #1	Electrical and Computer Systems	Associate Professor
Academic #2	Electrical and Computer Systems	Teaching Fellow
Academic #3	Mechanical and Aerospace	Senior Lecturer
Academic #4	Mechanical and Aerospace	Senior Lecturer
Academic #5	Civil	Lecturer
Academic #6	Chemical	Senior Lecturer

Thematic analysis is a systematic research design that is widely used in qualitative inquiry designed to identify and organise patterns of meaning in order to gain insights from data sets (Braun & Clarke, 2012). Such patterns of meaning are commonly referred to as themes which distil commonalities of meaning regarding how a certain topic is considered (e.g. how it is written about or spoken about) (Braun & Clarke, 2012). Thematic analysis is a flexible tool which can be applied to numerous studies and data sets. Braun & Clarke (2006) pioneered what is now known as reflexive thematic analysis which includes six steps of: familiarising yourself with your data, generating initial codes, searching for themes, reviewing themes, defining and naming themes and finally producing the report. This method of thematic analysis is associated with numerous advantages including producing accessible results, being participatory with respect to collaborators, offers a 'thick description' of dense data sets and is well placed to provide unanticipated insights (Braun & Clarke, 2006). As such, an inductive reflexive thematic analysis research design was chosen for this study, allowing emergent themes to be discovered in an interpretive manner that certain codebook and coding reliability approaches to thematic analysis can constrain through their relative rigidity (Braun & Clarke, 2021).

Transcripts of interview recordings were coded by the first author using NVivo 14 software with the final stages of reviewing, defining and naming themes occurring through consultation and conversation between the authors. This process of consultation was not enacted to achieve the more positivist notion of quantitative inter coder reliability but rather to elicit as much meaning and different perspectives from the initial codes and emergent themes to enhance the richness of our reflexive thematic analysis.

RESULTS AND DISCUSSION

Our data analysis process consequently led to the generation of three overarching themes of *Adaptive Integration*, *Balancing Efficiency with Deep Learning* and *Empowerment Through Training and Resource Allocation*. These themes are outlined and detailed individually in the following discussion.

Adaptive Integration

Academics were often emphasising the need for AI to be adaptable to diverse cultural and institutional contexts, highlighting the importance of understanding and adjusting to various educational environments and student needs.

Culture and Institutions

Issues of adaptability to and access across diverse cultures and institutions was prominent throughout our analysis, posing great concerns regarding the equitability of GAI tools locally, regionally and globally. Opinions varied somewhat on the broader issue of accessibility from *"I don't see it [as] something that is as inequitable as many things in society"* to participants expressing their concerns on a larger scale as *"it would definitely create a bit of a divide if you think worldwide… there are many many places where students still rely on books".* Global digital inequalities are ever present in our modernised world, impacting on educational outcomes and struggles for gender equality amongst other inequalities thereby supporting this latter contention (Ragnedda & Gladkova, 2020). Economic capital, a well-known determinant of technology adoption in educational settings was, however, a recurrent theme in many of these discussions with discourse generally centering around equality of access not being

possible *"if there's a cost involved"* (Warschauer & Matuchniak, 2010; Warschauer et al., 2004). This exemplifies the broader socio-cultural concerns of academics regarding equity of access to GAI tools, necessitating further analysis of cultural adoption considerations. *"There are going to be cultural determinants of outcomes. I can see, for example, it playing very differently in an American university setting to, say, a Chinese university setting to an Australian or New Zealand university setting because the cultures are different"* mused one of the participants when questioned about the existence of any divides relating to potential advantages garnered by particular groups. This sentiment was shared by other participants who indicated that *"different universities, different places [and] people have different levels of technology absorption"* where certain Australian universities may not have expectations of personal interaction with their academics compared to an *"American college where you typically have many more personal conversations with a lecturer".* These sentiments are supported in academic literature and really speak to the importance of avoiding any 'one size fits all' objectively 'correct' applications of GAI tools in teaching pedagogies (Hofstede, 1986). Cultures, institutions and students have vital, fundamental differences that need to be considered when choosing how to integrate GAI tools into varied settings as to not disproportionately advantage any setting or group of students over another.

Flexibility and Adaptability

Such differences are myriad and infinitely complex, thereby motivating flexibility and adaptability of GAI use by academics and students to achieve their intended learning outcomes. This is compounded by the innate variability of GAI tools as is exemplified in the following participant quotation *"What ChatGPT was good at in January is not the same thing as March… So, the really key thing to teach is almost adaptability".* This is a critical point as it extends the concept of adaptability and flexibility to something that not only affects the decision making of academics but something that also needs to be taught to students (Jonker et al., 2020). Each student has unique needs and our analysis indicates that academics want to empower their students to use GAI tools in personalised ways that help tailor their own learning placing GAI tools as a filter of sorts between academics and students.

