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Exploring the potential benefits of incorporating Generative AI in assessments and classroom engagement for tertiary engineering students and educators.

By

Frank Kenny

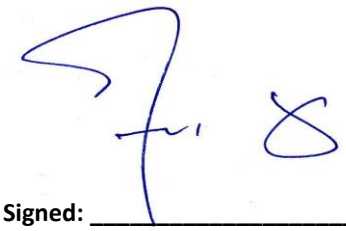
Dissertation submitted in partial fulfilment of the requirements for MA in Education, Learning and Development (*QQI*)

Faculty of Teaching and Learning

Griffith College Dublin

July 2024

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of the MA in Education Learning and Development, is my own; based on my personal study and/or research, and that I have acknowledged all material and sources used in its preparation. I also certify that I have not copied in part or whole or otherwise plagiarised the work of anyone else, including other learners.



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Abstract.

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The rapid advancement of Artificial Intelligence (AI), particularly Generative AI tools like OpenAI's ChatGPT, has significantly impacted the educational landscape since its introduction in November 2022. This research explores the integration of Generative AI into engineering education, focusing on the attitudes and perceptions of students and educators at a private Irish college. The study aims to understand the current engagement with Generative AI, its perceived benefits, and the challenges associated with its adoption in engineering education.

A mixed-methods approach was employed, combining quantitative data from student surveys and qualitative insights from semi-structured interviews with engineering educators. The findings reveal a notable gap between student and educator engagement with Generative AI. While students are generally enthusiastic about leveraging AI for their studies, educators exhibit hesitation, primarily due to a lack of familiarity and training. Key benefits identified by students include improved understanding of complex concepts, enhanced productivity, and a more enriched learning experience. However, educators express concerns regarding academic integrity, ethical use, and the need for skill development.

The study underscores the necessity for continuous professional development for educators to effectively incorporate Generative AI into their teaching practices. Recommendations include designing curricula that integrate AI tools while adhering to educational standards, providing formal training for educators, and developing innovative assessment strategies. Additionally, addressing ethical considerations and maintaining transparency in AI use are critical to fostering a responsible educational environment.

The research highlights the need for educational institutions to proactively adapt their policies and practices to keep pace with technological advancements. By bridging the gap between student enthusiasm and educator caution, institutions can harness the potential of Generative AI to enhance engineering education and prepare students for the evolving technological landscape. Future research should expand to other academic disciplines to gain a broader understanding of Generative AI's impact across different fields of study. (OpenAI, 2024)

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Chapter 1 – Introduction:

1.1 Introduction

Artificial Intelligence (AI) has been in the background of education ever since the 1950s, when Alan Turing posed the question *"Can machines think?"*. The use of AI in education has largely been the realm of researchers looking for machine intelligence. This all changed after November 2022, when OpenAI launched ChatGPT as a free Large Language Model using (LLM) using Generative Pre-trained Transformer (GPT) technology to enable the generation of text in response to user queries.

The impact of ChatGPT and other Generative AI tools took the world of education by storm and the technology is still evolving rapidly and will continue to do so for the foreseeable future. Key areas of focus include assessment and academic integrity, its application in teaching and learning, its role as a time saving tool and its usage by students.

This paper will look at the potential benefits of incorporating Generative AI in assessments and classroom engagement for tertiary engineering students and educators.

1.2 Purpose of this research

This research explores the attitudes and perceptions of students and educators, in one Irish private college, towards integrating Generative AI tools into engineering education. As AI technologies continue to advance, it is crucial to understand how these tools can be effectively utilised in teaching and learning within the engineering field. By surveying both students and educators, this study aims to gain insights into the receptiveness of the various stakeholders and any potential pushback that may need to be taken by incorporating Generative AI into the curriculum. Ultimately, this study seeks to contribute to the ongoing discussion on the role of Generative AI in shaping the future of engineering education and ensuring that students are well equipped with the necessary skills and knowledge to thrive in a rapidly evolving technological landscape.

1.3 Research objectives

The original research question was broken down into three sub questions for the purpose of this research:

1. How are students and educators engaging with Generative AI in engineering education?

This question aims to understand the current state of Generative AI adoption and usage among students and educators in the field of engineering education.

2. What, if any, are the major benefits of integrating Generative AI into engineering education?

This question explores the potential advantages and any positive impacts of incorporating Generative AI tools into the engineering education curriculum and learning experiences.

3. What are the challenges of integrating Generative AI into engineering education?

This question investigates the potential obstacles, barriers, or limitations that may arise when attempting to integrate Generative AI into engineering education.

These three sub questions were then used to guide the literature review, inform the development of the student survey and semi structured interviews with educators and ultimately shape the findings of the overall research.

1.4 Research justification

Since the emergence of Generative AI in 2022 there have been concerns regarding accuracy, privacy, ethical issues and the impact on students' personal development, education and future career prospects. Educators and policymakers must understand student perceptions in order to tailor Generative AI integration effectively, addressing needs and concerns to promote positive learning outcomes. Therefore, developing well informed guidelines and strategies for the responsible implementation of Generative AI is critical for enhancing teaching and learning in tertiary engineering education.

1.5 Research Structure:

The study was guided by a thorough review of the relevant and up to date literature on the topic (see Chapter 2), which informed the research questions and the design of the data collection methods.

The literature review formed the foundation for this research, providing an overview of the current state of Generative AI within the context of education. This review helped to identify the key aspects and issues surrounding the use of Generative AI in engineering education, which were then used to guide the development of the research questions and the data collection.

To better answer the research questions, a mixed methods approach was chosen, combining both quantitative and qualitative data collection and analysis. This approach was selected to gain a more

complete understanding of the issues than could be achieved through either qualitative or quantitative methods alone (Creswell and Creswell, 2018, p.17).

The literature review was used to inform the development of a student survey, which provided quantitative data on student attitudes and perceptions towards the use of Generative AI in their engineering education. This survey allowed for the collection of a broader range of data from a larger sample of students, enabling the research to identify trends and patterns in student perspectives.

To gain insights from the perspective of engineering educators, a series of semi structured interviews were conducted with faculty members from the Bachelor of Engineering degree programme. These interviews provided qualitative data that added depth and context to the findings from the student survey, allowing the research to better understand the educators' experiences and concerns regarding the use of Generative AI in their teaching practices. By combining the quantitative data from the student survey with the qualitative insights from the educator interviews, the research was able to develop a more comprehensive understanding of the current uses of Generative AI in engineering education and the implications for both students and faculty.

Chapter 2 - Literature Review:

2.1 Introduction:

The Impact of Artificial Intelligence on Education

Artificial intelligence (AI) has been a rapidly evolving field since the 1950s, and its influence has begun to permeate the education sector. This literature review explores the history of AI and its mark on education, examining both the potential benefits and challenges that AI presents.

The review begins by tracing the development of AI from its early theoretical foundations to the emergence of powerful Large Language Models (LLMs) like ChatGPT. It then looks at the ways in which AI is being utilised in educational settings, such as generating quizzes, providing feedback on student work, and assisting with research.

The potential benefits of AI in education are numerous, AI tools can personalise learning experiences, cater to individual student needs and automate time-consuming tasks for educators. This review also acknowledges the challenges associated with AI use in education, including ethical concerns, data privacy issues, and the potential for bias. Currently there is much ongoing debate surrounding the use of AI in education, while some hail AI as a revolutionary force that can transform learning, others express concerns about its potential to erode critical thinking skills and academic integrity. The review emphasises the need for a thoughtful and measured approach to AI integration within education, ensuring that this powerful technology is used ethically and responsibly to enhance, not replace, human educators.

2.2 A brief History of Artificial Intelligence and its mark on education:

The evolution of Artificial Intelligence (AI) has been continuous since the 1950s, a period marked by the visionary insights of Alan Turing, the British polymath. In a paper written for the Mind Association in 1950, Turing considered the question "*Can machines think?"* (Turing, 1950). Turing theorised that the human capacity for utilising information and using this information in reasoned decision-making and problem-solving could be replicated by machines (Anyoha, 2017). However, computers of the early 1950s did not have the capability of storing commands, which is a basic requirement of AI, they could only execute them. Also, computing was in its infancy, hence only large corporations and prestigious universities could afford to experiment with computing.

2.2.1 The Emergence of Artificial Intelligence:

Pinpointing the exact beginning of any movement presents difficulties, yet the Dartmouth Summer Research Project of 1956 is commonly seen as the inaugural academic conference on AI and the pivotal event that propelled its recognition as a formal research field. John McCarthy is widely credited with coining the term "Artificial Intelligence" and for setting the course of the field, (Moor, 2006). His goal was to investigate methods for creating a machine capable of emulating human reasoning, exhibiting abstract thinking, problem-solving abilities, and self-enhancement. McCarthy's vision for the conference was:

> *"The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it."* (Moor, 2006).

2.2.2 AI and Education:

The first AI researchers were also cognitive scientists who wanted to comprehend and explore the processes of thinking and learning in both machines and humans. Shayan Doroudi, in a piece for The International Journal of Artificial Intelligence in Education, states that:

> *"The point is not just that they were cognitive scientists whose work had implications for education, but rather that these researchers were also at times directly involved in education research and had a significant impact on the course of education research"* (Doroudi, 2022).

In early 1971, Simon and Newell (1971, p.158) wrote a paper "Human Problem Solving: The State of the Theory in 1970," in it they state, *"It does not seem premature at the present stage of our knowledge of human problem solving to undertake large-scale development work that will seek to bring that theory to bear upon education".*

2.2.3 The Emergence of Big Data:

From the late 1990s significant advancements have propelled us into the era of Big Data, wherein the ability to understand meaningful patterns extends to very large datasets encompassing both structured and unstructured information from diverse origins (IBM, n.d.). Organisations leverage large-scale data (big data) within their systems to enhance their operational efficiency, deliver better client experiences, create tailored marketing strategies, this in turn boosts income and profitability. An article by Dr. Ben Daniel, (2015) in the British Journal of Educational Technology makes the point that big data can offer higher education institutions the predictive capabilities necessary to enhance

individual student learning outcomes and maintain high-quality academic standards in their education programmes. By developing programmes that systematically gather data throughout students' learning journeys, higher education institutes can tailor modules, assignments, feedback mechanisms, and learning pathways in the curriculum to cater to each student's needs, thereby creating more effective and comprehensive learning experiences. In the field of AI, machine learning has become the preferred approach for developing practical software applications in areas such as computer vision, speech recognition, natural language processing, robot control, and various other domains (Jordan and Mitchell, 2015).

Andreas Schleicher, Director for Education and Skills at the Organisation for Economic Co-operation and Development (OECD) stated in 2013 that,

> *"Big Data is the foundation on which education can reinvent its business model and build the coalition of governments, businesses, and social entrepreneurs that can bring together the evidence, innovation and resources to make lifelong learning a reality for all. So, the next educational superpower might be the one that can combine the hierarchy of institutions with the power of collaborative information flows and social networks."* (Schleicher, 2013, cited in Daniel and Butson, 2013).

A 2020 study purports that much of what is called AI for education is actually data analytics and so called AI tools are largely used for student selection, group behaviour, dropout tendencies and grade predictions, in other words mostly administrative tasks. The study claims that there is little evidence, except for learning analytics, of any meaningful use of AI in higher education (Bates *et al.*, 2020).

2.3 The Emergence of Large Language Models (LLM):

On the 30th of November 2022, OpenAI unveiled their preliminary demonstration model of ChatGPT, a milestone that redefined the benchmarks for artificial intelligence. Its launch and the publicity surrounding it served as a pivotal moment in reshaping people's views on AI. Previously dismissed as a mere science fiction concept relegated to the distant future, the emergence of ChatGPT has suddenly brought to light the reality and feasibility of AI to all (Benoit, 2023).

ChatGPT uses a machine learning framework known as Generative Pre-trained Transformers (GPT), initially introduced in 2017. It undergoes pre-training using extensive portions of internet data, loaded into a library of information, allowing it to generate text in reaction to user inquiries (Webb, 2024). The initial version of ChatGPT has no direct access to the internet and relies on its library of preloaded information to answer users' questions. Because it uses a finite set of information it does not have the ability to supply information past January 2022. Subsequently OpenAI have launched ChatGPT-4, a

subscription service, which has increased functionality and can access the internet for information as well as having a pre-trained cut-off date of April 2023. This model displays unprecedented capabilities in understanding context, discerning nuance and humour and mastering the intricacies of human language (OpenAI, n.d.). In a span of five days, the generative AI tool had garnered a user base exceeding one million (Marr, 2023) and currently at the time of writing this thesis has 1.7 billion views per month (Shewale, 2024). Predictably, major technology corporations swiftly followed suit, including Microsoft with its integration of Copilot into the Bing search engine, and Google with the integration of its version, Gemini (formerly Bard), into Google. Microsoft, which currently holds a 49% stake in OpenAI, uses ChatGPT-4 in its Copilot version. Indeed, access to ChatGPT-4 is free if accessed through Copilot with a Microsoft account. One major advantage with Copilot (as with ChatGPT-4 upon which Copilot is based) is that it will cite sources as to where it pulled the information from. However, as noted by Lukasz Bialozor, (2023) ChatGPT-4 and indeed all LLMs tend to produce information that can appear enticing but may be inaccurate or misleading. Bialozor, (2023) further explains that the cited sources provided are often untrustworthy and can be influenced by imagination or attributing credit to information it has obtained from other sources. This is commonly referred to as Hallucinating and as AI systems today are so complex, there is no real understanding of how these hallucinations occur. This led to over 1,000 tech leaders in March 2023, among them Elon Musk (a co-founder of OpenAI) and Steve Wozniak (Co-founder of Apple), calling for a pause on AI development. Stating AI developers are "*locked in an out-of-control race to develop and deploy ever more powerful digital minds that no one — not even their creators — can understand, predict or reliably control,"* (Metz and Schmidt, 2023).

We have been using AI in the common search engines we use every day. According to Justin Burr, (2023) from the Google AI team, Google uses AI to identify spam in e-mails, provide the most up to date routing in Google Maps, understand spoken words for Google Assistant through Natural Language Processing (NLP) and search for content within photographs using Google Photos, along with many other uses.

2.4 Generative AI in Higher Education:

Because Generative AI is such a recent phenomenon, there have not been too many, peer reviewed , evidence based, research studies into the impact that Generative AI is having on higher education. However, large language models like ChatGPT have suddenly become a powerful force in higher education due to their diverse range of applications. They have significantly impacted tertiary education from the standpoint of both students and academics. They can also present a valuable opportunity for academic learning designers to enhance their work. While these benefits can be

enjoyed by students, academics, and practitioners, it is crucial to address the challenges associated with their use, such as ethical concerns, data privacy, and potential biases (Rasul *et al.*, 2023).

There has been and will continue to be much debate over the use of LLMs within education. Audrey Watters, (2023), in her book, Teaching Machines, studies the history of educational technology, emphasising that it goes beyond mere technological aspects. She argues that educational technology mixes with human dynamics, market forces, political influences, cultural elements, and power structures both historically and in contemporary contexts. Watters, (2015), further explores the evolution of teaching machines from the twentieth century in a paper entitled, Education Technology and Skinners Box, highlighting key figures like B. F. Skinner and Sidney Pressey who contributed to the development of educational technology. She challenges the idea that computerised education is inevitable and highlights that technological progress is not the only driver of events in education. Her analysis shows that throughout history, so called teaching machines have consistently benefitted the creators of the technology, rather than genuinely serving the learners they purport to assist. This may be true of Open AI, as a Murgia and Hammond (2024) report in the Financial Times, outlines that OpenAI hit revenue of $2 billion in 2023 and secured a US$13 billion investment from Microsoft. They further highlight that this helps to give OpenAI a valuation of US$86 billion. Bear in mind that the company started as a not-for-profit research lab in 2015 and only added a business arm in 2020.

The rapid emergence of the LLM AI model has caused a certain amount of panic in third level institutions. A recent article in The Irish Times illustrates how the Irish academic standards watchdog Quality and Qualifications Ireland (QQI) sees AI tools as a significant threat to academic integrity (O'Brien, 2023). QQI is looking to extend misconduct legislation to cover the use of AI as well as asking education providers to review their own policies to mitigate the risks associated with its use. The National Academic Integrity Network (NAIN), which is a network of higher educational institutions, student representatives and other educational representatives coordinated by QQI and hosted on the QQI website, states in their NAIN Generative AI Guidelines for Educators 2023 paper,

> "*It is crucially important for everyone to be aware that these tools generally are based on mimicry and reproduction of content, style, and genre and are not always optimised to provide factually correct answers. Nor should their speed, conversational interface, and apparent quality of their output be taken as evidence of any 'intelligence' or subject expertise"* (QQI, 2023).

However not everyone agrees that AI should be condemned, more recently, the Regional VP for EMEA at Turnitin, Aaron Yaverski,(2023), has stated, "*There is a disconnect where we have students actively leveraging the tool and instructors who may not be familiar with it. We have to narrow the gap as we think about those policies".*

An August 2023 article in the Irish Independent highlights how many universities in Ireland are looking at the greater use of in-person written examinations or interactive oral forms of assessment as opposed to traditional continuous assessment methods such as essays (Donnelly, 2023). The article also comments on how QQI are funding eight research projects pertaining to AI with one looking at interactive oral assessments.

The European Commission, (2022) outlines that as AI systems undergo continuous evolution and as the expansion of AI usage persists, there is a growing requirement to cultivate a deeper understanding of its impact, particularly in the realm of education and training. The rapid rise in AI use requires that educators and learners acquire a foundational understanding of AI and data usage. This knowledge is essential for fostering positive, critical, and ethical engagement with the technology to unlock its full potential. Maphosa and Maphosa, (2023) maintain that the application of AI can help lecturers to adopt more effective methods of teaching that have the ability to consider individual learner's capacity and formulate assessments, grading systems and feedback. Nevertheless, there are extensive considerations regarding ethical deliberations that require attention from stakeholders, policymakers, educators, and learners. Along with the ethical considerations are issues of fairness, openness and transparency (Holmes *et al.*, 2022). Perhaps the biggest obstacle to implementing AI into further education is that historically education itself lags behind the technology and there is a reluctance to divert from traditional teaching methods (Wheeler, 2019)..

Rasul *et al.* (2023) argues it is evident that ChatGPT, functioning as an AI-driven tool, holds the capacity to help create a constructivist learning environment for students. A constructivist approach empowers them to delve into and test ideas, pose inquiries, and obtain prompt feedback, thus aiding in the construction of their individual understanding of knowledge. The constructivist perspective supports the view of providing students with an immersive environment where they actively construct their own knowledge rather than passively absorb it from external sources (Piaget, 1980), (Schunk, 2012). Extensive research supports the notion that the educational impact is greatly enhanced through this constructive process (Ploetzner *et al.*, 1999). AI can be employed effectively to scaffold the students' existing knowledge along with their experience and assist them in creating new knowledge. By providing specific feedback to the student, AI can suggest further learning along with other sources of information that the student can use to build on their existing knowledge base.

Regardless of one's attitude to AI, it is evident that AI is here to stay and with time and investment, its capabilities will only become more powerful. Soon it will be an integral function within our mobile phones, computers and software programmes such as Microsoft 365 (Mearian, 2024).

2.4.1 AI and Academic Search Engines:

Pinzolitis', (2023) recent article in the journal, MAP Education and Humanities, outlines that in the world of academic inquiry, novel AI driven search platforms have arisen. These platforms are tailored to search through scholarly literature and publications instead of performing broad based internet queries. Pinzolits, (2023) continues to discuss how AI tools that incorporate NLP, LLM and machine learning techniques are revolutionising the research process. These AI tools provide researchers and students with innovative methods to search, analyse, and summarise research articles, thereby opening new horizons for literature research.

