IMPACTS OF GENERATIVE AI ON ENGINEERING AND PRODUCT DESIGN STUDENTS' PERFORMANCE

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ABSTRACT

There has been a growing interest in recent years in the use of artificial intelligence (AI) and computer science applications within the field of education. Previous systematic reviews and meta-analysis research has shown that use of AI and computer science can enhance students' performance in educational contexts. However, studies are mixed in their impressions of the use of Generative AI as a disruptive technology, with educators citing concerns over plagiarism and misuse of such technology by students. These tools represent a stark contrast to many traditional educational approaches and require reshaping of assessments to ensure that learning outcomes can still be measured. Nevertheless, there is still a significant lack of studies examining the students' perspectives on the use of these technologies and their impact on their academic performance. Therefore, the current paper aims to investigate how generative AI impacts upon product design and engineering students' performance within educational contexts in the UK. Through the distribution of an online survey, the study aims to assess student's attitudes, preferences, and challenges concerning the use of AI powered tools. Furthermore, it aims to capture valuable insights from students into how generative AI technologies can impact on various aspects of their academic achievement, learning outcomes, and engagement.

Keywords: Generative AI, education, teaching and learning, disruptive technologies

1 INTRODUCTION

Recent developments in machine learning have resulted in improving technologies for generating digital content, such as generative artificial intelligence (AI) [8]. Generative AI models utilize smart algorithms to understand patterns and produce novel content such as texts, images, sounds, videos, codes, amongst others [4]. Previous literature has indicated two major types of generative AI, these are named as Generative Adversarial Network (GAN) and Generative Pre-Trained Transformer (GPT) [7]. The Generative Adversarial Network (GAN) is a type of generative AI framework which contains two neural networks, known as a generator and a discriminator, working in competition to generate realistic data [2]. Conversely, the Generative Pre-trained Transformer (GPT) models employ a neural network architecture which effectively captures and comprehends contextual relationships within data. These modes are based on diverse datasets meaning that they can learn from a diverse set of examples to understand the complexities of language and context. The importance of Generative AI in education cannot be emphasized enough. AI-driven tools have begun to transform the learning sphere, reshape the teaching paradigms, influence research productivity and present complex challenges. In higher education, Generative AI tools are widely used to improve students learning process by generating highly original outputs in response to user prompts [5]. For instance, ChatGPT, Gemini and Claude are text-to text AI generators which can support students, specifically non-native speakers, in brainstorming ideas and receiving feedback on their writing [1]. In addition, Grammarly improves written work with grammar checking and style suggestions, benefiting students' communication skills in different ways. Furthermore, text to images AI Generators tools such as Dall-E, Midjourney, Vizcom and Stable Diffusion, can be considered as valuable tools for teaching technical and artistic concepts in arts and design [6]. For instance, Vizcom enhances learning by improving comprehension by producing visuals like diagrams and videos, catering to diverse learning styles for more effective education. Despite the numerous advantages of using Generative AI tools, these tools can introduce certain challenges and raise

concerns in the academic community. One major concern involves AI-assisted cheating, where students using AI tools to write assignments and complete their exams [11]. Therefore, ensuring unbiased and fair outcomes in assessments and grading could be a big challenge for academic evaluators. In addition, some concerns may be associated with students depending heavily on AI tools instead of utilizing their analytical thinking abilities. This may result in a decline in problem solving proficiency and creativity among students as these tools often provide quick and automated answers, potentially discouraging students from engaging in critical analysis and fostering independent thinking [5, 10]. On the other hand, it's worth noting that these tools could also promote a deeper investigative approach to inquiry. Learning how to question AI tools effectively can be beneficial, but it requires a substantial amount of knowledge and training [9]. While extensive research has been conducted on Generative AI in recent years, there is still shortage of studies exploring its impact on educational settings, particularly from a student perspective of utilizing Generative AI tools in the UK. There. Considering the growing interest in the use of Generative AI tools among students, it is important to understand their attitudes and views on it. Therefore, the current paper aims to assess the influence of these tools on student performance within educational contexts in the UK. By employing an online survey, this study aims to understand how generative AI technologies influence academic success, learning outcomes, student engagement, and any potential impacts on the overall educational experience.

2   METHODOLOGIES

The current study gathered data from 110 engineering (55) and product design (55) students in the UK through an online Qualtrics based survey, distributed through social media platforms including Reddit, LinkedIn and through the researchers 'direct contact' using a snowball effect. The primary objective of the questionnaire was to assess engineering and product design students' views and perspectives on using Generative data Technologies. The study was approved by the Nottingham Trent University, School of Science and Technology ethics committee. Informed consent was acquired before each participant completed the online questionnaire. A questionnaire employed a mixed-methods approach, incorporating dichotomous, matrix table and multiple-choice quantitative questions and open-text qualitative questions. All data were coded and analysed using SPSS and NVivo software.