Educational Environments and Student Needs

When used as an intermediary between academics and students, educational environments may be tailored to students needs in a variety of ways. This has been seen to be absolutely critical, as is expressed by multiple participants as *"Some differently abled people I've run across really appreciate having resources delivered to them in their own environments"*. Tailored lecture notes, lecture transcription services, individualised assessment and differentiated content delivery were all raised by our participants as benefits of using GAI tools to meet different student needs and requirements as is consistent with literature (Pal, 2009). Using GAI to help improve writing and English skills of non-native English speakers was the most prominent benefit proposed. Participants saw GAI tools as *"an infinite source[s] of consultation"* where students of all levels of English proficiency, but particularly those who are non-native speakers, by allowing them to *"run [their writing] through gen AI to tidy it up and then compare with their initial version… until their brain starts to pick up those patterns themselves"*. These iterations lower the barriers to students seeking feedback on their work due to the non-judgemental nature of asking a chatbot or similar tool a question as opposed to an academic or teaching associate who may judge them for the quality of their work. As one participant states "*You have this very peachy view of yourself like, oh, I'm very approachable…but of course that doesn't mean that they won't be [scared of approaching an academic]"* in doing so, suggesting that just saying that students should feel free to approach

teaching staff is not enough. Students, especially from minority identities in engineering, can very easily feel intimidated approaching say a white man who is considerably older than them and in a direct position of authority (White, 2011). Harnessing and fostering students' *"willingness to interrogate gen AI, show it their work, and ask for general feedback"* in addition to shaping their own learning environments based on their specific needs presents itself as a huge opportunity to increase the equity, diversity and inclusiveness of engineering education environments yet there remains a balancing act between efficiency and deep learning.

Balancing Efficiency with Deep Learning

Balancing efficiency with deep learning was a prominent theme, acknowledging the efficiency and practical applications of AI in education, while being aware of its limitations in fostering deep learning, critical thinking, and creativity.

Efficiency Gains

The prevailing lens through which our participants viewed the future of GAI was that *"there will always be a human element involved [in education]"* but at the same time GAI tools are here to stay and educators *"cannot run away from it, otherwise we will all become obsolete"* leading numerous discussions on how to maximise efficiency gains. This is both in terms of educational delivery as well as student learning as one participant simply put it *"does it improve the quality of the output that [the students] produce. Yes, it does."* Improved student efficiency in getting more fundamental and broad guidance from GAI tools was also seen to have a knock-on effect for academics as if they *"have more time to dedicate to students… often students with EDI factors who need more support [and] guidance… I think that could even be a positive change".* This efficiency gain can be realised through using the aforementioned freed up time to spend more time with students on *"high value interactions"* rather than *"spending human time doing dumb tasks"* or *"grunt work"* as this is required for higher-level work (Ismailov, 2022). Aside from this, GAI tools were used widely to perform certain teaching related administrative tasks on a *"superficial level"* including *"tidying up emails or announcements… generating communications"* that have certain formatting or structural requirements. Additionally, our participants spoke to GAI's ability to streamline their brainstorming processes on a wide variety of tasks and activities including "*brainstorming ideas, for example, project assessments… ideas on what we could do in the EDI space in terms of an event"* and coming *"up with some project ideas and a rubric as well*" which is consistent with contemporary literature on brainstorming (Lavrič & Škraba, 2023). In terms of assessment, participants indicated GAI's potential utility in generating multiple choice questions, helping students write reports to a rubric and with their professional writing. Ultimately these avenues of efficiency gains hold great potential in allowing academics and educators to spend more valuable time with students, especially those who may be differently abled or require additional assistance. However, such gains must be considered in conjunction with potential threats to students' deep learning, critical thinking and creativity.

Opportunities and Threats to Deep Learning

There was much trepidation over the impact of GAI tools on students' depth of learning and understanding with participants speaking to the potential benefits of their use but *"in terms of [improving] their understanding, I'm not sure".* This stems from a sense of scepticism over the role that GAI tools can play in the knowledge transfer process as a *"shortcut"* of sorts *"that it isn't as deeply rooted as when that information is taken in by like different ways. Slower ways reading something. Discussing the finer points".* This assertion is bolstered by numerous

participants who also indicated that the current lack of sophistication of GAI tools is a hugely limiting factor on their willingness to use them in their classes, something that has been raised with regards to AI's technical skills (Nikolic et al., 2023a). Proposed means of tempering such surface level learning include encouraging students to engage in the critical analysis of GAI outputs. As one participant noted *"I'm able to view [GAI outputs] and go, this isn't particularly useful, this is quite useful, and so forth"* indicating how they believe GAI tools are to be used as well as warning students that *"it often tells you things that aren't right or it can't justify it's answers."* A further concern that was expressed was that participants generally found that it is *"students who are struggling and who would really benefit from these tools aren't sufficiently engaged to actually realise there's an opportunity [to help themselves]"* and instead rely on GAI tools as a crutch rather than a tool or as another participant put it *"its showing, perhaps, a lack of willingness to engage critically with some tasks".* To avoid this tendency, students need to instead engage critically by *"having a discussion about why its wrong, if its wrong"* ultimately encouraging students to use GAI in a *"proactive way around challenging the assumptions [of GAI tools]".* In a similar vein, the theme of critiquing and challenging GAI outputs was also extended to questioning algorithmic bias by some participants. Put simply, *"its much easier to call a computer racist than a human"* largely due to the lack of power that GAI tools have over students as opposed to say their bosses or lecturers. This points to how engaging with GAI outputs critically can actually be an empowering force for social change and potential bias reduction within our field. Many participants also mentioned the potential to enhance student creativity as GAI tools can allows students *"to be more creative on complex things… because basic things were too time consuming or too energy consuming"* as well as *"explore their creativity a lot more than what they have now."* Despite concerns to the quality of learning of engineering students with additional use of GAI tools, through engagement with critical analysis of its outputs and creativity, there is great potential to enhance the deep learning of our engineering students whilst maximising the efficiency gains associated with GAI use.