It is important to note that conventional academic search engines such as Google Scholar use AI powered search algorithms to enhance search results. It can tap into a vast repository of over two hundred million articles but lacks the ability to retrieve metadata, (Shah, 2023). One of the newer academic search engines is Ought's Elicit.org which claims to search through 125 million academic papers and then summarises four abstracts that best match the enquiry prompt (Tay, 2023). Another recent addition, Scite.ai was launched in April 2023. It claims to have a database of over one billion citations scoured from academic papers (Liu, 2023). These are just two examples of the new academic search engines being developed. Other versions currently available include, Semantic Scholar which has a plugin called Semantic Reader claiming to,

> "*Create a better reading experience, Semantic Reader uses artificial intelligence to understand a document's structure and merge it with the Semantic Scholar's academic corpus, providing detailed information in context via tooltips and other overlays."*(Semantic, n.d.)

Also available are Connected Papers, Paper Digest, Research Rabbit, Copilot, Google Scholar, ChatGPT and Perplexity, (Xiao, 2024).

2.4.2 AI as a Teaching Aid:

Currently educators are using AI to assist in the development of quizzes, lesson plans, rubrics, slide presentations, and even exam questions for learners. In some instances, school teachers are making use of AI to create feedback to deliver to their learners (Langreo *et al.*, 2023). Already there are commercial education tools such as chatbots and virtual assistants offering round the clock personalised support to learners (Omowaire, 2023). However, one of the largest problems for educators, particularly at third level is in the grading and assessment of learners' work, coupled with the increasing requirement for timely formative feedback to the learner (Banta and Palomba, 2014). AI grading systems eliminate the potential impact of human biases on the grading process. By adhering

to predetermined algorithms and criteria, these systems ensure that each learner's work is assessed impartially and without any inadvertent bias that could manifest itself in human corrections (The Princeton Review, 2024). Consequently, the evaluation process becomes neutral and equitable. The true efficacy of AI grading lies in its capacity to deliver personalised feedback to individual learners. These systems can assess learners' strengths and weaknesses by thoroughly analysing their responses. Such tailored feedback empowers learners to focus on improving weaker areas while reinforcing their strengths (The Princeton Review, 2024).

A recent publication for the World Economic Forum noted that, in an AI driven world the essential skills for students remain uncertain, yet a crucial starting approach involves developing a basic understanding of AI that encompasses its functionality, capabilities and constraints, (Zahidi, 2023). This means moving beyond traditional forms of assessment like essays and problem exercises towards more advanced, modern, and relevant deliverables. Examples of these could involve developing operational prototypes, software applications, or other tangible creations, thereby enhancing learners' readiness for the future stages of their lives and careers (Acar, 2024).

Alnaqbi and Fouda (2023) determine that education, when integrated with AI and social media, faces the challenge of navigating the vast amount of online information that ranges from authentic and reliable to misleading or false. These AI powered tools can serve various functions, acting as knowledgeable tutors or assistants focused on delivering support, with the aim of enhancing students' competencies, boosting motivation, and improving the overall educational experience.

2.4.2.1 Automatic Essay Scoring:

AI can be of assistance to educators by automating some of the repetitive tasks. One such assistant is Automated Essay Scoring (AES). These systems have been in research since the 1960's and today most of the United States schools are using AES systems (Ramesh and Sanampudi, 2022). Some of these systems work with both formative and summative assignments and can provide feedback to the learners as well as providing opportunities for essay writers to improve their writing skills. The University of Michigan has been developing its own M-write programme since 2015, with the aim of providing feedback to students on their written work (Brown, 2017). Joshua Wilson, assistant professor of education at the University of Delaware states *"People who outright reject these systems forget what the status quo is. Unfortunately, we know that instructors don't give enough feedback, often because the teacher-student ratio is such that they don't have time."* (Wilson, c.f., Brown, 2017). The ability to scale up AES systems is a major advantage, particularly in the realm of Massive Open Online Courses (MOOCs) as well as various other digital learning platforms. All of these AES systems have challenges and depend hugely on machine learning and the algorithm used but still need to take

a collection of words and assess it for relevance to the question asked, coherence, cohesion and overall subject knowledge (Ramesh and Sanampudi, 2022); (Digisaksham, 2023). It must be acknowledged that Generative AI models are only as good as the data they are trained on, and if the training data contains biases, the model will also be biased. For example, if a model is trained on a dataset of essays that are primarily written by students from a certain demographic, it may not be able to accurately grade essays written by students from other demographics (Baidoo-Anu and Ansah, 2023). One study showed that a generative AI model that is trained on a large collection of text from the internet exhibited gender bias in its language generation (Bolukbasi *et al.*, 2016). The research community is exploring ways to make AES more transparent, accountable, fair, unbiased, and trustworthy while maintaining high accuracy levels (Kumar and Boulanger, 2020). Despite their efficiency, AES systems are most effective when used as part of a broader assessment strategy that combines automated scoring with human judgment and feedback (Dwivedi *et al.*, 2023); (Kumar and Boulanger, 2020).

2.4.2.2 Automatic Question Generation:

Automatic Question Generation (AQG) is a field within Natural Language Processing (NLP) and AI that focuses on automatically generating questions from text-based content. AQG systems can be valuable tools for educators, content creators, and assessment developers, as they can rapidly generate a variety of questions to assess comprehension, stimulate critical thinking, and support learning activities, while also providing immediate feedback to students, (Bachiri *et al.*, 2023, p.8). AQG facilitates the generation of a large variety of quizzes, allowing for their rotational use and ensuring wide ranging assessment of recall across different knowledge domains. Question generators can be added to learning management systems such as Moodle through plugins like Moodle Quiz. Moodle describes the quiz as "*a very powerful activity that can meet many teaching needs, from simple, multiple-choice knowledge tests to complex, self-assessment tasks with detailed feedback."* (Moodle, n.d.).

2.4.3 AI as a Student Assistant:

One advantage of ChatGPT and other Generative AI models, lies in the ability to assist students by generating ideas for assessments, research, analysis, and writing tasks, potentially enriching their overall education (Saini, 2023). Students can use the capabilities of advanced Generative AI to offer structured explanations of more complex concepts. Generative AI can function as a virtual tutor, offering responses to students' inquiries and expanding on a diverse array of subjects. This resource proves especially beneficial for students who encounter difficulties with specific topics or who need

additional assistance outside of traditional classroom settings, (Baidoo-Anu and Ansah, 2023). However, it is important to recognise the potential downsides, including the risks of academic misconduct, bias, the spread of inaccurate information, and insufficient assessment design, all of which can restrict the development of vital graduate skills and encourage surface-level learning. As a result, it is crucial for both third level educators and students to exercise vigilance and guarantee the ethical, trustworthy, and proficient use of this technology within academic settings (Limna *et al.*, 2023).

The pervasive popularity of Large Language Models (LLMs) like ChatGPT, Bard, and Copilot is in part attributed to their user-friendly interfaces and the remarkable capacity to furnish thorough and pragmatic responses to a diverse array of inquiries. Since its launch, ChatGPT and other LLMs, have become a hit with learners and a problem for educational institutions, (Barnett, 2023). The ability to produce written work on almost any subject with just a few clicks on a keyboard, coupled with their free access, has emboldened learners to explore their capabilities. A recent publication in the Irish Journal of Technology Enhanced Learning showed just how easy it is to generate academic material with citations and references, which when checked on Google Scholar were for the most part valid and appropriate publications if somewhat dated, (Donlon and Tiernan, 2023). Indeed the capacity of these AIs to produce messages, blogs, reports, songs, and virtually any textual form played a significant role in prompting the Writers Guild in America (WGA), commonly known as scriptwriters, to initiate a strike in 2023 (Coyle, 2023).

Recent studies have evaluated ChatGPT's performance in educational settings, particularly in short-answer assessments. While ChatGPT was able to generate responses that passed assessment problems, it primarily outperformed underperforming medical students and faced challenges in more complex cognitive reasoning tasks. This poses a risk to these underperforming students in that by using generative AI tools such as ChatGPT, their tutors may not recognise that these students are struggling (Morjaria *et al.*, 2023).

It is important to acknowledge that these LLMs do not “know” anything or understand anything in the way that a human does, (Marcus *et al.*, 2023). Humans build knowledge based on experience or explicit knowledge and we combine it with tacit knowledge that is codified in some manner. We then use language to relay that experience and knowledge to others so they may learn from others’ experiences (Nonaka, 1994). Recent advancements in AI have led to the development of powerful applications that can generate synthetic language and realistic images based on textual prompts. These applications, such as ChatGPT, DALL·E 2, Imagen, and Stable Diffusion, have captured the public's attention and imagination, (Marcus *et al.*, 2023). Bear in mind that Generative AI tools do not inherently produce factual content, instead, they generate text based on the associations between

words (Lee and Soylu, 2023). The responses from Generative AI can vary in accuracy, relevance, and logic depending on how the query is posed, potentially leading to incorrect, outdated, or illogical outputs. They have no aptitude for common sense and will use language to create something that sounds plausible even though our experience tells us that it is complete nonsense (Jiang *et al.*, 2021). As AI develops more, Naveed et al. (2024) explains that these LLMs can now exhibit remarkable capabilities like reasoning, planning, decision-making, contextual learning and recognition of concepts or scenarios without having seen any examples before, commonly called zero-shot scenarios. These abilities are believed to arise from the immense scale of these LLMs, even when they are not explicitly trained for these tasks.

2.4.4 AI and Innovative Assessment Activities:

Generative AI has received recognition for its capacity to create assessment questions, design lesson plans, and develop curricula within the realm of higher education (Dwivedi *et al.*, 2023). The challenge lies in creating learning environments that not only offer engaging learning experiences but also generate accurate data for assessing the students' progress. This requires design of activities that are both effective for learning and capable of providing detailed assessment data to support the students learning (Zhai, 2022). Melissa Bowden, (2023), outlines some examples where students are asked to research a particular subject and document their findings. They can engage Generative AI by presenting inquiries and subsequently analysing the responses provided. Because not all Generative AI responses may be true, how do the students verify the responses they are given. This fosters the use of the students critical thinking skills by using the information from Generative AI as a supplementary educational tool.

Gamification can be utilised to motivate and influence behaviour, thereby enhancing the learning experience in higher education, by the application of game elements to non-gaming situations (Murillo-Zamorano *et al.*, 2021). Harve, (2023) explains that AI tools can help teachers create engaging assessments and provide automated feedback on students' performance. These can be in the form of in-class quizzes and by receiving instant feedback on their scores, this encourages students to learn from their mistakes and improve their performance to climb up the dashboard in future quizzes.

2.4.5 AI and inclusivity for students:

Lazányi, (2023), highlights the fact that educators bear a pivotal responsibility to empower individuals from diverse backgrounds or with disabilities to actively participate in and successfully complete higher education. This task requires dedication and additional efforts to extend educational opportunities and assistance to disadvantaged or marginalised students. By doing so, educators

facilitate their progression alongside their peers and enhance their socio-economic prospects. Prioritising students with disabilities is particularly critical. Crafting personalised study plans and resources tailored to their unique needs ensures that they can overcome learning challenges within conventional educational frameworks, (Woods, 2018). Recent advancements in AI are opening new avenues for aiding and facilitating individuals facing various learning obstacles. These technological innovations promise to transform education, making it more inclusive and accessible for all. AI can help by offering text-to-speech and speech-to-text tools. These tools enable individuals to access and create written content. AI can also enhance accessibility, support communication and social skills, provide reminders and feedback, and develop specific skills through targeted interventions (Daniel, 2024). As outlined at the 2023 World Economic Forum in Davos, AI can play a crucial role in helping individuals overcome learning challenges, (Kopp and Thomsen, 2023).

2.4.6 AI in the Workplace of Today, an Engineering perspective:

As technological advancements persist, educational institutions must evolve to embrace emerging learning methods and equip students with skills that are relevant to today's work environments. The integration of Generative AI into graduate education presents a unique opportunity to equip students with the necessary skills to effectively utilise and apply large language models in the workplace. This incorporation of AI can help graduates adapt to the changing job landscape, where some positions may be replaced by AI while also creating new opportunities for employment (Cradle, 2023). Marr, (2024) notes that ChatGPT and similar Generative AI models have the potential to assume various roles currently occupied by humans, such as junior reporters, speechwriters, researchers, marketing personnel, and legal professionals involved in document processing and summary. This technology can manage tasks like data entry, transcription, translation services, basic customer service inquiries, and content creation. Marr, (2024) also predicts that this trend suggests a possible transformation in the job market, with AI potentially replacing positions typically held by lower-paid workers or outsourced service providers.

Pareek, (2023), identifies that engineering professionals are facing increased demand to leverage data for informed decision making as AI and machine learning technologies become more prevalent in the industry. Consequently, many engineering programmes are integrating additional data analysis and visualisation techniques into their curricula. This shift aims to equip students with the skills needed to collect, analyse, and interpret evidence effectively to make sound decisions.

Barry, (2023) comments that the combination of Generative AI with continuous process improvement is transformative. Generative AI mines data, extracts actionable insights, and serves as a catalyst for process evolution. From identifying bottlenecks to suggesting re-engineering and automation

opportunities, this synergy enables organisations to optimise their workflows and achieve greater efficiency.

Nunez and Lantada, (2020), outline how AI plays a crucial role in advancing engineering science, technology, and research. This is evident in recent breakthroughs such as autonomous cars, collaborative robots, unmanned aircraft systems, self-managed manufacturing systems, data management, machine optimisation and material design. It is imperative for engineering educators to educate students on the capabilities of AI, impart fundamental knowledge in this domain and facilitate the application of AI technologies in real engineering projects. These elements are essential components of contemporary engineering curricula.

While the advantages of these Generative AI tools for businesses have been extensively covered by numerous media sources, it is crucial to grasp the limitations of Generative AI. The limitations can include potential risks to reputation and legality, such as the generation of offensive or copyrighted content, breaches of privacy, involvement in fraudulent activities, and dissemination of misinformation (Dwivedi *et al.*, 2023).

Generative AI capabilities are making significant strides in providing workplace productivity tools. These AI based tools can assist users with various tasks such as writing emails, drafting reports as well as developing concepts and proposals (Thiga, 2024 ; McKinsey Digital, 2023). It is essential to recognise that while these tools aim to enhance efficiency, they may inadvertently reduce users' critical thinking skills when it comes to their writing. McKinsey, (2023) further highlights that while these tools can lead to substantial time savings and productivity gains, the benefits will vary based on the task complexity and the users' experience of using the tools. McKinsey, (2023) also maintains that to leverage Generative AI, a structured approach involving training, coaching, case selection, workforce upskilling and risk controls is recommended.

Dede *et al.*, (2021) notes that as AI becomes increasingly proficient in calculation, computation and prediction, there will be a growing demand for human judgement skills such as decision making under conditions of uncertainty, deliberation and practical knowledge.

2.5 Current research on Generative AI in tertiary engineering education:

There have been many studies concerning the use of AI in educational use, Ahmad *et al.*, (2020) outlines various surveys that target specific areas where AI can be applied to education. More recently Qadir, (2023) notes that with Generative AI models such as ChatGPT, having been recently released in November 2022, there is a scarcity of research specifically focused on engineering education, despite the abundance of studies related to their application in general education. Qadir, (2023) notes in his

conclusion that engineering education and the engineering profession will inevitably embrace AI tools, thereby necessitating the further evolution of assessment strategies to deter unethical behaviour while enabling the productivity potential they offer. A more recent article (Yelamarthi *et al.*, 2024) outlines how Generative AI is instrumental in the different fields of engineering education as it can tackle the hurdles associated with creating and delivering educational content. The article outlines that to enhance educators' ability to effectively incorporate Generative AI in their teaching, it is essential to implement ongoing faculty training and professional development initiatives. These programmes should emphasise both the technical proficiency required to utilise Generative AI and the pedagogical strategies necessary for integrating AI-generated content into classroom instruction.

An article in the European Journal of Engineering Education benchmarked ChatGPT against various assessments used in engineering education. The reported results are:

> "*Analysis was undertaken both subject-by-subject and by assessment type. Strengths, weaknesses and opportunities presented by ChatGPT were discussed. In a subject-by-subject analysis, ChatGPT passed three, failed five, and two subjects were too close to call. When it came to assessment types, ChatGPT passed four, failed three, and two types were tied. Therefore, the discussion becomes more on the types of assessments used in a subject, rather than if ChatGPT is better at one subject area or another"* (Nikolic *et al.*, 2023).

The author determines that as engineers, it is essential to adopt tools that enhance our efficiency and productivity. Just like we integrated calculators as educational tools instead of log tables and slide rules, we should similarly incorporate AI technology to enable us to work smarter and more effectively.

Chapter 3 – Research Methodology:

3.1 Introduction:

The research aim is to explore the potential benefits of incorporating Generative AI in assessments and classroom engagement for tertiary engineering students and educators. In order to examine this research project there are three basic questions that must be addressed.

1. How are students and educators engaging with Generative AI in engineering education?
2. What, if any, are the major benefits of integrating Generative AI into engineering education?
3. What are the challenges of integrating Generative AI into engineering education?

Check and Schutt, (2012, p,160.) define survey research as *"the collection of information from a sample of individuals through their responses to questions".*

As outlined by Creswell, (2009) the purpose of research is to examine the underlying philosophy that guides the research questions, the methodologies employed in the data collection, and the specific design of these methods. Additionally, it will explore the ethical considerations surrounding the research and highlight any limitations that may have been identified in conducting the research.

3.2 Research Philosophy:

Research designs serve as the foundation for any research project, acting as a detailed roadmap that outlines the various components of the research process. Crafting a research design involves making several crucial decisions, which do not necessarily need to follow a strict linear or sequential order. Creswell, (2009), notes that the choice of research design depends on several factors, including the nature of the research problem or question, the researcher's personal experiences and expertise, and the intended audience for the study. The use of a mixed methods approach necessitates the understanding of quantitative and qualitative approaches.

Creswell, (2009) refers to differing philosophies as worldviews, others refer to paradigms or epistemologies to describe a *"basic set of beliefs that guide action"* Guba, (1990, p.17).

The following three sections look at the three main philosophical approaches.

3.2.1 Quantitative Research Philosophy:

A quantitative worldview is largely represented with a positivist/postpositivist view. A positivist worldview is a philosophical perspective that views the world as objective and measurable, and that

knowledge can be gained through empirical observation and scientific methods, (Dudovskiy, 2011). Spencer *et al.* (2020), describe how positivism is founded on the belief that there exists an objective truth or reality that is separate from our beliefs and interpretations, that can be discovered through direct observation and experience. In this worldview, science tries to establish universal laws governing nature and in psychology, universal principles of human development and experience. The acquisition and trust in this knowledge rely on adhering to systematic methods that allow for the verification of claims about truth. As outlined by Cohen *et al.*, (2017), positivism faces challenges in the study of human behaviour, because the intricate and multifaceted nature of human beings and the complex characteristics of social phenomena contrast with the predictable and structured patterns found in the natural world. Whereas, in post positivism it is widely acknowledged that our understanding of the world is shaped by social constructs, leading to inherent biases in our perceptions, (Phillips and Burbules, 2000). Due to the influence of individual and cultural biases, all observations are subject to error. Creswell and Creswell, (2018) propose that while absolute certainty in reaching the truth may be unattainable, proponents of post-positivism advocate for persistent efforts to approach the truth to the best of our abilities. This worldview is rooted in the belief that knowledge is based on identifying causes that influence outcomes, often using experiments and reductionistic approaches to test hypotheses.

According to Creswell and Creswell, (2018), quantitative approaches largely fall into two categories of survey.

- Survey research is a method of quantifying the prevailing trends, viewpoints, and feelings of a larger population by analysing a smaller subset of that population.
- Experimental research aims to establish whether a particular treatment affects an outcome by administering the treatment to one group and withholding it from another, then comparing the outcomes of both groups.

3.2.2 Qualitative Research Philosophy:

A qualitative worldview is based on various philosophical approaches that shape its methodology and underpin its fundamental principles. Some of the major overarching philosophical approaches of qualitative research include post-positivism, constructivism, critical theory and feminism, (Spencer *et al.*, 2020, p.83). Creswell, (2007, p.16) highlights that these philosophical perspectives influence the ontological (nature of reality), epistemological (nature of knowledge), and axiological (values) assumptions that guide a qualitative worldview. Post-positivism emphasises the importance of understanding the context and complexity of phenomena, while constructivism focuses on the

subjective nature of reality and the role of interpretation in research. Critical theory aims to uncover power dynamics and social inequalities and feminism emphasises gender perspectives. Creswell and Creswell, (2018, p.17) outline that a qualitative approach is based on a constructivist worldview employing an ethnographic design to observe behaviour. This is achieved through a narrative design with open ended questioning.

Creswell and Creswell, (2018, p.13) further identify five main strategies for conducting qualitative research.

- Narrative research is an investigative approach where the researcher delves into the experiences of individuals, inviting one or more participants to share personal stories about their lives.
- Grounded theory where the focus is on understanding the meaning and significance of social phenomena from the perspective of those who experience them.
- Ethnography is an investigative approach where the researcher immerses themselves in a real-life cultural setting for an extended duration, gathering data predominantly through observations and interviews.
- Case studies is a strategy of inquiry that involves a researcher deeply examining a specific programme, event, activity, process, or individual. The research often involves multiple sources of data, such as interviews, observations, and documents.
- Phenomenological research is an investigative approach in which the researcher uncovers the fundamental nature of human experiences related to a specific phenomenon by gathering descriptions from research participants.

3.2.3 Mixed Methods Research Philosophy:

Creswell and Plano Clark define mixed methods research as:

> *"Mixed methods research is a research design with philosophical assumptions as well as methods of inquiry. As a methodology, it involved philosophical assumptions that guide the direction of the collection and analysis of the mixture of quantitative and qualitative approaches in many phases of studies. Its central premise is that the use of quantitative and qualitative approaches, in combination, provide a better understanding of research problems than either approach alone".* (Creswell and Plano Clark, 2011, p.5)

Mixed methods researchers acknowledge that while both quantitative and qualitative methods possess limitations, they believed that the biases present in one method could counterbalance or offset the biases found in the other method (Creswell and Creswell, 2018, p.14).

Alele and Malau-Aduli, (2023) identify that two primary philosophical foundations for mixed methods research are Pragmatism and Realism. These positions are commonly seen as dialectical stances that connect postpositivist and social constructivist worldviews, blending pragmatic and transformative perspectives.

- A pragmatic viewpoint involves utilising effective methods, embracing diverse strategies, giving importance to the research problem and question, and recognising the value of both objective and subjective knowledge.
- Realist approaches emerged primarily in reaction to a recognised necessity for research that could directly benefit policymakers. These methodologies delve into the underlying dynamics of intricate social situations, aiming to uncover the hidden mechanisms at play.

Mixed-methods researchers integrate worldviews that facilitate exploration from both inductive and deductive perspectives, that enable the combination of theory-building and hypothesis testing within a single study, (Ruark and Fielding-Miller, 2016).

Integrating qualitative and quantitative data can provide several key advantages in research and analysis:

- Qualitative data can be leveraged to assess the validity and accuracy of quantitative research findings.
- Quantitative data can inform and guide the selection of samples for qualitative research.
- Qualitative research can be used in conjunction with quantitative data to help explain and contextualise research findings.

In conclusion, integrating qualitative and quantitative data can strengthen research by enhancing validity, guiding sample selection and providing a more complete explanation of findings. By leveraging the strengths of both data types, researchers can gain a richer, more nuanced understanding of complex social phenomena, (Creswell and Creswell, 2018, p.17).

3.3 Research Approach:

In looking at the three methods of research identified above, it was decided that a mixed methods approach would be the most appropriate in order to address the primary research inquiry. The study aims to explore:

1. How are educators and students integrating Generative AI technologies into engineering education?
2. What are the major benefits of integrating Generative AI into engineering education?
3. What are the challenges of integrating Generative AI into engineering education?

The goal is to assess the perspectives of engineering students and educators regarding the implementation of Generative AI in engineering education. To achieve a balanced overview between students and educators, a mixed methods approach was developed to thoroughly examine the research question. Creswell and Creswell, (2018) explain that mixed methods research is a comprehensive investigative approach that entails gathering quantitative and qualitative data, merging these two types of data, and employing unique designs that may include philosophical beliefs and theoretical structures to gain additional understanding about the data collected. At the heart of this methodology lies the fundamental belief that combining qualitative and quantitative data results in deeper insights that go beyond what each type of data gathered could offer independently.

Quantitative data was obtained through a student survey distributed to Industrial Engineering degree students. Qualitative data, on the other hand, was gathered through semi-structured interviews with the teaching staff of the engineering faculty.

The integration of quantitative and qualitative research methods involves all aspects of the research process including the philosophical position and the conclusions drawn from the resulting information.

3.3.1 Research Objectives:

The study aims to explore the potential benefits of incorporating Generative AI in assessments and classroom engagement for tertiary engineering students and educators. A mixed-methods design was employed, starting with the collection of quantitative data followed by a detailed analysis of the quantitative results through qualitative data.

3.3.2 Study Phases:

1. Quantitative Data Collection: The initial phase involved gathering survey data from engineering students to assess their attitudes towards the potential utilisation of Generative AI in their educational experience.

2. Qualitative Exploration: The subsequent phase delved deeper into the potential benefits of Generative AI by engaging with engineering faculty educators. This phase aimed to uncover the potential advantages and highlight any downside of integrating Generative AI in teaching practices through qualitative insights and discussions.

3.3.3 Quantitative Data Collection – The Student Survey:

Based on the literature review in chapter 2, a pilot quantitative survey regarding student attitudes to the use of Generative AI in third level Industrial Engineering education was developed and tested with a small group of students to assess their comprehension of the questions asked. On review of the pilot the final survey consisted of 19 closed-ended questions and a final open-ended question that asked if there was anything else they would like to share around their experiences with Generative AI as it relates to their engineering education? A five-point Likert scale was used to measure the students' attitudes to the use of Generative AI within their engineering studies.

Ethical approval for this research was obtained from the MAELD Faculty Ethics Committee (see appendix A). The Programme Director for the Engineering Faculty within Griffith College was asked for permission to distribute the survey among the current engineering students on the Bachelor of Engineering in Industrial and Systems Engineering (BEISE) course. One cohort started their degree in February 2023, another cohort started their degree in September 2023 and the third cohort started their degree in February 2024. Permission was granted and a Survey Participant Information Sheet (see appendix B) along with a link and QR code to the survey was emailed to 168 students (see appendix C) in April 2024. The survey was entirely voluntary and no student was asked to provide any information that could identify them. The survey was sent out to three cohorts all studying for their BEISE degree. These three cohorts were chosen because they are all current students within the Engineering faculty in Griffith College. It was decided not to ask any students that had completed their engineering degree as Generative AI only emerged in November 2022 and therefore was not available for the entire course of study to previous cohorts.

The student survey collection results were collected (see appendix D)

3.3.4 Qualitative Data Collection – With Faculty Educators:

Semi-structured interviews were conducted with three teaching staff members of the BEISE degree programme. These staff members interact with students at different points during their academic journey and are tasked with both setting and grading assignments and exams for the modules they teach.

Based on the answers received from the students in the quantitative data collection phase, a set of eight questions was developed to further explore the possible benefits of using Generative AI in engineering education from the perception of the educators.

Each participant was sent a Participant Information Sheet (see appendix E) along with a Consent Form (see appendix F) and a list of the Interview Questions (see appendix G). The purpose of providing the interview questions in advance was to allow the interviewee time to prepare their responses. This was done in the hopes that the interviewee would be able to formulate thoughtful, on-topic answers without veering too far from the subject matter being discussed. By structuring the interview in this way, the goal was to facilitate a more productive, focused, and informative discussion between the researcher and the interviewee.

The interviews were conducted over Zoom and with the permission of each interviewee, recorded to the researcher's computer for transcribing. The same eight questions were posed to each of the interviewees but because it was a semi structured interview it allowed the researcher to follow up on some answers with a supplementary question to aid clarification of the answer given. The video recording of each interview allowed the researcher to observe nonverbal clues and reactions to the questions being asked. Each interview was scheduled to last 30 minutes.

Once the interviews were transcribed (see appendix H), a thematic review of the text was undertaken to identify targeted insights and recurring themes related to the research, aiding in the formulation of research hypotheses and enabling a more detailed analysis of specific aspects of the research question.

3.4 Analysing the Data:

Once the quantitative data from the two surveys was collected it was analysed. This took the form of numerical information as gathered in the quantitative student survey or coded textural information as collected in the semi structured qualitative survey of the educators.

3.4.1 Quantitative Analysis of the Student Survey:

The quantitative data was analysed and displayed in graphical format complete with a numerical breakdown of the findings for each question asked. This allowed for a statistical interpretation of the collected data (see appendix D for the numerical data).

3.4.2 Qualitative Analysis of the Semi Structured Interviews with Faculty Educators:

The three interviews conducted with the engineering educators were transcribed using the Dictate function contained within Microsoft Word. Once the interviews were transcribed it was possible to subject each interview transcript to a thematic review or coding process. This is a fundamental process that involves systematically categorising and organising excerpts from the transcribed data to identify themes and patterns. This process is essential to make sense of the data received in the qualitative survey and develop meaningful theories from the answers received. (see appendix H).

3.5 Limitations of this Research:

This research was conducted in Griffith College with three cohorts of the Bachelors Degree in Industrial and Systems Engineering (BEISE). As such it is limited to just Griffith College engineering faculty and only the field of Industrial Engineering. Therefore the results are somewhat limited and more akin to a case study.

The students involved in this research are all mature students and varied in age from 23 to over 50 years and come from differing backgrounds including their prior level of education.

3.6 Validity and Reliability of the Research:

As outlined by Zohrabi, (2013) "*It is believed that using different types of procedures for collecting data and obtaining that information through different sources (learners, teachers, programme staff, etc.) can augment the validity and reliability of the data and their interpretation"*

By utilising perspectives from both the students and the educators it is hoped that a broad understanding of the potential benefits of incorporating Generative AI into engineering studies could be achieved that was both valid and reliable.

For the purpose of the quantitative student survey, Survey Monkey was utilised to create the survey. Creswell and Creswell, (2018, p. 153) highlight the validity of using this instrument as it facilitates data

collection and creates graphical diagrams of the collected data along with organised spreadsheets that facilitate data analysis while eliminating any possible data entry errors associated with manual entry.

- The student survey was distributed to 168 students currently enrolled in the BEISE (Bachelor of Engineering in Industrial and Systems Engineering) course at Griffith College.
- The survey was sent to all students via email at the same time.
- The students surveyed were either just starting the BEISE programme, halfway through their studies, or in the final stage of the programme.
- Participation in the survey was anonymous and voluntary.
- A total of 53 students participated in the survey out of the 168 students who were invited.

For the qualitative survey with the faculty educators, three educators were selected to participate in the survey.

- These educators were chosen to represent a diverse range of subject modules taught within the BEISE degree course.
- This diversity ensured that the survey captured perspectives from faculty members across different disciplines and course content.
- The semi-structured interview questions were designed to reflect some of the key questions asked in the student survey.
- This approach allowed for triangulation of the data, providing insights into the perspectives of both students and faculty educators on various aspects of the BEISE programme.
- By incorporating questions that mirrored the student survey, the qualitative interviews enabled a deeper understanding of the educational experience from the educator's point of view. This allowed for a more comprehensive analysis.
- The semi-structured format of the interviews also provided flexibility, allowing the educators to share additional insights and perspectives that may not have been captured in the student survey.
- The same set of questions was posed to each educator. However, due to the semi-structured nature of the interview this permitted the researcher to probe further into some of the answers given.
- This open-ended approach facilitated a rich dialogue and a more holistic understanding of any potential benefits of incorporating Generative AI within the engineering curriculum.

3.7 Ethics:

Prior to conducting this research ethical approval was sought from and granted by the Griffith College MAELD Faculty Ethics Committee.

All data collected for the purpose of this study was collected from Griffith College students and educators with the Engineering Faculty.

Informed consent is crucial in social research surveys to respect participant rights, minimise risks, maintain public trust, fulfil legal requirements and enable participants to make informed decisions about their involvement. Failing to obtain informed consent can undermine the ethical integrity of the research (Cohen and Manion, 1994, p.350).

All participants in the student survey were notified that their participation in the survey was entirely voluntary and that they would not be required to provide any identifying information. One question did ask for their age within categories of five years, so no individual could be identified.

As the researcher is an educator and thus responsible for awarding exam and assignment marks on the BEISE degree programme within Griffith College, it was crucial that no element of coercion could be attributed to participating in the survey. Therefore, the anonymous and voluntary aspects of participating in the survey were emphasised in the Survey Information Participant Sheet (see appendix B). In parallel with anonymous and voluntary aspects of the survey, the students were also informed that they could withdraw at any point without the need to provide any explanation as outlined in The British Educational Research Association, Handbook, (BERA, 2018).

For the qualitative survey with the engineering faculty educators a semi-structured interview process was conducted. The survey participants were informed of their GDPR rights as well as the anonymous nature of the survey. While their identities are known to the researcher, they will be anonymised in any presentation of the survey results by representing them as Educator 1, Educator 2 etc. Each participant was asked to sign a consent form prior to their interview.

Chapter 4 – Presentation of Results

4.1 Introduction:

This chapter reports the analysis findings from the engineering student survey questionnaire and the semi-structured interviews conducted with engineering educators. These findings will be compared to the information gathered during the literature review in Chapter 2.

The literature review highlighted areas where Generative AI can be used to enhance student learning and support both teaching and learning using quizzes, lesson plans, rubrics, slide presentations, and even exam questions. Additionally, Generative AI has the capability to provide feedback on student assignments. Students are rapidly recognising the ability of Generative AI to aid in research, analysis, and writing tasks, effectively functioning as a virtual tutor. The student survey aimed to gather students' opinions on their acceptance and use of Generative AI as a potential tool to support their engineering education. The semi-structured interviews with engineering educators sought their opinions on the use of Generative AI from their perspective.

4.2 Quantitative data from the student survey:

The student survey was distributed to 168 students currently enrolled in the Bachelor of Engineering in Industrial and Systems Engineering (BEISE) with the Engineering Faculty in Griffith College. These students are all mature students and almost all are currently employed within industry. The students are spread throughout Ireland and all lectures are conducted over the Zoom platform. The students were not asked about their nationality or gender. Overall, there are approximately 20% international students and the gender balance is roughly 10% female. The quantitative student survey was completed by 53 students. All students answered all the Likert scale questions and 21 students added comments to the question “Is there anything else you would like to share around your experiences with Generative AI as it relates to your engineering education”?

The complete breakdown of how students answered the student survey, including their comments is laid out in appendix D.

4.2.1 Students age groups:

Students were asked to identify what age bracket they fell within.

RESPONSES		
18-24	2	3.77%
25-30	6	11.32%
31-35	13	24.53%
36-40	13	24.53%
41-45	5	9.43%
46-50	9	16.98%
51+	5	9.43%
TOTAL	53	

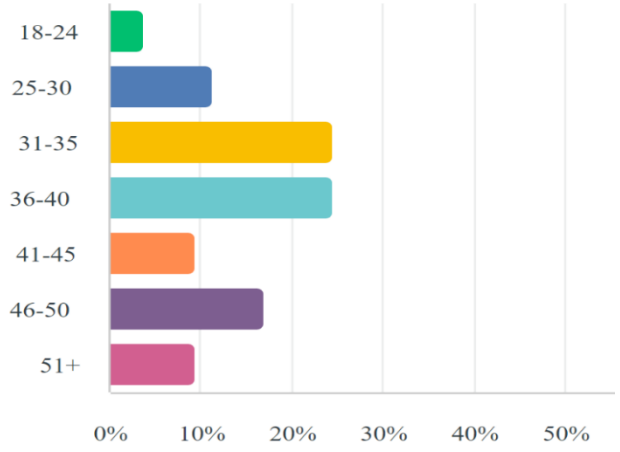

Figure 1.

Looking at the above table of ages (Figure 1) it can be calculated that the average age of all respondents to the study was approximately 38.

This contrasts with the HEA Trends in Mature Student Participation (HEA, 2021) report for the years 2017 / 2018 which reported that only 20% of mature students were aged over 40. See figure 2 below.

Age of Mature Students in HEIs, 2017/18

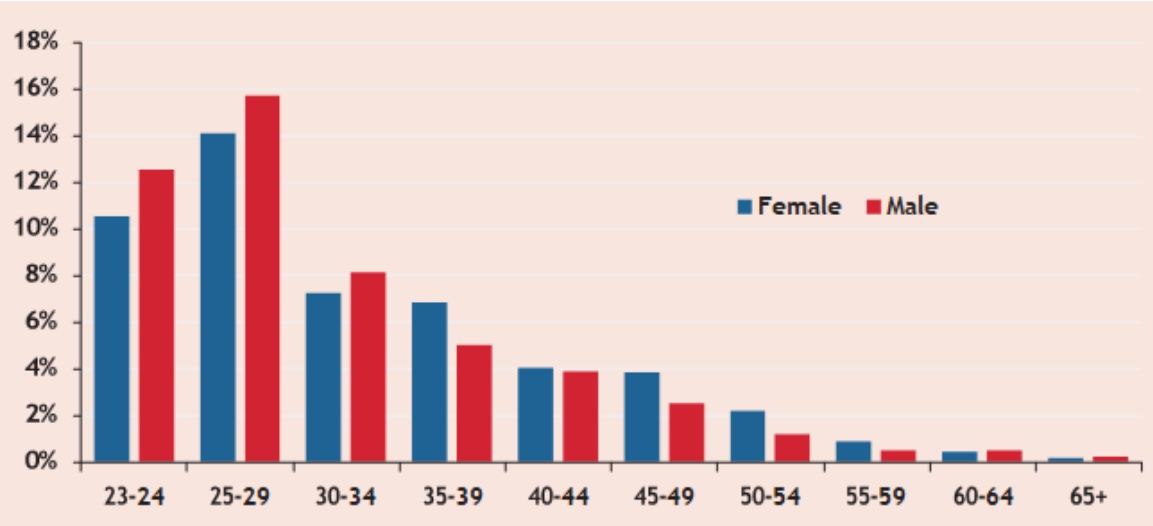

Figure 2. Source: Higher Education Authority 2021 report

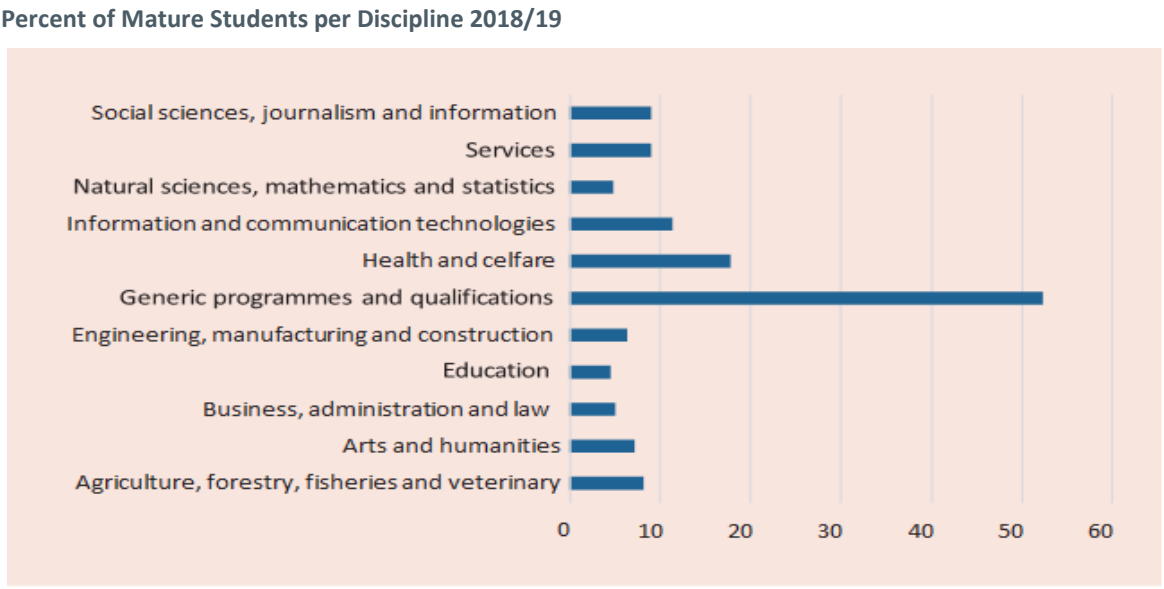

Figure 3. Source: Higher Education Authority 2021 report

The HEA, (2021) report further identifies that in the Engineering, Manufacturing and Construction fields , mature students represent less than 10% of all students enrolled in these courses. See figure 3 above.