Empowering Through Training and Resource Allocation

Training and resource allocation centres around the importance of providing adequate resources, training, and guidelines to empower educators and students to effectively utilise AI in a way that enhances learning and maintains ethical standards.

Training and Resource Allocation

Educators and students require adequate training and resources regarding GAI tools in order to truly harness the potential of such tools. Currently, uptake of GAI tools by academics seems to be largely dependent on personal gains as *"not everyone is motivated by benefits to the students. It'll be benefits to [academic's] personal circumstances".* This is understandable given the rapidly evolving nature of such tools that requires academics to participate in *"constant active engagement"* even *"during the delivery of the course"*. Both points speak to the lack of time within academics' schedules to truly engage with and learn about GAI tools as one participant highlighted *"given my busy teaching and research role, I mean I would love to just sit down and muck around with chat GPT… and I'll be honest, I do not have time to do it."* This was a strong theme throughout the study, and is consistent with findings in current literature, as academics instead relied on other informal methods of learning about GAI tools such as peer learning and informal workshops put on by colleagues (Vinichenko et al., 2020). Solutions to address this largely involved structured approaches to GAI education both in the curriculum and in a policy sense. Calls were therefore made for GAI tools to become integrated into the *"ecosystem of our teaching"* with the need for *"training and a framework, a [set of] guidelines"*. Structured approaches to training and resource allocation that harness informal

learning networks are sorely needed in the field of engineering education that also acknowledge the importance of affording academics the time required to engage with GAI tools.

Ethical Concerns and Standards

Such structured frameworks for GAI use must be underpinned by certain ethical and moral standards, many of which were raised as concerns by our participants. Concerns regarding embedded bias were in-line with those discussed in the previous literature review as a common sentiment amongst participants was *"if its being trained on real world data, the biases of the real world come in."* Concerns included issues of gender bias as *"if it is fed that men are engineers and men author all the papers in engineering… then what does that say about our workforce"* in addition to racial bias for instance regarding *"our knowledge about traditional owners, traditional custodians of water ways… none of that stuff is really brought into a [GAI] model."* Both quotations amplify the concerns over GAI models *"regressing to the mean"* and ignoring marginalised individuals, communities and ways of knowing, further pushing them to the margins of society. In essence, our participants spoke to a larger issue of centralization of knowledge as a result of widespread GAI use that repackages existing data, relating to the majority, as opposed to generating new knowledge as is encapsulated in the following quotation *"When you start using AI more heavily it is just going to be repackaging and regurgitating stuff that's already there… there's a risk that you might no longer be at the forefront, right? Because that requires some human discretion."* Ethical guidelines and frameworks must also help academics avoid the overuse of GAI tools in student interactions, using them for smart automation rather than having students being "*palmed off onto something cheap"* and suffering from a *"telephone menu effect"* of sorts when students really need and expect a human to human interaction. Moving forward we need to start developing such ethical guidelines and frameworks for GAI use otherwise we risk worsening societal marginalisation, knowledge stagnation and lower student engagement and satisfaction.

CONCLUSION

This study represents the first step in understanding the readiness and willingness of engineering academics to implement GAI tools in their classes to achieve the goals of EDI. Whilst many of our participants were largely unaware of any specific pedagogical uses of such tools, their perspectives are instrumental in illuminating potential concerns regarding GAI implementation as well as the factors that would enable them to use GAI in the future. Our reflexive thematic analysis of six participant semi-structured interviews revealed three main themes of *Adaptive Integration*, *Balancing Efficiency and Deep Learning* and finally *Empowering Through Training and Resource Allocation*. Future research should seek to delineate the mechanisms of algorithmic bias within the field of engineering as to better understand how to reduce such biases in engineering programs. Further investigation is also required regarding scholarship of teaching and learning in instances where GAI tools have been scaffolded into engineering classes as to illuminate its efficacy in addressing the goals of EDI. This study further motivates the application of qualitative research methodologies in a largely quantitative field in order to truly understand the perspectives of engineering education stakeholders at the coal face of teaching and learning. We encourage institutional leaders to be proactive in not only scaffolding GAI training for academics and students, but also in constructing guiding ethical frameworks and guidelines for the use of GAI tools to avoid myriad concerns discussed in this study.

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