4.2.2 How likely are the students to use Generative AI tools to improve their understanding of industrial engineering concepts?

RESPONSES		
Very Likely	13	24.53%
Likely	20	37.74%
Neutral	18	18.87%
Unlikely	7	13.21%
Very Unlikely	3	5.66%
TOTAL	53	

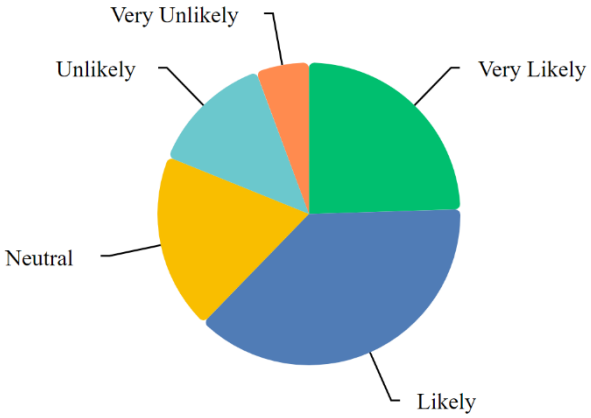

Figure 4.

In answering this question, it can be seen above in figure 4, that 33 out of the 53 (62.3%) students surveyed responded that they were likely or very likely to use Generative AI to improve their understanding of industrial engineering concepts.

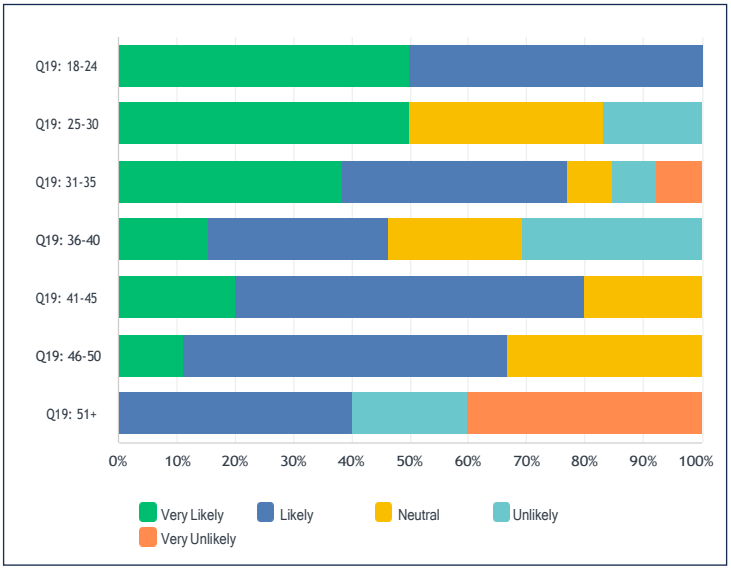

Figure 5.

If we break these answers down by the age of the students, we can see that a higher percentage of the younger students are more likely to accept Generative AI as a tool to improve their understanding of these concepts. See figure 5. The students who responded to this survey have not had any training or exposure to Generative AI as part of their BEISE degree programme.

It should be noted that there were only 5 students aged over 51, whereas there were 13 students in the 31 to 35 age group and 13 students in the 36 to 40 age group, see figure 1.

4.2.3 How likely are the students to believe Generative AI tools can enhance their productivity in academic tasks?

RESPONSES		
Very Likely	18	33.96%
Likely	20	37.74%
Neutral	8	15.09%
Unlikely	6	11.32%
Very Unlikely	1	1.89%
TOTAL	53	

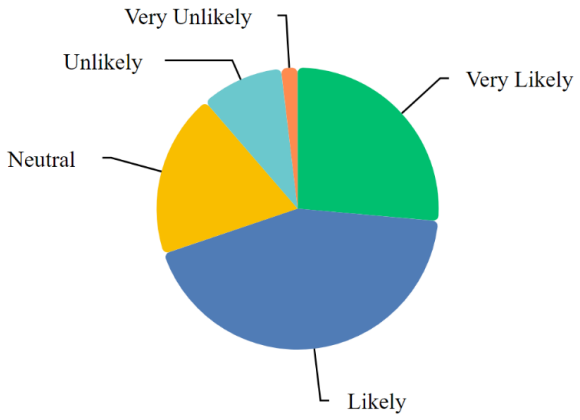

Figure 6.

The responses to this question found that 38 students out of the 53 students surveyed (71.7%) thought that Generative AI could enhance their productivity in academic tasks.

While students are warned about the use of Generative AI in their assignments it is evident from marking assignments that many students are using Generative AI as a tool to assist in their writing

tasks. As outlined in the literature review, the Irish Journal of Technological Enhanced Learning (Donlon and Tiernan, 2023) highlights how the generation of academic material complete with citations and references can now be achieved with just a few clicks. With no clear guidelines as to the permitted use of AI within the education sector, and now that Generative AI is built into search engines such as Microsoft's Bing as well as all the academic search engines, students are being bombarded with all manner of AI tools to find information and structure for their assignments.

With around 20% of students being international students, maybe a demographic question as to nationality should have been included in the survey. This might have highlighted where non-native English speakers might have used AI to assist in their assignments.

4.2.4 How likely are the students to think Generative AI tools can improve their ability to summarise complex information effectively?

RESPONSES		
Very Likely	14	26.42%
Likely	23	43.40%
Neutral	10	18.87%
Unlikely	5	9.43%
Very Unlikely	1	1.89%
TOTAL	53	

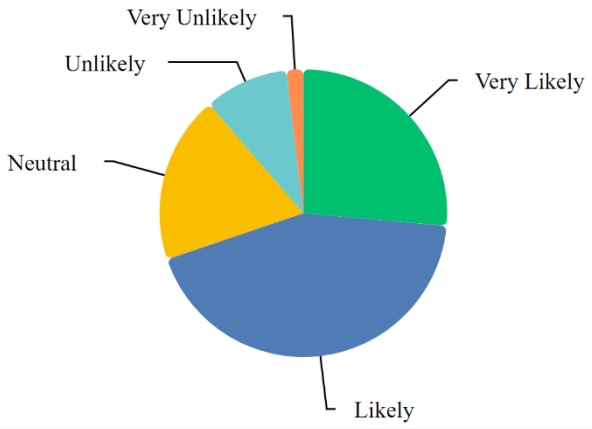

Figure 7.

37 out of the 53 (70%) students surveyed were likely or very likely to think that Generative AI could improve their ability to summarise complex information effectively. See figure 7. Pinzolitis, (2023) as mentioned in the literature review, discusses how AI tools incorporating LLM provide students with new ways to search, analyse and summarise research articles.

Once again though, if we look at the age profile of the students , we note that the younger students are more likely to think that AI can improve their ability to summarise complex information.

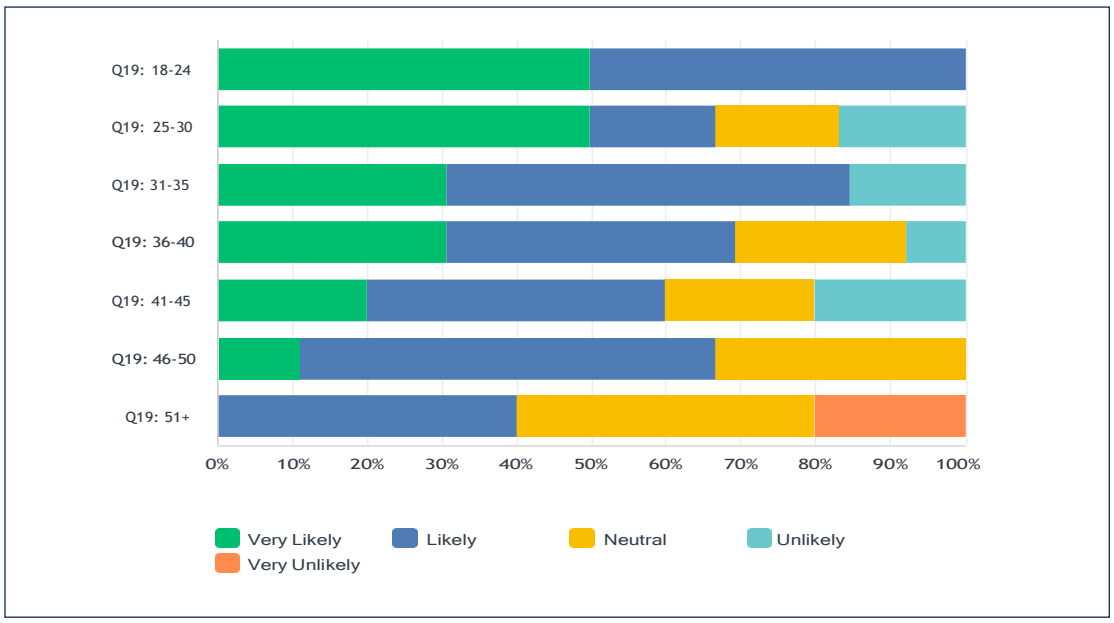

Figure 8

Younger students may be more accepting of Generative AI and therefore more inclined to use it to summarise information they have obtained through literature or other research. However, Broady *et al.*, (2010) discovered that older students often exhibit an initial lack of confidence that can be overcome with practice and usage.

4.2.5 How likely are the students to believe that integrating Generative AI into their studies could enhance their overall learning experience and academic performance.

RESPONSES		
Very Likely	11	20.75%
Likely	22	41.51%
Neutral	9	16.98%
Unlikely	8	15.09%
Very Unlikely	3	5.66%
TOTAL	53	

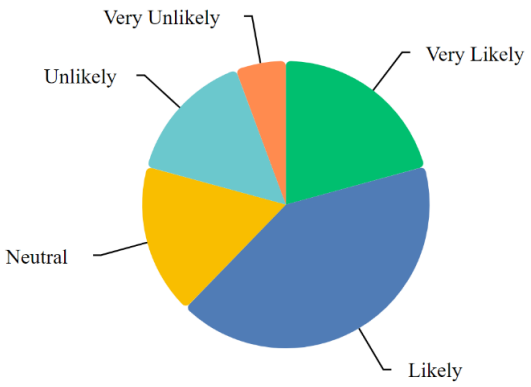

Figure 9.

A total of 33 students (62.3%) believed that the integration of Generative Ai into their studies could enhance their learning and academic performance. See figure 9.

Again, if we look at the age profile of the students we see a broad acceptance of this belief amongst the lower age groups. See figure 10 below.

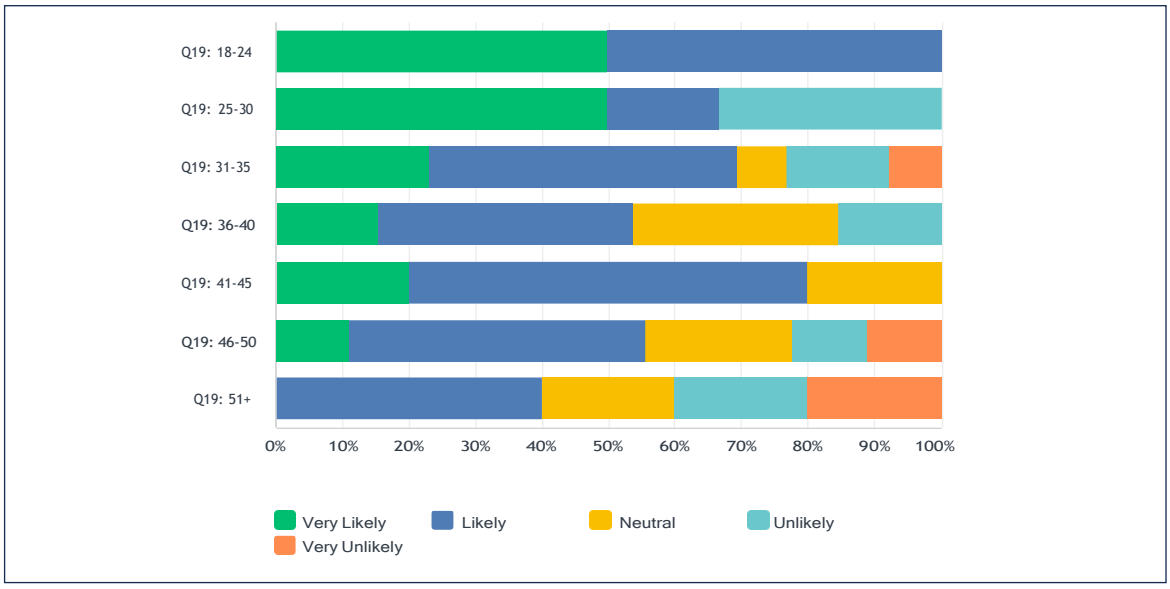

Figure 10.

A total of 11 students (20.75%) thought that it was unlikely that Generative AI could enhance their learning experience.

The one student aged 31-35 who answered “Very Unlikely” commented *“I personally don't use AI. I know many do but I completely disagree with using it as people are copy and pasting information to complete assignments. There is no learning outcomes from this and the quality of graduates will be negatively impacted due to lack of understanding and knowledge gained by completing studies the "correct" way. Just my opinion”.*

While the one student aged 46-50 who answered “Very Likely” commented *“I use AI as a tool, but would not trust it 100% and I research any information independently before using it. One caveat I have found is that I trust myself less now and feel I have to check my work with AI prior to completion and submission. If the findings are similar it makes me more reassured”.*

4.2.6 How likely are the students to believe that Generative AI should be incorporated into engineering education as a teaching and learning tool?

RESPONSES		
Very likely	11	20.75%
Likely	21	39.62%
Neutral	11	20.75%
Unlikely	7	13.21%
Very unlikely	3	5.66%
TOTAL	53	

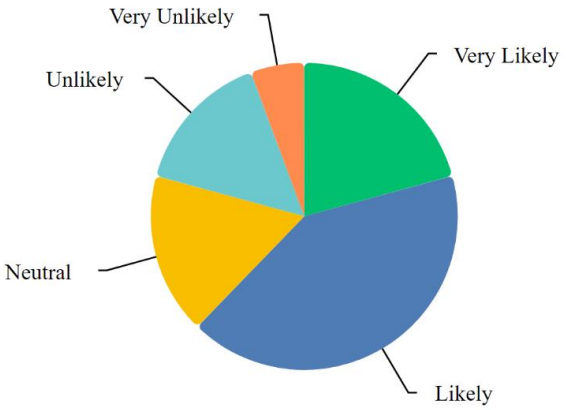

Figure 11.

Again, there was a high percentage (60.4%) of students who believed that Generative AI should be incorporated into engineering education.

If we examine the age profile of the students' responses and compare those who selected "likely" and "very likely" with those who chose "unlikely" and "very unlikely," we observe that a higher proportion of younger students opted for "likely," whereas a higher proportion of older students selected "unlikely." See figure 12 below.

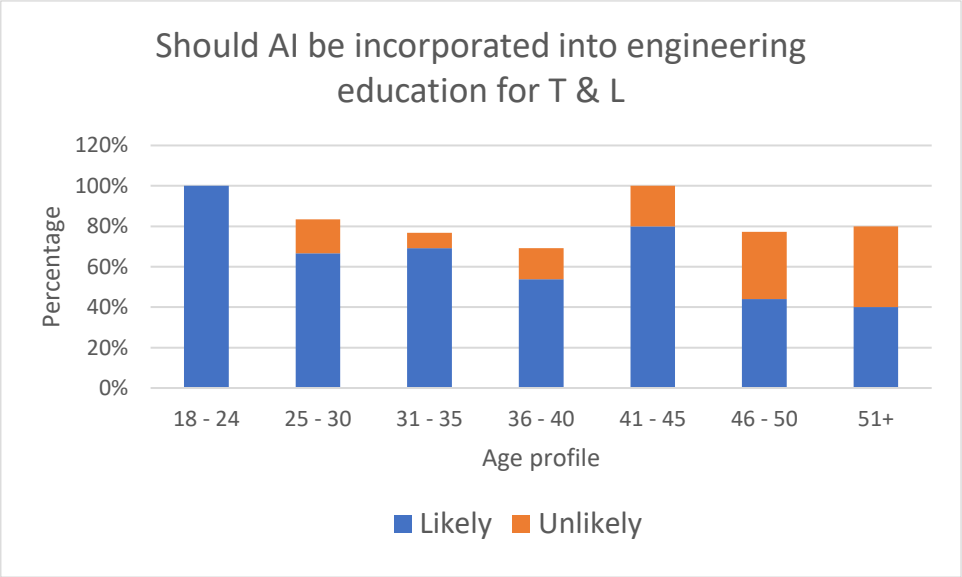

Figure 12.

4.2.7 How likely are the students to believe that Generative AI tools can support the teaching and learning process effectively in higher education?

RESPONSES		
Very Likely	10	18.87%
Likely	27	50.94%
Neutra	9	16.98%l
Unlikely	7	13.21%
Very Unlikely	0	0.00%
TOTAL	53	

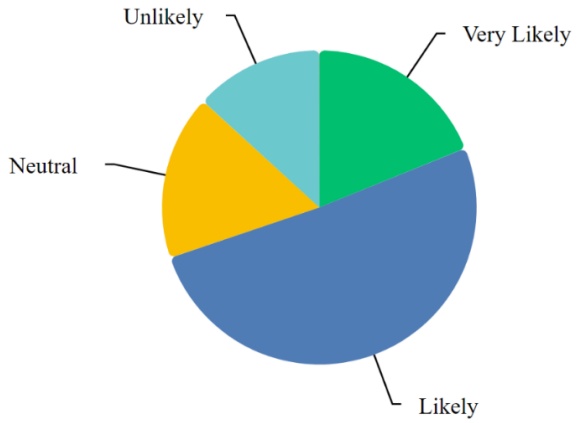

Figure 13.

There was a strongly positive belief to this question with 37 (70%) of the student responses showing "likely" and "very likely". No students thought it "very unlikely" that generative AI could support T&L in higher education.

Zahid (2023) writing in the World Economic Forum notes that it is crucial to start developing a basic understanding of AI that encompasses its functionality, capability and constraints. Acar (2024) maintains that education needs to move on from traditional forms of assessment towards more relevant forms of assessment in line with future stages of a student's career. This is largely borne out by most of the students' belief that AI tools can support the T&L process.

4.2.8 How likely are the students to be concerned about the impact of Generative AI tools on personal development and future career prospects?

RESPONSES		
Very Likely	9	16.98%
Likely	23	43.40%
Neutral	13	24.53%
Unlikely	6	11.32%
Very Unlikely	2	3.77%
TOTAL	53	

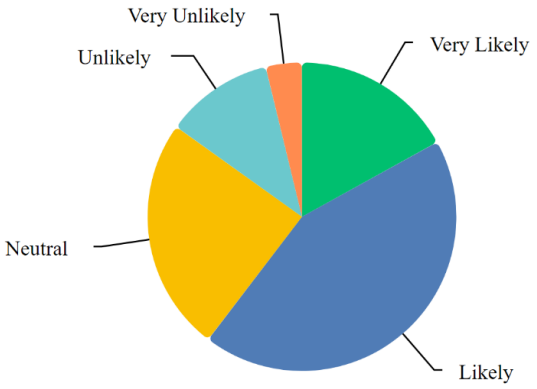

Figure 14.

32 (60.3%) of the 53 students surveyed were concerned about Generative AI impacting their personal development and future career prospects.

This question is to assess the future impact of Generative AI on the students' career development. As reported in the European Journal of Engineering Education (Nikolic *et al.,* 2023) where the authors determine that for engineers it is essential to adopt tools that can increase efficiency and productivity. Historically, AI systems were designed to augment human capabilities, primarily by automating repetitive tasks and providing data-driven solutions. However, the advent of Generative AI has taken this partnership to a new level.

The review of literature on the subject noted that Nunez and Lantada, (2020) maintain that it is important for engineering educators to guide students regarding the capabilities of AI and to incorporate AI technologies into real world engineering projects.

As students' progress through their studies there can be a perception that they are not keeping up with the technologies now being adopted by businesses today.

4.2.9 How likely are the students to engage with Generative AI tools for research and analysis tasks in industrial engineering?

RESPONSES		
Very Likely	10	18.87%
Likely	19	35.85%
Neutral	15	28.30%
Unlikely	8	15.09%
Very Unlikely	1	1.89%
TOTAL	53	

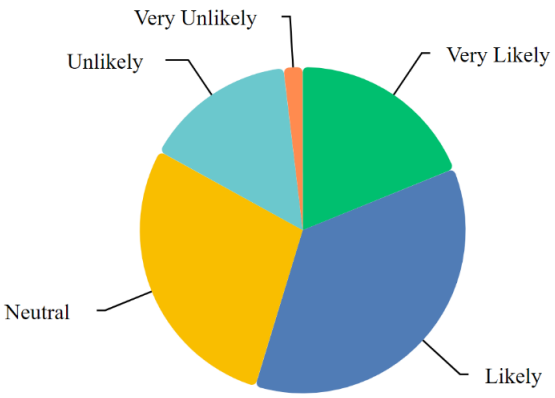

Figure 15.

9 out of the 53 student responses (17%) expressed a negative likelihood of using Generative AI tools for research and analysis. This may be because the students have not received any instruction as to the possible uses of Generative AI for research and analysis.

A closer look at the survey results notes that one student who answered "Unlikely" to this question went on to comment *"I think a lot of the Generative AI tools are too new and unproven so far. It might take some more time and testing to ensure these tools can be used in the way this survey mentions".*

Another student who answered "Unlikely" commented *"AI is good in many ways but generated question / answers always need validation, whilst there are valuable faucets of AI that are good there are also parts that don't meet standards, basically take all information in moderation and always prove your work".*

The literature (Sani, 2023) noted that Generative AI can assist students with research and analysis tasks. This is reflected by the 29 (54.7%) students who said they were likely to use Generative AI for research and analysis.

4.2.10 How likely are the students to be concerned about the accuracy and reliability of Generative AI generated content?

RESPONSES		
Very Likely	14	26.42%
Likely	21	39.62%
Neutral	11	20.75%
Unlikely	6	11.32%
Very Unlikely	1	1.89%
TOTAL	53	

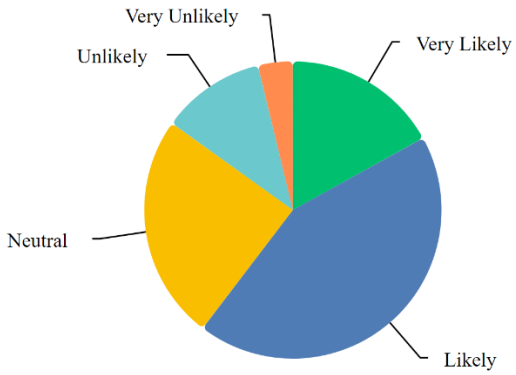

Figure 16.

35 (66%) 0f the student responses confirmed that they were concerned about the accuracy and reliability of Generative AI generated content. This is highlighted in the literature as described by Lee and Soylu, (2023) and Jiang et al., (2023).

One student (Age 46-50) who responded "Likely" further commented *"It can, however, be detrimental if taken as "gospel" when used. It can often produce misinformation and should be used in conjunction with knowledge and class based learnings".*

4.2.11 How likely are the students to use Generative AI for idea generation in their coursework and assignments?

RESPONSES		
Very Likely	7	13.21%
Likely	18	33.96%
Neutral	11	20.75%
Unlikely	14	26.42%
Very Unlikely	3	5.66%
TOTAL	53	

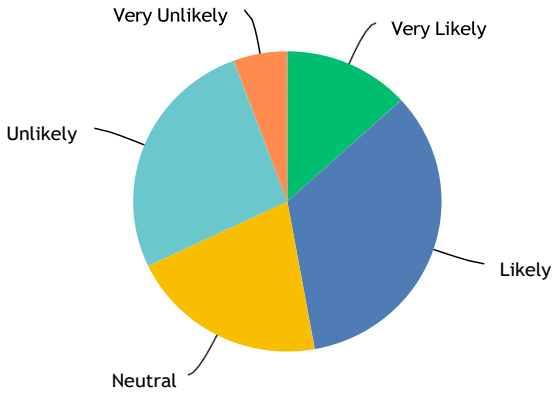

Figure 17.

As identified in the literature (Saini, 2023) Generative AI can be a useful tool to assist students in generating ideas for their assessments and conducting research, analysis and writing tasks. This was borne out in the student survey where 25 students (47.2%) were likely to use Generative AI for idea generation versus 17 (32.1%) students that were unlikely to use Generative AI. See figure 17 above.

4.2.12 How likely are the students to use Generative AI for text editing and revision purposes?

RESPONSES		
Very Likely	9	16.98%
Likely	12	22.64%
Neutral	10	18.87%
Unlikely	15	28.30%
Very Unlikely	7	13.21%
TOTAL	53	

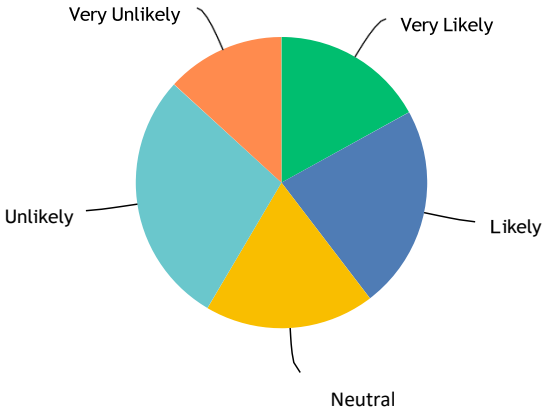

Figure 18.

The literature outlined examples where students are asked to research specific topics or subjects and then document their findings (Bowden, 2023). Discussions with students in class suggested that students could use Generative AI to condense topics into short paragraphs to aid revision of these

topics for exam purposes. However, when asked this question in the student survey the answers received tended towards the neutral to unlikely range.

4.2.13 How likely are the students to explore Generative AI tools for enhancing their problem solving skills and critical thinking in industrial engineering?

RESPONSES		
Very Likely	8	15.09%
Likely	15	28.30%
Neutral	13	24.53%
Unlikely	10	18.87%
Very Unlikely	7	13.21%
TOTAL	53	

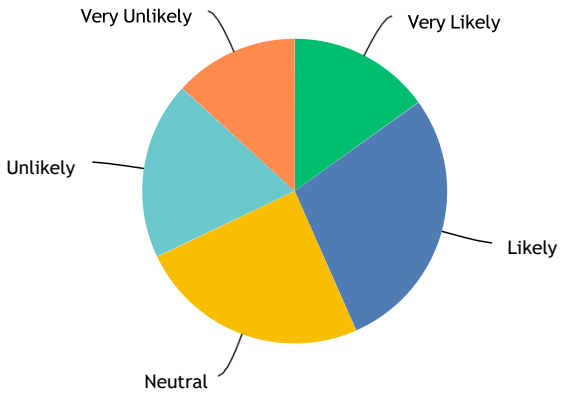

Figure 19.

Thiga, (2024) and McKinsey Digital, (2023) highlighted how Generative AI can be used to aid productivity, assist in critical thinking and problem solving within the workplace. However, they both point out that to maximise benefit to the workplace, the use of Generative AI needs a structured approach and training in the use of the tools available.

This is somewhat borne out by the students' responses to the question. Where the overall likelihood of using Generative AI for problem solving and critical thinking was more neutral.

Looking at the age profile of the student responses we can see that those under 45 years were more likely to explore Generative AI tools for these purposes. See below in Figure 20.

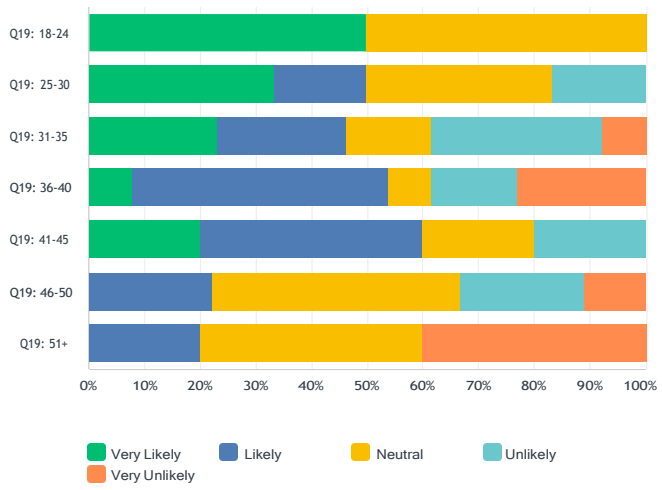

Figure 20.

4.2.14 How likely are the students to be concerned about the ethical implications of using Generative AI tools in their engineering studies?

RESPONSES		
Very Likely	9	16.98%
Likely	13	24.53%
Neutral	21	39.62%
Unlikely	9	16.98%
Very Unlikely	1	1.89%
TOTAL	53	

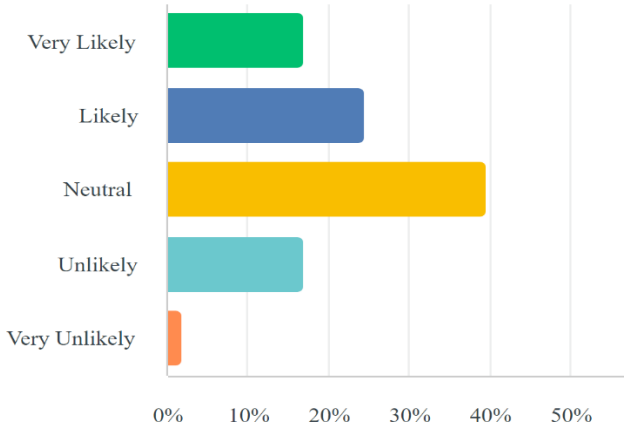

Figure 21.

The student responses show that 22 students (41.6%) had some concerns regarding the ethics of using Generative AI tools in their engineering studies. However, the data shows that the largest single response was neutral, with 21 students (39.6%) selecting this option.

The literature suggests that the Irish academic standards' watchdog (QQI) sees Generative AI as a significant threat to academic integrity (O'Brien, 2023). While Rasul et al. (2023) points out that it is crucial to address the challenges associated with their use. The European Commission, (2022) outlines the need to understand the impact of Generative AI within education and that educators and learners gain a greater understanding of AI. Wheeler, (2019) maintains that further education needs to catch with the technologies available today.

4.2.15 How likely are the students to be aware of any potential bias that may exist in Generative AI generated content?

RESPONSES		
Very Likely	11	20.75%
Likely	23	43.40%
Neutral	15	28.30%
Unlikely	4	7.55%
Very Unlikely	0	0.00%
TOTAL	53	

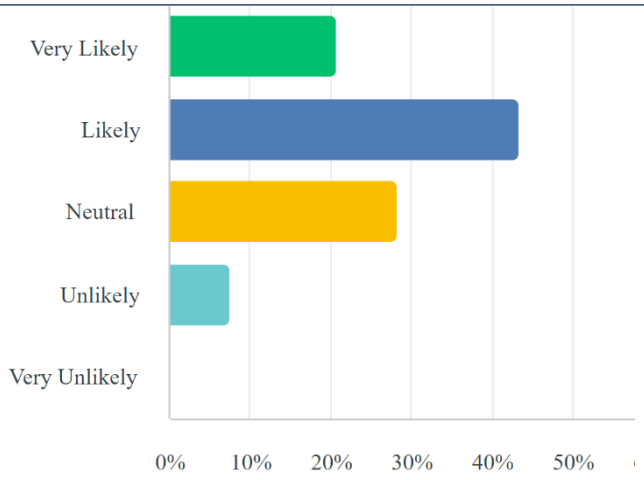

Figure 22.

The students show a strong awareness (64.2%) of potential bias in Generative AI generated content.

Generative AI tools will exhibit bias in their responses if the data that is preloaded to their knowledge base contains bias. This can potentially influence the information that Generative AI produces.

Bias can also be introduced if the Generative AI is more frequently queried on certain topics or in specific ways, it might learn and perpetuate biases based on those interactions.

4.2.16 How likely are the students to accept Generative AI as a means of setting in class tests, giving instant results to the students?

RESPONSES		
Very likely	3	5.66%
Likely	17	32.08%
Neutral	13	24.53%
Unlikely	15	28.30%
Very unlikely	5	9.43%
TOTAL	53	

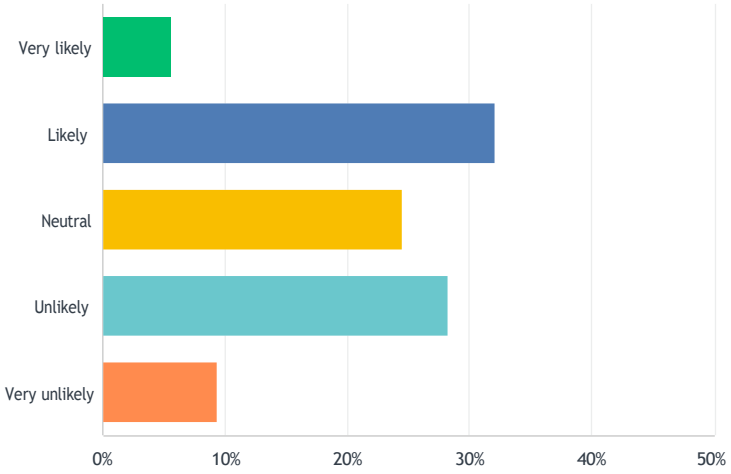

Figure 23.

The students were split evenly between those who thought it likely and those who thought it unlikely.

As noted in the literature (Bachiri et al., 2023) Automatic Question Generation can be added to learning management systems such as Moodle. These AQG systems can not only generate the questions for assessment and in class tests but to provide instant feedback to the students upon completion of the assignment.

4.2.17 How likely are the students to accept that Generative AI could be used for the marking of class assignments?

RESPONSES		
Very likely	10	18.87%
Likely	14	26.42%
Neutral	15	28.30%
Unlikely	9	16.98%
Very unlikely	5	9.4%
TOTAL	53	

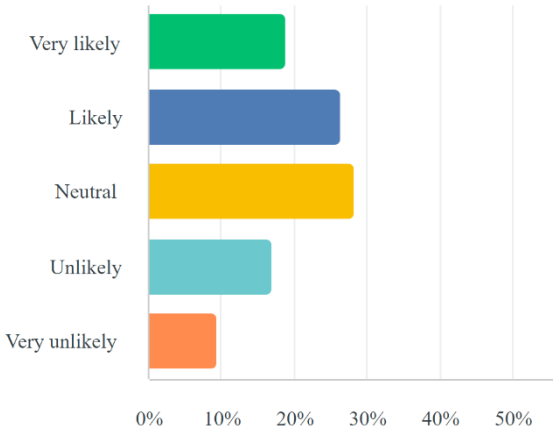

Figure 24.

The students were inclined to accept the use of Generative AI for marking assignments with 24 students (45.2%) selecting likely. Whereas 14 students (26.4%) selected unlikely. There was however a large proportion of students (28.3%) that selected neutral.

The literature shows that Automatic Essay Scoring (AES) is prevalent in most of the United States schools, (Ramesh and Sanampudi, 2022). However, Dwivedi *et al.* (2023) and Kumar and Boulanger (2020) highlight that to be most effective AES systems work best when combining automated scoring of essays in combination with human judgement.

4.2.18 How likely are the students to believe that Generative AI can provide personalised and constructive feedback similar to human educators?

RESPONSES		
Very Likely	3	5.66%
Likely	3	5.66%
Neutral	16	30.19%
Unlikely	17	32.08%
Very Unlikely	14	26.42%
TOTAL	53	

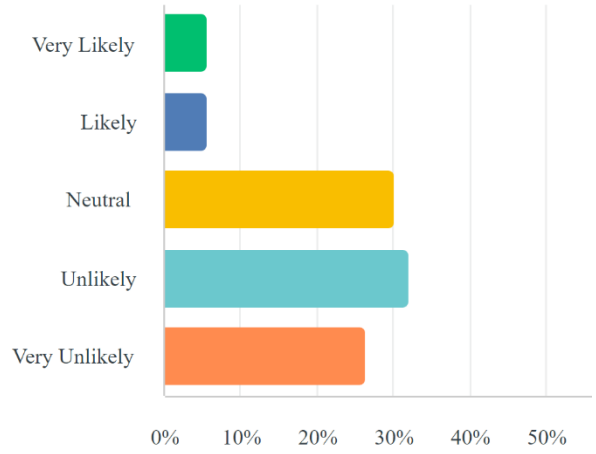

Figure 25.

Most of the students (58.5%) thought that Generative AI could not provide personalised and constructive feedback similar to human educators.

A look at the age profile of the student responses shows that with students under the age of 40, there were 6 students who answered that it was likely, while 18 students in this age group thought it unlikely. For students over the age of 41 there were no students who thought it likely and 13 students who thought it unlikely. Of the 13 students that thought it unlikely, 7 students (13.2%) thought it very unlikely. See below in figure 26.

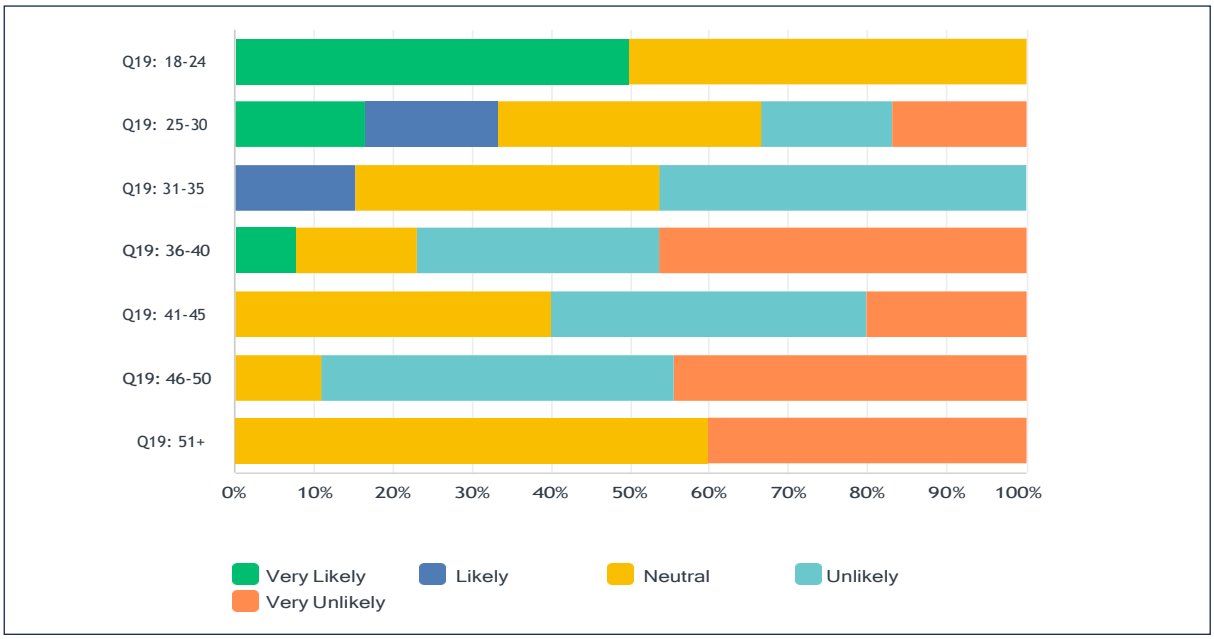

Figure 26.

The literature refers to work being undertaken in the University of Michigan to develop its own programme for providing feedback to students on their written work (Brown, 2017). This is to counter the fact that human instructors do not give enough feedback because of high student / educator ratios.

4.2.19 Have students been made aware of the guidelines and policies regarding the use of Generative AI tools at their place of study?

RESPONSES		
Very Likely	18	33.96%
Likely	11	20.75%
Neutral	15	28.30%
Unlikely	6	11.32%
Very Unlikely	3	5.66%
TOTAL	53	

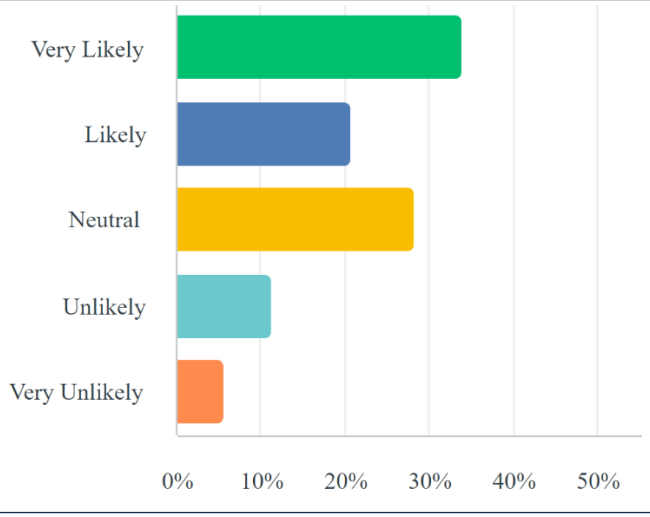

Figure 27

It is evident from the student answers to this question that most (19 students, 54.7%) have been made aware of the engineering faculty guidelines on the use of Generative AI.

4.3 Summary of findings from student survey:

A report from the National Centre for AI (Webb, 2024) outlines that Generative AI is having a profound impact on education today. A look at the answers the students provided in the student questionnaire shows that the students were positive towards Generative AI tools being used for the following :-

- Improve understanding of industrial engineering concepts.
- Enhance productivity in academic tasks.
- Improve their ability to summarise complex information.
- Enhance their overall learning experience.
- Believe that Generative AI should be incorporated into engineering education.
- Support the teaching and learning process.
- Use Generative AI for idea generation.

The students polled were more circumspect regarding the use of Generative AI for the following :-

- Using Generative AI for text editing and revision.
- Enhancing problem solving and critical thinking skills.
- The setting and marking of in-class tests.
- The use of Generative AI for the marking of assignments.

The students had a negative opinion of the following :-

- The use of Generative AI to provide personalised and constructive feedback.

The majority of students had concerns about the following :-

- The impact of Generative AI on personal development and future career.
- The accuracy and reliability of AI generated content.

Most students were aware of :-

- Any potential bias that may exist in Generative generated content.
- The guidelines and policies regarding the use of Generative AI tools.

The survey revealed some surprising insights into the student attitudes towards the ethical implications of using generative AI tools. Even though most students were aware of the guidelines and

policies governing the use of Generative AI, their overall response was neutral when it came to the ethical considerations.

One potential explanation for this neutral stance is the lack of clear, comprehensive policies from the college regarding the use of AI tools in academic settings. Without definitive guidance students may feel uncertain about the ethical boundaries and potential consequences of leveraging Generative AI for their studies.

Another key observation from the student survey was that there was a greater acceptance and openness towards the use of Generative AI tools within engineering education among the younger students surveyed.

As the survey respondents were all mature students, meaning they were over the age of 23, the findings may not fully capture the attitudes of younger students still in secondary or early tertiary education. More research is needed to understand how students at different educational levels and of varying ages perceive the role of Generative AI in their studies.

4.4 Qualitative data from the semi-structured interviews with engineering educators:

Three educators were invited to participate in the qualitative semi-structured interview process. The three educators are responsible for delivering a wide range of engineering modules within the BEISE degree programme. Two of the educators were male and involved with the technical aspects of industrial engineering and one was female and involved with the career development of the engineering students. For the purpose of this study the three participants will be referred to as Educator 1, 2 and 3.

All participants are qualified in their specific areas of knowledge and have a combined 80 years of experience in their particular fields. In the area of of educational training, Educators 1 and 2 have completed the Level 9 Certificate in Education, Learning and Development while Educator 3 has completed the MA in Training and Education.

4.4.1 Have the educators used Generative AI?

All three confirmed that they had used Generative AI. Educators 1 and 3 indicated that they had only used Chat GPT.

4.4.2 What is their overall perception of Generative AI tools such as Chat GPT and the potential impact on engineering education?

The educators expressed various concerns regarding the impact of Generative AI on engineering education.

Educator 1, speaking from an engineering perspective, acknowledged that Generative AI is a further development in the quest for productivity. However, they emphasised the importance of understanding the development of AI and creating an environment that will deliver benefits.

Educator 2 perceived AI as having a significant impact on education and believed that it will be a huge aid in the future. However, they also expressed caution, stating that "*at these early stages it should be approached with extreme caution.*"

Educator 3 acknowledged that they found AI very helpful for idea generation. It is interesting to note that under half (47.2%) of the students surveyed agreed with this. Educator 3 further highlighted they were worried about students *"taking AI generated information as gospel."* They expressed concern about the potential over reliance of AI generated information by students.

Both Educators 1 and 2 expressed caution regarding the use of Generative AI in education. Educator 1 stated that *"we need to have a very thorough understanding of the tool we're using before we put it into widespread use."* Educator 2 also commented that *"it is a challenge and a lot of it, I think, comes from education for both the lecturer and the student."*

The European Commission, (2022) also identified this aspect of the use of Generative AI in education. They outlined that as AI systems evolve and their use expands, we must cultivate a deeper understanding of these systems, particularly in education and training.

The educators expressed a range of concerns about the impact of Generative AI on engineering education, including the need for a thorough understanding of the technology, the potential misuse of AI generated information, and the importance of educating both educators and students on the appropriate use of these tools.

4.4.3 How familiar are the educators with the capabilities and limitations of Generative AI tools and how does it influence your attitude towards them?

All the educators have had some limited exposure to using Generative AI tools.

Educator 1 has a superficial understanding of the capabilities of Generative AI tools. They have supplemented this limited exposure by reading about the subject to gain a better grasp of the technology.

Educator 2 has used Generative AI as a tool for testing exam questions or assignments. They have used the generated references to compare the structure and language generated by the AI to actual student-generated work. This has helped Educator 2 gain a better understanding of how Generative AI compares to human produced content.

Educator 3 has received some training from the college representatives on the National Academic Integrity Network (NAIN). They have learned that Chat GPT and other Generative AI models only contain information up to a certain date. However, Educator 3 sees Generative AI as a useful tool to use as a guide or a starting point, rather than a replacement for human-generated content.

This is born out in the literature where, according to Webb, (2024), the first step for all educators is to directly interact with Generative AI tools and experiment with the technology themselves. By gaining hands-on experience, educators will develop a better understanding of how these AI tools work and the potential impacts on student assessments. Dedicating time to learn about Generative AI is crucial for staying informed and adapting to this rapidly evolving field.

4.4.4 What concerns do the educators have about the potential for academic dishonesty and plagiarism with the use of Generative AI tools in engineering education?

The three educators expressed several concerns about the use of Generative AI in assessments:

Educator 1 commented that they would be very concerned about the use of Generative AI, particularly if it is undetectable. They are worried about the potential for students to misuse this technology to cheat on assessments.

Educator 2 regards the use of Generative AI as a form of plagiarism, similar to any other form of academic dishonesty. They view its use as being attractive to lazy students and they are concerned about the impact this could have on the integrity of the assessment process.

Educator 3 does not set academic assignments, but they have encountered students who use Generative AI to generate phrases or sections of their answers. They also view this as a form of laziness, in addition to the obvious plagiarism issue.

Both Educators 1 and 2 remarked that there could be a need to change the types of assignments set to negate the use of Generative AI by the students. Educator 2 specifically mentioned that they are looking at oral and individual forms of assessment to assess the students' understanding of the knowledge they acquire during their engineering studies.

The educators' concerns highlight the challenges that Generative AI poses for academic integrity and the need for educational institutions to adapt their assessment practices to address these emerging issues. The *Irish Independent* article, (Donnelly, 2023) comments on how Irish universities are looking at more use of interactive oral forms of assessment versus traditional essays.

4.4.5 How confident are the educators about their ability to detect AI generated content compared to identifying work generated by the students themselves?

Overall, the educators expressed a range of perspectives on their ability to detect Generative AI content in student work. While some felt reasonably confident, others expressed concerns about the challenges posed by this technology, both now and in the future.

Educator 2 expressed a medium level of confidence in their ability to detect Generative AI content in student work. However, they noted that this becomes more challenging when students paraphrase or reword the generated text. Interestingly, they commented that this may not necessarily be a bad thing, as the student must have some comprehension of the subject matter in order to reword the

generated text correctly. Educator 2 sees this as a challenge for education, but also acknowledges that it can be good to be challenged occasionally.

Educator 3 feels fairly confident in their current ability to detect Generative AI content. However, they expressed concern about their future ability to do so as Generative AI tools continue to progress without the use of some identification tool. This suggests that Educator 3 is aware of the rapidly evolving nature of Generative AI and the potential challenges it may pose for educators in the future.

In contrast, Educator 1 had a very low level of confidence in their ability to detect Generative AI content in assignments, particularly if students have taken care to disguise its use. This highlights the difficulty that some educators may face in identifying Generative AI content, especially when students make efforts to conceal its use.

4.4.6 How do the educators think that Generative AI could enhance or hinder the development of critical thinking and problem-solving skills in engineering education?

All the educators began by discussing how Generative AI, such as ChatGPT, could hinder critical thinking and problem-solving skills if used improperly. Educator 1 commented, *"I think it could hinder critical thinking because at a low level it will do all of the easy solutions for people and it robs them of the opportunity for practice."* Educator 2 agreed, stating, *"If it's used in a lazy way to solve problems and not to understand how the problem is being solved."* Educator 3 also concurred, saying, *"instead of taking the time to think through a question, the first instinct is to ask somebody, ask the ChatGPT."*

However, the educators also acknowledged the potential benefits of Generative AI in enhancing critical thinking and problem-solving skills. Educator 1 suggested that Generative AI could, at a high level, be capable of delivering unique solutions. Educator 3 remarked that there were ways that Generative AI could be useful, but its use must be managed carefully. Educator 2 maintained that it is a huge advantage if Generative AI is used as a method to understand how a problem is being solved.

The educators agreed that currently, educators, students, and professionals need to do the critical thinking, but that could completely change in the next ten years. Educator 2 emphasised the importance of using Generative AI as a tool to enhance understanding rather than as a replacement for critical thinking.

The student survey showed some ambivalence to this subject with the younger students being more accepting of the prospect.

4.4.7 What strategies or policies do the educators think should be implemented to enable the responsible and effective integration of Generative AI tools in engineering education?

The three educators all agreed that clear guidance should be given to students about the responsible use of Generative AI tools. Educator 1 outlined, that this should include what is acceptable and what is not acceptable. Educator 2 agreed but commented how training of the students in the ways to use Generative AI effectively is important. Educator 3 further agreed about integrating Generative AI tools into the students education, to include outlining how to use the tools responsibly as part of their study.

Educator 1 started by saying that they thought methods of detection are *"very, very important"* along with clear codes of conduct.

Educator 2 maintained that students need to be honest in their use of Generative AI and properly reference it, just as they would with any other resource they utilise in their work.

Overall, as highlighted in Rasul *et al.,* (2023), the educators agreed that a comprehensive approach, including clear guidelines, effective training, and responsible integration of Generative AI, is crucial for ensuring students use these powerful tools in a responsible, ethical and productive manner.

4.4.8 What opportunities and challenges do the educators foresee in terms of using Generative AI tools to support and enhance their teaching practise in engineering education?

All the educators recognised the potential of incorporating Generative AI into their teaching practices. From designing assignments and exam questions to assisting with CV creation, the benefits of this transformative technology are being widely embraced.

Educator 1 highlights the ease with which Generative AI can be used to design assignments and exams, as well as generate solutions. This not only saves time and effort but also allows for the creation of more diverse and engaging assessment materials.

Educator 2 emphasises the value of using Generative AI to quickly generate different responses, answers, and perspectives on the questions and topics being explored in the classroom. This can introduce new angles and insights that enrich the learning experience.

Educator 3 acknowledges the significant impact of Generative AI on how they now teach CV creation. The technology has necessitated a shift in their approach, ensuring that students are equipped with the latest and most effective strategies for presenting themselves in the job market.

Educator 2 further explains that Generative AI can be leveraged to quickly access information, which can then be incorporated into their teaching. This allows for more dynamic and up to date content delivery, enhancing the overall educational experience.

Educator 1 recognises that as Generative AI transforms engineering practices, it will inevitably lead to changes in engineering education.

As outlined by Dwivedi *et al.,* (2023); Zhai, (2022) and Bowden, (2023), Generative AI can be used to create lesson plans, assessments and develop relevant curricula. While Harve, (2023) outlines how AI tools can be used to create engaging assessments in the form of in-class quizzes.

However, as noted in the student survey, the student's response to the possibility of AI generated in class tests and quizzes was fairly neutral.

4.5 Summary of findings from semi structured interviews:

The interview process gave an insight into how the educators were adapting to the presence of Generative AI and its impact on engineering education.

It is evident from the interviews that the three educators have only superficial knowledge regarding the use of Generative AI and how it might be applied in engineering education. While the educators are starting to dip into Generative AI tools, they have not considered how they could be fully incorporated into the engineering curriculum. There is much talk about assessments and how the use of Generative AI might denote a lazy student, but it is interesting to note how none of them see this as an opportunity to re-think assessment for a better, more inclusive assessment strategy in this new world of Generative AI and education.

The interviews highlighted how two of the educators have had no formal instruction in the use of Generative AI tools with the third educator having had some sessions with the NAIN representatives on campus.

The literature outlines many ways to use Generative AI within the third level education but as stated by Aaron Yaverski, (2023), *"There is a disconnect where we have students actively leveraging the tool and instructors who may not be familiar with it. We have to narrow the gap as we think about policies".*

Chapter 5 – Conclusions and Recommendations:

5.1 Introduction:

The rapid advancement of Generative AI has raised concerns about its ethical implications, potential for bias, and impact on academic integrity in higher education. However, as this technology becomes increasingly integrated into our daily tools, it is crucial for educators to adapt their teaching methods and find ways to leverage Generative AI to promote critical thinking and problem-solving skills among students.

This study aimed to explore the potential benefits of incorporating Generative AI in assessment and classroom engagement for tertiary engineering. The author identified a gap between student perceptions and faculty educators' attitudes towards the use of Generative AI in education. While students may see the potential benefits of incorporating Generative AI into their studies, many faculty members remain nervous and somewhat reluctant to use it in their teaching practices due to the fear of the unknown.

As Generative AI continues to evolve, it will be crucial for educators to adapt their teaching methods and integrate this technology, like whiteboards, calculators and e-learning, this technological advancement is here to stay. By embracing Generative AI, educators can create engaging learning environments that prepare students for the technological advancements they will encounter in their future careers.

While the incorporation of Generative AI in education holds promise, it is essential to address the ethical concerns and potential biases that may arise. Educators must ensure that the use of Generative AI in assessment and classroom engagement is transparent, fair, and unbiased. By addressing these concerns proactively, educators can create a framework for the responsible and effective use of Generative AI in tertiary engineering education and on into the workplace.

The study highlights the need for a balanced approach to the integration of Generative AI in tertiary engineering education. By bridging the gap between student perceptions and faculty concerns, adapting teaching methods to embrace Generative AI, and addressing concerns, educators can harness the power of this technology to enhance student learning and prepare them for the challenges of the future.

5.2 Key Findings:

The original research question was broken down into three sub-questions for the purpose of this study:

1. How are students and educators engaging with Generative AI in engineering education?

The surveys revealed a disconnect between students and educators in their engagement with Generative AI in engineering education. The data showed that students are generally open to utilising Generative AI in their studies, while educators are more hesitant and uncertain about how to effectively integrate Generative AI into their teaching practices, aside from generating assignment and exam questions. This finding is supported by the literature. As Aaron Yaverski (2023) stated, "*There is a disconnect where we have students actively leveraging the tool and instructors who may not be familiar with it.*" Additionally, the European Commission, (2022) has highlighted the growing need for both educators and students to acquire a foundational understanding of Generative AI as the technology continues to evolve. Furthermore, Wheeler, (2019) argues that one of the biggest obstacles may be that education is lagging behind the rapid advancements in technology, and educators may be reluctant to deviate from traditional methods of assessment and teaching.

2. What are the major benefits of integrating Generative AI into engineering education?

The student survey highlighted specific areas where most students were either likely or very likely to believe that Generative AI could be beneficial to their engineering studies:-

- Improve understanding of industrial engineering concepts.
- Enhance productivity in academic tasks.
- Improve their ability to summarise complex information.
- Enhance their overall learning experience.
- Believe that Generative AI should be incorporated into engineering education.
- Support the teaching and learning process.
- Use of Generative AI for idea generation.

From the educator's perspective, they are using Generative AI, in a very limited way, for trial assessments, exam questions, CV and ideas generation. This may be due to lack of any formal training regarding Generative AI for the educators and caution as to its use. Without any specific training regarding the advantages of Generative AI the educators are left to explore its capabilities on their own. The literature supports the notion that in order to incorporate Generative AI effectively it is

essential to implement ongoing faculty training and professional development initiatives, (Yelamarthi et al., 2024)

3. What are the challenges of integrating Generative AI into engineering education?

The educators raised concerns about Generative AI in relation to academic integrity, ethical and responsible use, assessment strategies and lack of skills development by students. The students on the other hand demonstrated a more pragmatic approach to the integration of Generative AI into their engineering studies.

To overcome some of the challenges requires the engineering faculty to implement changes that include :-

- Designing curriculum that effectively integrates Generative AI while aligning with the existing education standards and objectives.
- Provide adequate training to educators to understand and be able to teach Generative AI concepts effectively as part of their Continuous Professional Development (CPD).
- Develop methods to keep students engaged with Generative AI content which can be abstract and challenging such as gamification, (Murillo-Zamorano *et al.*, 2021).
- Create new assessment strategies that can accurately measure students understanding and the application of Generative AI concepts as highlighted by Zhai, (2022).

These are in addition to the ethical, academic integrity, transparency and fairness issues posed by Generative AI to the college.

5.3 Recommendations:

Without clear guidelines to what is acceptable and what is unacceptable use of Generative AI within the college it is hard to provide guidance to the educators and students. Many colleges and universities such as Purdue, are leaving the decision as to how students can use Generative AI up to individual faculties and professors, (Paykamian, 2024).

As Generative AI continues to impact the future of education, it is crucial for educational institutions to proactively adapt their policies and practices. Regular reviews and updates, that consider technological advancements and changing educational needs, will help to ensure that Generative AI is leveraged responsibly and effectively to enhance learning outcomes and promote innovation within the classroom.

5.4 Limitations of the study:

This study was limited to engineering students and educators within one private Irish college. The answers given in this study may differ greatly from other courses of study such as humanities, finance or law. Other limitations are that all the students surveyed were mature students who are conducting their studies through distance learning.

As Generative AI is less that two years old, peer reviewed literature is scarce. Literature is largely limited to Journal articles, blogs and webpages.

5.5 Areas for further research:

The study of student and educator perceptions of the potential benefits of integrating Generative AI tools into higher education is crucial to inform policy development, enhance teaching and learning and prepare students for the evolving technology landscape they will encounter in their personal and professional lives.

As this study was limited to just the engineering faculty, other faculties and institutions could benefit from similar studies as to their students and educators' attitudes to incorporating Generative AI into their course curricula. Similar research projects across multiple faculties would provide more comprehensive analysis of the issues involved.

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Appendices:

Appendix A. Ethics Approval

GRIFFITH COLLEGE DUBLIN

FACULTY ETHICS COMMITTEE, FEEDBACK - 16th February 2024

Student: Frank Kenny

Title: Explore the use of Artificial Intelligence as an efficient and effective learning aid for educators and learners in Engineering.

Student Number: 3081115

Supervisor: Peter Gillis

The Master of Arts in Education Learning and Development (MAELD) *Faculty Ethics Committee (FEC) has approved this proposed study you may proceed.

Peter Gillis
Dissertation Module Lead

Appendix B. Survey Participant Information Sheet

Survey Participant Information Sheet:

Research Topic: *Exploring the potential benefits of incorporating Generative AI in assessments and classroom engagement for tertiary engineering students, as viewed by educators and students.*

My name is Frank Kenny and I am currently studying for an MA in Education, Learning and Development at Griffith College. My dissertation for this degree is on the research topic listed above. To assist in this research, I am asking for your help in completing an anonymous survey. No personal data will be collected and there is no onus on you to participate.

If you would like to take part in this study, it will consist of the following steps:

- You will be asked to click on a link to a Survey Monkey questionnaire.
- You will be asked to complete a series of 20 questions, grading them from Very Likely to Very Unlikely.
- The survey should take no longer that 10 minutes to complete.
- The survey and any answers you provide will be recorded by Survey Monkey in a password protected electronic format. The survey data will be anonymised by Survey Monkey and you will not be asked for your name or email.

Please take time to read the following information carefully and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information.

What are the Aims and benefits of the research?

The study aims to investigate the use of Generative AI tools in engineering education from various perspectives, including students and educators in the Engineering Faculty. The study will assess how Generative AI tools can influence teaching methods and explore the implications of integrating these tools into teaching and learning. Based on the study findings, the study will suggest recommendations for the successful implementation of Generative AI tools in engineering education and develop guidelines and ethical considerations for educators to use Generative AI tools in engineering education.

Who is the Researcher?

Frank Kenny from Griffith College Dublin is conducting this research as part of the requirements for the Master of Arts in Education, Learning and Development.

What is required of you?

Should you agree to participate in this survey, you will be asked to take part in an online survey using Survey Monkey. In the survey you will be asked 20 questions to which you are asked to tick a rating between Very Likely to Very Unlikely. This survey should only take 10 minutes to complete.

What happens to the data collected?

Your privacy is very important.

Your responses in the survey are anonymous .

Your survey answers will never be shared with any third parties.

How will the Data be Stored?

The survey answers you provide will be stored securely in a password protected file on a password protected laptop. This data is only accessible by the researcher. I give my assurance that all information gathered as part of this research will be destroyed after graduation or in 24 months, whichever is sooner.

Are there any Risks?

All measures to minimise any risk to you will be taken. All information will be treated confidentially. However, In the event of the survey triggering an emotional event or you feel uncomfortable continuing, you may stop the session.

What happens to the Research Findings?

The research findings will be submitted to the Dissertation Examiners and the Examining Board in Griffith College for final grading. You can request access to the findings. The final dissertation may be published on the Griffith College dissertation repository in the library.

Has this research been approved by an Ethics Committee?

This research study has been approved by the Griffith College Faculty Research Ethics Committee.

Is my Participation Voluntary?

It is up to you to decide whether or not to take part. If you decide to take part, you are still free to change your mind at any time and without giving a reason.

If you do decide to take part, you will be given this information leaflet and a link to the survey.

Who can I Contact for more Details?

If you would like any further information regarding this research study or clarification of any of the points raised above, please contact Frank Kenny at frank.kenny@griffith.ie (the researcher) or Peter Gillis at peter.gillis@griffith.ie (the research supervisor)

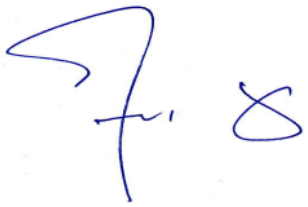
Links to the Survey:

If you wish to take part in this survey, please click on the link below:-

https://www.surveymonkey.com/r/PS8CTHV

Or use the QR code below:-

Thank you very much.



Appendix C. Student Survey:

Student attitudes to the use of Generative AI in third level Industrial Engineering education.

1. How likely are you to use Generative AI tools to improve your understanding of Industrial Engineering concepts?

- ○ Very Likely
- ○ Likely
- ○ Neutral
- ○ Unlikely
- ○ Very Unlikely

2. How likely are you to believe Generative AI tools can enhance your productivity in academic tasks?

- ○ Very Likely
- ○ Likely
- ○ Neutral
- ○ Unlikely
- ○ Very Unlikely

3. How likely are you to be concerned about the ethical implications of using Generative AI tools in your engineering studies?

- ○ Very Likely
- ○ Likely
- ○ Neutral
- ○ Unlikely
- ○ Very Unlikely

4. How likely are you to use Generative AI for idea generation in your coursework and assignments?

- ○ Very Likely
- ○ Likely
- ○ Neutral
- ○ Unlikely
- ○ Very Unlikely

5. How likely are you to think Generative AI tools can improve your ability to summarise complex information effectively?

- ○ Very Likely
- ○ Likely
- ○ Neutral
- ○ Unlikely
- ○ Very Unlikely

6. How likely are you to accept that Generative AI could be used for the marking of class assignments?

- ○ Very likely
- ○ Likely
- ○ Neutral
- ○ Unlikely
- ○ Very unlikely

7. How likely are you to be concerned about the accuracy and reliability of Generative AI generated content?

- ○ Very Likely
- ○ Likely
- ○ Neutral
- ○ Unlikely
- ○ Very Unlikely

8. How likely are you to use Generative AI for text editing and revision purposes?

- ○ Very Likely
- ○ Likely
- ○ Neutral
- ○ Unlikely
- ○ Very Unlikely

9. How likely are you to believe that Generative AI can provide personalised and constructive feedback similar to human educators?

- ○ Very Likely
- ○ Likely
- ○ Neutral
- ○ Unlikely
- ○ Very Unlikely

10. How likely are you to be aware of any potential bias that may exist in Generative AI generated content?

- ○ Very Likely
- ○ Likely
- ○ Neutral
- ○ Unlikely
- ○ Very Unlikely

11. How likely are you to explore Generative AI tools for enhancing your problem solving skills and critical thinking in industrial engineering?

- ○ Very Likely
- ○ Likely
- ○ Neutral
- ○ Unlikely
- ○ Very Unlikely

12. How likely are you to believe that integrating Generative AI into your studies could enhance your overall learning experience and academic performance?

- ○ Very Likely
- ○ Likely
- ○ Neutral
- ○ Unlikely
- ○ Very Unlikely

13. How likely are you to believe that Generative AI should be incorporated into engineering education as a teaching and learning tool?

- ○ Very likely
- ○ Likely
- ○ Neutral
- ○ Unlikely
- ○ Very unlikely

14. How likely are you to be concerned about the impact of Generative AI tools on your personal development and future career prospects?

- ○ Very Likely
- ○ Likely
- ○ Neutral
- ○ Unlikely
- ○ Very Unlikely

15. How likely are you to accept Generative AI as a means of setting in class tests, giving instant results to the students?

- ○ Very likely
- ○ Likely
- ○ Neutral
- ○ Unlikely
- ○ Very unlikely

16. How likely are you to engage with Generative AI tools for research and analysis tasks in industrial engineering?

- ○ Very Likely
- ○ Likely
- ○ Neutral
- ○ Unlikely
- ○ Very Unlikely

17. How likely are you to believe Generative AI tools can support the teaching and learning process effectively in higher education?

- ○ Very Likely
- ○ Likely
- ○ Neutral
- ○ Unlikely
- ○ Very Unlikely

18. Have you been made aware of the guidelines and policies regarding the use of Generative AI tools at your place of study?

- ○ Very Likely
- ○ Likely
- ○ Neutral
- ○ Unlikely
- ○ Very Unlikely

19. Please indicate what age bracket you fall within

- ○ 18-24
- ○ 25-30
- ○ 31-35
- ○ 36-40
- ○ 41-45
- ○ 46-50
- ○ 51+

20. Is there anything else you would like to share around your experiences with Generative AI as it relates to your engineering education?

Appendix D. Student Survey Results:

Q1. How likely are you to use Generative AI tools to improve your understanding of Industrial Engineering concepts?

RESPONSES		
Very Likely	13	24.53%
Likely	20	37.74%
Neutral	18	18.87%
Unlikely	7	13.21%
Very Unlikely	3	5.66%
TOTAL	53	

Q2. How likely are you to believe Generative AI tools can enhance your productivity in academic tasks?

RESPONSES		
Very Likely	18	33.96%
Likely	20	37.74%
Neutral	8	15.09%
Unlikely	6	11.32%
Very Unlikely	1	1.89%
TOTAL	53	

Q3. How likely are you to be concerned about the ethical implications of using Generative AI tools in your engineering studies?

RESPONSES		
Very Likely	9	16.98%
Likely	13	24.53%
Neutral	21	39.62%
Unlikely	9	16.98%
Very Unlikely	1	1.89%
TOTAL	53	

Q4. How likely are you to use Generative AI for idea generation in your coursework and assignments?

RESPONSES		
Very Likely	7	13.21%
Likely	18	33.96%
Neutral	11	20.75%
Unlikely	14	26.42%
Very Unlikely	3	5.66%
TOTAL	53	

Q5. How likely are you to think Generative AI tools can improve your ability to summarise complex information effectively?

RESPONSES		
Very Likely	14	26.42%
Likely	23	43.40%
Neutral	10	18.87%
Unlikely	5	9.43%
Very Unlikely	1	1.89%
TOTAL	53	

Q6. How likely are you to accept that Generative AI could be used for the marking of class assignments?

RESPONSES		
Very likely	10	18.87%
Likely	14	26.42%
Neutral	15	28.30%
Unlikely	9	16.98%
Very unlikely	5	9.4%
TOTAL	53	

Q7. How likely are you to be concerned about the accuracy and reliability of Generative AI generated content?

RESPONSES		
Very Likely	14	26.42%
Likely	21	39.62%
Neutral	11	20.75%
Unlikely	6	11.32%
Very Unlikely	1	1.89%
TOTAL	53	

Q8. How likely are you to use Generative AI for text editing and revision purposes?

RESPONSES		
Very Likely	9	16.98%
Likely	12	22.64%
Neutral	10	18.87%
Unlikely	15	28.30%
Very Unlikely	7	13.21%
TOTAL	53	

Q9. How likely are you to believe that Generative AI can provide personalised and constructive feedback similar to human educators?

RESPONSES		
Very Likely	3	5.66%
Likely	3	5.66%
Neutral	16	30.19%
Unlikely	17	32.08%
Very Unlikely	14	26.42%
TOTAL	53	

Q10. How likely are you to be aware of any potential bias that may exist in Generative AI generated content?

RESPONSES		
Very Likely	11	20.75%
Likely	23	43.40%
Neutral	15	28.30%
Unlikely	4	7.55%
Very Unlikely	0	0.00%
TOTAL	53	

Q11. How likely are you to explore Generative AI tools for enhancing your problem solving skills and critical thinking in industrial engineering?

RESPONSES		
Very Likely	8	15.09%
Likely	15	28.30%
Neutral	13	24.53%
Unlikely	10	18.87%
Very Unlikely	7	13.21%
TOTAL	53	

Q12. How likely are you to believe that integrating Generative AI into your studies could enhance your overall learning experience and academic performance?

RESPONSES		
Very Likely	11	20.75%
Likely	22	41.51%
Neutral	9	16.98%
Unlikely	8	15.09%
Very Unlikely	3	5.66%
TOTAL	53	

Q13. How likely are you to believe that Generative AI should be incorporated into engineering education as a teaching and learning tool?

RESPONSES		
Very likely	11	20.75%
Likely	21	39.62%
Neutral	11	20.75%
Unlikely	7	13.21%
Very unlikely	3	5.66%
TOTAL	53	

Q14. How likely are you to be concerned about the impact of Generative AI tools on your personal development and future career prospects?

RESPONSES		
Very Likely	9	16.98%
Likely	23	43.40%
Neutral	13	24.53%
Unlikely	6	11.32%
Very Unlikely	2	3.77%
TOTAL	53	

Q15. How likely are you to accept Generative AI as a means of setting in class tests, giving instant results to the students?

RESPONSES		
Very likely	3	5.66%
Likely	17	32.08%
Neutral	13	24.53%
Unlikely	15	28.30%
Very unlikely	5	9.43%
TOTAL	53	

Q16. How likely are you to engage with Generative AI tools for research and analysis tasks in industrial engineering?

RESPONSES		
Very Likely	10	18.87%
Likely	19	35.85%
Neutral	15	28.30%
Unlikely	8	15.09%
Very Unlikely	1	1.89%
TOTAL	53	

Q17. How likely are you to believe Generative AI tools can support the teaching and learning process effectively in higher education?

RESPONSES		
Very Likely	10	18.87%
Likely	27	50.94%
Neutra	9	16.98%
Unlikely	7	13.21%
Very Unlikely	0	0.00%
TOTAL	53	

Q18. Have you been made aware of the guidelines and policies regarding the use of Generative AI tools at your place of study?

RESPONSES		
Very Likely	18	33.96%
Likely	11	20.75%
Neutral	15	28.30%
Unlikely	6	11.32%
Very Unlikely	3	5.66%
TOTAL	53	

Q19. Please indicate what age bracket you fall within

RESPONSES		
18-24	2	3.77%
25-30	6	11.32%
31-35	13	24.53%
36-40	13	24.53%
41-45	5	9.43%
46-50	9	16.98%
51+	5	9.43%
TOTAL	53	

Q20. Is there anything else you would like to share around your experiences with Generative AI as it relates to your engineering education?

- *"The use of AI is not essential for me. However, I sometimes / have used AI when writing reports because most or all other students in the class are using".*
- *"It can only be a positive addition if used in the correct manner".*
- *"Generative AI can be an excellent tool for learning, researching & studying for exams. It can, however, be detrimental if taken as "gospel" when used. It can often produce misinformation and should be used in conjunction with knowledge and class based learnings. It should not be used to learn from, as Generative AI does not "learn" in the most effective ways and produces what it thinks you are looking for if you ask an open question. It can, though, produce good answers if asked a direct educated question. This method can support and enhance education".*
- *"AI is good in many ways but generated question / answers always need validation, whilst there are valuable faucets of Ai that are good there are also parts that don't meet standards, basically take all information in moderation and always prove your work".*
- *"AI needs to be taught".*
- *"I would not always trust AI as it can make up a lot of information that looks real and factual".*
- *"I personally don't use AI. I know many do but I completely disagree with using it as people are copy and pasting information to complete assignments. There is no learning outcomes from this and the quality of graduates will be negatively impacted due to lack of understanding and knowledge gained by completing studies the "correct" way. Just my opinion".*
- *"AI is great but should not be used in places where accountability is important".*

- *"I use AI as a tool, but would not trust it 100% and I research any information independently before using it. One caveat I have found is that I trust myself less now and feel I have to check my work with AI prior to completion and submission. If the findings are similar it makes me more reassured. Good luck with your survey".*
- *"In my experience with generative AI I found asking for a black or white answer was never really successful and often found myself questioning or correcting the answer it would give me. I found it more useful when bouncing ideas off it and asking it to help articulate and put my own workings into a more presentable and readable answer".*
- *"Students who used AI were aware of its quirks and failings and used it as they were familiar with it. I am old school and feel it is actually cheating in a way. Not for me I'm afraid".*
- *"Generative AI is a tool to be used. In the early days of Wikipedia it was seen as a problem in education as students would copy from it. Over the years it has become a valuable learning tool, but only a fool would copy from it verbatim for an assignment. I see AI the same way, a tool to be understood and used and incredibly valuable, but don't expect that copying material from it will produce a good assignment. I expect the same from educators. by all means use it as a tool to correct papers and provide feedback, but if I'm expected to write something, I expect someone to read it. I don't think the current generation of LLMs are good enough to fully take over critical review of assignments now, but maybe in the future".*
- *"Useful tool but even with an answer, I would still research its accuracy. Tool to point you in the right direction".*
- *"While it can be seen as an aid to research I find it can also lead off on side tangents or away from area you are looking into".*
- *"I have found the information provided by AI to be completely unreliable but I have found it very useful as a word smiting tool".*
- *"I think a lot of the Generative AI tools are too new and unproven so far. It might take some more time and testing to ensure these tools can be used in the way this survey mentions".*
- *"I found it very helpful for layout and structuring of assignments, which helped me to focus on the actual content of them. I would not trust it to provide reliable information and would make sure anything like that is done by the student. I'm fairly certain that at least one assignment was marked by a lecturer using AI. All of my group got very similar comments, many not very relevant to the actual assignment. There also seemed to be a rather negative bias compared to marking of other assignments".*

Participant Information Sheet– for Interview Participants:

Research Topic: *Exploring the potential benefits of incorporating Generative AI in assessments and classroom engagement for tertiary engineering students, as viewed by educators and students.*

You are invited to take part in a research study into the above topic. Before you decide if you want to take part, it is important for you to understand why the research is being done and what taking part involves.

Please take time to read the following information carefully and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information.

What are the Aims and benefits of the research?

The study aims to investigate the use of Generative AI in engineering education from various perspectives, including students and educators. The study will assess how Generative AI tools can influence teaching methods and explore the implications of integrating these tools into teaching and learning. The study will also evaluate existing Generative AI tools that may be relevant to engineering education, considering factors such as usability, effectiveness, and adaptability to engineering.

Who is the Researcher?

Frank Kenny from Griffith College Dublin is conducting this research as part of the requirements for the Master of Arts in Education, Learning and Development.

What is required of you?

Should you agree to participate in this survey, you will be asked to take part in a one on one Zoom interview. The interview will last no longer that 30 minutes and will be held at a time convenient to you.

What happens to the data collected?

Your privacy is very important.

Any information used in the survey report or any presentation will have the name removed so that your identity remains confidential. The data will be part of a thematic analysis, the view of interest in

this research is the collective perspective of all participants. Any mention of individual contributions will be solely for illustrative purposes and will be anonymised.
Any audio or video files will never be shared with any third parties.

What are my data protection rights?

The legal basis for processing your personal data is Article 6(1)(e) of the EU General Data Protection Regulation (GDPR).

Information will only be used for this research study which aims to develop, improve and increase the knowledge of how AI can be used in third level engineering education.

You are entitled to request any of the rights below unless it would make it impossible or very difficult to carry out the research study:

- The right to access to your personal data;
- The right to receive a copy of your personal data;
- The right to ask the researcher to restrict their use of your personal data;
- The right to ask the researcher to correct inaccurate information about you;
- The right to ask the researcher to delete your personal data.

You are entitled to object to any further processing of the information that is held about you (except where it is anonymised).

How will the Data be Stored?

Your personal information and the Zoom recordings along with any transcripts of the interviews and the associated collected data, will be stored securely in a password protected file on a password protected laptop. This data is only accessible by the researcher. I give my assurance that all information gathered as part of this research will be destroyed after graduation or in 24 months, whichever is sooner.

Are there any Risks?

All measures to minimise any risk to you will be taken. All information will be treated confidentially. However, In the event of the interview triggering an emotional event or you feel uncomfortable continuing, the interviewer will stop the session.

What happens to the Research Findings?

The research findings will be submitted to the Dissertation Examiners and the Examining Board in Griffith College for final grading. You can request access to the findings. The final dissertation may be published on the Griffith College dissertation repository in the library.

Has this research been approved by an Ethics Committee?

This research study has been approved by the Griffith College Faculty Research Ethics Committee.

Is my Participation Voluntary?

It is up to you to decide whether or not to take part. If you decide to take part you are still free to change your mind at any time and without giving a reason.
If you do decide to take part you will be given this information leaflet to keep and asked to sign and return the consent form.

Who can I Contact for more Details?

If you would like any further information regarding this research study or clarification of any of the points raised above, please contact Frank Kenny at frank.kenny@griffith.ie (the researcher) or Peter Gillis at peter.gillis@griffith.ie (the research supervisor)

Should you decide to participate in this study, please sign the attached consent form and send it to frank.kenny@griffith.ie

Interview Participant Consent Form – to be signed by the participant:

Consent to take part in research Interview

Research Title:

Exploring the potential benefits of incorporating Generative AI in assessments and classroom engagement for tertiary engineering students, as viewed by educators and students.

- I *(insert name in block capitals)* .....voluntarily agree to participate in this research study.
- I confirm that I have read and understood the information sheet regarding this research.
- I have had the purpose and nature of the study explained to me in writing and I have been given the opportunity to ask any further questions I may have.
- I agree to having a one on one 30 minute interview over Zoom with the researcher.
- I agree to the interview being recorded and the recording along with any subsequent transcripts being held on the researcher's laptop in a password protected file. Such files will be deleted within 24 months.
- I understand that all information I provide for this study will be treated confidentially.
- I am satisfied that any data I provide as part of this research will remain anonymous and will be used for the sole purpose of this research study.
- I understand that I can withdraw from the study at any time, without any consequences.

Participant's Signature:_____ Date:_____

Researcher's Signature:_____ Date:_____

Appendix G: Semi Structured Interview Questions:

Semi Structured Interview Questions for Engineering Educators.

1. Have you used Generative AI?
2. What is your overall perception of Generative AI tools such as ChatGPT and their potential impact on engineering education?
3. How familiar are you with the capabilities and limitations of Generative AI tools and how does this influence your attitude towards them?
4. What, if any, concerns have you about the potential for academic dishonesty and plagiarism with the use of Generative AI tools in engineering assignments?
5. How confident are you in your ability to detect AI generated content in student work and how does this compare to your confidence in identifying work generated by students themselves?
6. In what ways do you think Generative AI could enhance or hinder the development of critical thinking and problem-solving skills in engineering education?
7. What strategies or policies do you think should be implemented to ensure the responsible and effective integration of Generative AI tools in engineering education?
8. What opportunities and challenges do you foresee in terms of using Generative AI tools to support and enhance your teaching practice in engineering education?

Appendix H: Semi structured interviews with engineering educators.

Question 1	Educator 1	Educator 2	Educator 3
Have you used Generative AI?	Yes, I have. I've used ChatGPT. That's the only one I've used.	Yes	I have. I've used ChatGPT a couple of times. If I'm trying to put something together, Frank, maybe if I'm trying to put a question together for students. I've used it for content you know. So, when I'm putting together content for maybe the website or kind of a document for students. I have used it, yeah.
Question 2	**Educator 1**	**Educator 2**	**Educator 3**
What is your overall perception of Generative AI tools such as ChatGPT and the potential impact on engineering education?	I see it as a further development in the quest for productivity. But it comes with pros and cons and we need to understand this particular development very thoroughly and create an environment in which you will deliver benefits. Because a lot of engineering work is very repetitive. And this lends itself to doing exactly that. But we need to have a very thorough understanding of the tool we're using before we put it into widespread use.	Well, I think it's going to have a big impact on the education because what you need to do is you need to make sure that when you're getting feedback from the students that they understand what they're talking about and that they're not just using information that they don't understand to either answer or complete a question. So that's a challenge. It's not insurmountable. But it is a challenge and a lot of it, I think, comes from education for both the lecturer and the student. I think in the future it will be a huge aid and in much the same way that you know, reading references and books are you can pull that together, you can find different references. But I think at the moment it cannot be the primary answer or reference because I don't think one, the accuracy is proved and secondly, it doesn't demonstrate acquired knowledge for the students, both of which are important. So, I think at these early stages it should be approached with extreme caution.	You see from my perspective of using it, I personally find it very helpful. I wouldn't be the best at getting going writing something. So, for instance marketing asked me would I do a little article for them around career development and I was like, where do I even start? They gave me a list of questions so I use chat GPT to get me going. But just as a template, just as a give me a guide of where to go with this and then I correct it for myself. My worry is students are absolutely taking as gospel what it's giving back to them and they're not changing it. And you can tell, you know, you can tell because it's so perfect. And it's, you know, you can tell that like. When I'm working with students, I get very familiar with them and I can hear them in their answers in the way they write their answers. And you can kind of tell if they've taken something and not made it their own. So, for me, I've used it myself and I've used it to give me kind of a starting point on things but you definitely have to change it up and just use it in that way. Use that as a guide more so than anything, but my concern is there are students who are absolutely taking that as gospel when they use it.

Question 3	Educator 1	Educator 2	Educator 3
How familiar are you with the capabilities and limitations of ChatGPT and how does it influence your attitude towards them?	I really only have a superficial understanding of what the whole thing is capable of. I've used it as I say, and I've read a little bit a bit about it, but I wouldn't claim to have a comprehensive knowledge of it at all. My attitude towards it is favourable thus far, but my attitude is very susceptible to change. Should I find you know that it's something that, you know, is other than what I expect it to be.	I would say my exposure to them would be medium in that I have used it for various things. I have tested it for various things. For example, I very often run an exam question or an assignment through it and I run it through at different. So, I asked it to do it for 500 words for 1500 words and for 10,000 words and then I ask it to reference it and see where the referencing is coming from. So, I'm trying to kind of figure out, you know, a little bit to where it's drawing from because our field of industrial engineering could be a bit special. Realised and very often it doesn't get there, it stays in the general concepts and sometimes when I read a paper that it produces, I think that would not be a good paper if it was presented to me because it's off topic and it is not necessarily verifiable? So those are my concerns. Now when you read it, I would have that same concern if I was reading a student's paper too, you know, you take it for what it is. But having said that, there is a lot of language that's used in the AI that I would recognise as not being part of the student's familiar background, so if you know your students, you probably have a fair idea how their vocabulary works.	Yeah, my understanding is and this is just from a couple of the things we've done on campus. Like XXXX or XXXX, you know have done different sessions with us and my understanding is that the information that GPT has only kind of goes up to a certain point in time as such. So, when they give you the answer, you know when they answer a question you posed to it, it's giving you the answer based on that limited information that they have at that time, it wouldn't necessarily be completely up to date. It wouldn't necessarily be reference checked or anything like that. So, my understanding and I suppose how I view it when I'm using it is that again, it's great as a guide and a starting point, but I certainly wouldn't be taking it as you know, I would be taken as gospel what it's given me back.

Question 4	Educator 1	Educator 2	Educator 3
What, if any, concerns have you about the potential for academic dishonesty and plagiarism with the use of Generative AI tools in engineering education?	Well, I'd be very concerned about that. If the use of AI tools was undetectable. But I don't believe that's going to be the case. I think it will be detectable. In which case I have, I have a much reduced level of concern, but if the reality of it becomes that it is undetectable, then I think we're going to have to change the assessment methods.	Pretty much the same as any other form of plagiarism. You know, if they want to be clever and do that and put their efforts into concealing. You know where they got knowledge because they don't understand knowledge, you know, that's kind of what they're doing there. And they can do that with obscure books. They can do that with other information. But AI makes it a lot easier and it makes it, it's attractive to a lazy performance. And I think you just have to be aware of that. Part of the thing is we change our assignments and some of the, well, not so much the exams because they at this point, they don't use them on the exams, but in the assignments. If you think about them cleverly, the AI will be of minimal help. Particularly if it's individualised, a little bit. And we're also looking at bringing in interviews as a form of assessment and I think they would be a good addition to the engineering curriculum.	My, assignment is a little bit different in terms of I'm very clearly asking them to give me their story and I expect it to be written that way. I expect to be it to be written a bit, roughly a bit rough around the edges. And I always say to my students if you're giving me references, you've gone about this the wrong way. But I have definitely gotten one or two where I've gone, that language isn't that in the wrong context that, you know, a word is being used in the wrong context. So, there's definitely that. Unfortunately, that's the issue there that I would think that even aside from plagiarism. Actually, just laziness, you know. So even aside from it being kind of a plagiarism type issue, even just the laziness of it. Rather than sitting down and just writing on what they think, because for my assignment it's not academic, it's very much telling me what they think. And I've still had one or two who I can tell have used some kind of a phrase finder or some kind of a, you know, something to generate that answer for me. And so, it's even concerning just from a like using your own thoughts side of things as well as the actual plagiarism issue, which is definitely there.

Question 5	Educator 1	Educator 2	Educator 3
How confident are you about your ability to detect AI generated content in student work and how does this compare to your confidence in identifying work generated by the students themselves?	Well, as of right now I have a very low level of confidence in my own ability to detect AI. If any degree of care is taken and using it. That doesn't really correlate at all with the level of confidence I have, however, misplaced in my ability to detect all other forms of plagiarism.	I'm pretty confident that I can pretty much with medium confidence that I can identify longish passages. What is more difficult is where they paraphrase or reword it. And to some degree, if when they're doing that, they may have to understand it in order to do it correctly. So that's not the worst thing. But I do think it can limit their research to one source and they're just using AI to try to get through and it's lazy and it's also, there's a lack of awareness as to where the material is coming from and therefore it's not put into its perspective. Is this the most important thing, or the least important thing or is it just another thing that it's being added to the overall essay? So yeah, there's a lot there. It's a challenge it's a new challenge for us and that's OK. It's probably good to be challenged occasionally.	At the moment I feel fairly confident. For what I'm asking for, so for what I'm requesting of the students, the type of essay that I'm looking for I can kind of tell fairly quickly if it's somebody's own words or if it's just too much of it. You know, just ours was the use or something. But unfortunately, I imagine that's going to get harder as AI progresses and as AI gets like we're even talking in college about, you know, the pop up. You know, when you go on to the chat, the customer service chat and the little the chat bot pops up like even they're getting so good that sometimes people actually think they're talking to a human and not a chatbot. So, at the moment I'm fairly confident only because of what I'm asking only because my assignment, my essay is not academic. It's very much looking for their story. If my assignment was a bit more academic, I think it probably be much harder to actually distinguish and be able to pick it out without having some sort of a tool to help.

Question 6	Educator 1	Educator 2	Educator 3
In what ways do you think Generative AI could enhance or hinder the development of critical thinking and problem solving skills in engineering education?	I think that could go two ways. I think it could hinder critical thinking because at a low level it will do all of the easy solutions for people and it robs them of the opportunity for practise opportunity at a low level. And if you don't have practise opportunity at a low level as you move to the higher levels, your skills are not as well developed. However, at a very high level, I think it's capable of delivering unique solutions and perhaps a critical thinking and so doing.	Well, we'll start with how it might prevent that, and that is if it's used in a lazy way to solve problems and not to understand how the problem is being solved. If it is used as a method to understand how the problem is being solved, it's a huge advantage because they'll be able to, you know, it's not that the information is, is that all information is good for them, but it's how you discriminate between the information and what you prioritise and use now. I don't want a logarithm to determine that for my students, and I don't want them all to consider the same thing because they're individuals, and if they go to AI that it's going to be very similar. That's not actually what's best for engineering. What's best for engineering is a variety of ideas that are then evaluated and sometimes modified and you know, bits of each of them taken and combined. This is not a linear thing. Engineering requires thought, requires imagination and it requires, sometimes making connections that are not logical and testing them so you know it will not solve engineering problems like those. It will help to identify the things you need to have to solve the problems. But I believe that the student or the lecturer or the professional will still need to do the thinking. The critical thinking and evaluate that. That's where I think it's at, at the moment. Where is it going to be in 10 years time? That could be a whole different situation.	I think on the hindering side, it's just not actually just instead of taking the time to think through a question, the first instinct is to ask somebody, ask the ChatGPT. So, I think definitely on the hindering side. Again, I think it could probably be used in really good ways to actually enhance the information that we're giving or enhance the way we're giving information. So, I think down the line, it could probably be really, really useful even in terms of putting together kind of you know content that's accessible and that you know given in lots of different ways that students can take depending on their own learning needs and stuff. So, I think there's definitely ways that it could be very useful, but in a very managed way. But the hindering side definitely for me in education, it's not thinking like not using their own thoughts, not whether they're right or wrong. I think we live in an age where the students now because of social media and everything online, and the rate at which information is actually just like accessed on a daily basis and there's a fear of being wrong and not just failing an assignment. Not to that extent, but just your thoughts not being put down in the exact right way or so I think that's a fear where people as well, which is why these things then go, oh my God, this is amazing I'm definitely, you know, this will be great for me because I don't want people judging my thoughts. So yeah, I'll just use something else to make them.

Question 7	Educator 1	Educator 2	Educator 3
What strategies or policies do you think should be implemented to enable the responsible and effective integration of Generative AI tools in engineering education?	Well, as I said already, I think methods of detection are very, very important. I think there needs to be very clear codes of conduct available. There should be very clear examples of what is and what is not acceptable and there should be opportunity to practise both of these. And I think there's a need for a very effective feedback and communication system generally.	I think people need to be honest when they're using it. It needs to be referenced and it and I think, I think you know, if you're honest about the use of it and it's used in combination with other resources, that's a really good thing. That's another tool that you have and this tool should extend your reach of knowledge in a way that possibly a lot of effort would do or it might do in a more complete way. So, it offers a lot more to consider and I think that it's good, because a lot of engineering has to deal with disruptive technology now, and that is the kind of thing that requires to move outside of the box outside of anybody's box. But you need to have a lot of information to make those jumps and you get this information if you like inside the texts. So, you need to understand that you need to be able to use that but you also need to have that unique thing, which is human, which is the kind of an irrational combination that might appear logical to you. And you know what? Sometimes that's the thing that works. Well, that's the thing that is successful. Engineering is not linear; I keep saying that I don't think it is. So, I think that AI, you know, it's pluses and minus once again it's how much effort you put into using it effectively and training the people who use it and what should they include in their answer and what shouldn't they include? You know, a little bit of, rather than saying we're going to pretend that AI doesn't exist, but if we detect it in the students, we're going to tell them that's wrong, because that's plagiarism. Well, I think it's an informal mission. So, let's use it correctly. Identify it correctly and evaluate it like any other information that we would do. No, I don't want an AI written paper from a student, but anyone I've gotten that I felt like that, I rang them up and told them that, and they said sorry about that I'll write my paper now. So, I haven't been wrong yet, but that I'll say I have been wrong with ones that maybe I haven't identified, but you know, other than that I still feel they're reasonably easy identified and part of the reason is because I produce a lot of the assignments myself at different versions of an AI. Scan through them and when I see a section of those paragraphs coming up again, or that particular idea which was not discussed in class and not covered, forming the basis of the paper, then I know there's something else happened in here.	I think probably actually integrating into what we do and being really open about what it is and how it can be used and showing how it can be used as part of an assignment or as part of your study prep and then showing how it shouldn't be used. I know people who would be terrified to even say they use chat GPT for stuff, but I was working on the website and XXX on campus was like, oh yeah, sure, we pop into ChatGPT because I have no idea what way you should go about saying this and I was like, are we allowed? And XXX was like, yeah, it's just giving us a guide on what to do. XXX said it's so helpful. XXX said, it's so helpful in ways but we all have this fear of it because it's like, oh, no, if I use that, it's going to mean I'm plagiarising. It's going to mean I'm copying. So, I think way more awareness is needed amongst students of listen, this is a tool. This is a resource, but here's how to use it correctly and here's how not to use it. You know and then hopefully lots of resources on our side for being able to find when they use incorrectly.

Question 8	Educator 1	Educator 2	Educator 3
What opportunities and challenges do you foresee in terms of using Generative AI tools to support and enhance your teaching practise in engineering education?	Well, it creates a number of shortcuts, doesn't it, for example, it makes it much easier to design assignments and exams and their solutions. All of that can be very easily done. On the other hand, I think that AI has the potential to change engineering practise and if it changes engineering practise well, then I think it's inevitable that engineering education will have to change accordingly.	I see it helps me a lot because I can, I can very quickly get different responses, answers to questions and things that I'm thinking of posing and maybe seeing a slightly different side that maybe I want to introduce this into the conversation because I haven't used it. The other thing it's good for us to ask questions is I'd like to connect this concept with this concept. Where would I get information on it? What information is there? What connections have been made before, a lot of those type of things? You can get information pretty quick and see because I usually ask it to reference stuff because I'm interested in seeing where it's pulling this from and I'm also interested to see if the students have a similar bibliography, because that's another tip that if you see you know their bibliographies are not as obvious, and they certainly would not reflect somebody who just sat in the class. So, to be able to come up with a bibliography like that for a beginning student you definitely have questions.	So, from the careers side of things, it's actually huge. So, like it's being used for interviews, or it's being used for CV. So even the way I now teach how to do a CV has had to change. Because I've had to take into account the fact that it's going to be an AI programme, that looks at the CV before any human being. So, it has changed the way that I would say how to write a CV and what to write on. And unfortunately, it's become a little bit of a pain, a game. You're trying to make your CV match the jobs, but rather than really spending the time getting across why you're the best person for the job, you're purely trying to play this matching thing to get it past that first instance. So, it's definitely changed the way for the subject that I'm teaching. And that's in terms of recruitment, it's had a huge effect and good candidates are getting disqualified very early on in recruitment campaigns. For purely not matching 100% or because the AI technology has said this, the CV doesn't match and the person could have tonnes of experience and be the best person for the job but the computer can't read into a CV what a human being will, so that's been very hard because I now feel like I'm being disingenuous and I'm having to tell students to kind of do things to play a game. And so, it has definitely changed what I teach in that way.