3   RESULTS
3.1 Quantitative Findings

The sample comprised 79 males (71.2%), 28 females (25.2%), 2 other (1.8%) and 1 Prefer not to say (0.9%). Participants were aged 18 to 44 years old (M=23.61, SD=5.44). Out of 110 students surveyed, 59 identified themselves as UK home students, while 51 identified as international students. Table 1 displays the highest academic qualifications reported by participants.

Table 1. Academic Qualifications

	Frequency	**Percent**
PhD/doctorate or equivalent	2	1.8
Postgraduate/master's degree or equivalent	13	11.8
Undergraduate/bachelor's degree or equivalent	34	30.9
A levels, AS levels or equivalent	58	52.7
GCSE(s) or equivalent	1	0.9
None of the above	2	1.8
Total	110	100

Note. 'None of the above' could mean more specific international qualifications were not listed in available options and not those students had no qualifications.

81.8% of participants (90 people) indicated that they have used AI tools, while 18.2% (20 people) have not used them. It is important to note that use of AI was not restricted to students' studies and would include responses on personal use as well then. The most common AI tool used by participants was Chat GPT. Participants also mentioned other platforms such as Gemini, QuillBot, Snapchat AI, Vizcom, Auris AI, Copilot AI, Notion AI, Bing Chat, Dream image generator, Midjourney, Grammarly, Writesonic and

Adobe Firefly as other types of AI tools they used. Table 2 shows the frequency of using these tools among participants.

Table 2. Frequency of AI Tools Usage Among participants

	Frequency	Percent
Daily	6	5.8
More than 3 times a week	18	15.9
1-3 times a week	21	19.1
1-3 times a month	21	19.1
Less than once per month	11	10
Few times a year	13	11.9
Total	90	81.8

In addition, figure 1 illustrate the percentage of users who utilize AI tools for different tasks.
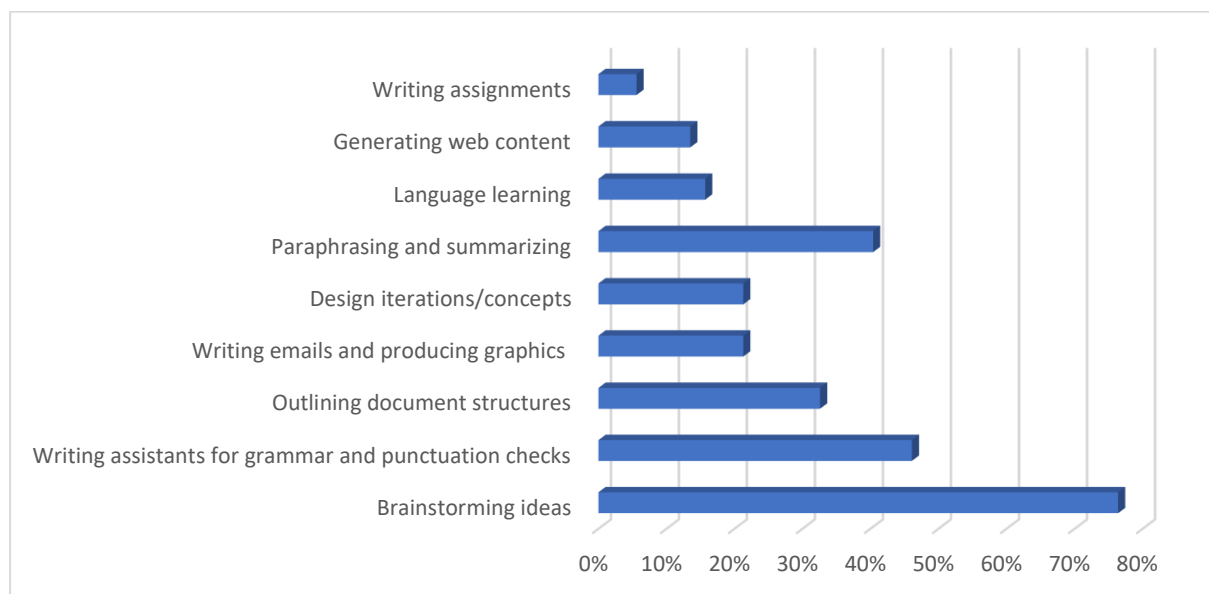

Figure 1. Diverse Applications of AI Tools Among Users

Furthermore, participants were asked a series of statements based on Likert scale to discover their opinions on the use of AI (Table 3).

Table 3. Participants view on different aspects of AI tool use

	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree
Generative AI tools *could* assist writing	34.5%	53.6%	9.1%	0%	2.7%
Generative AI tools *should* assist writing	12.7%	39.1%	33.6%	9.1%	5.5%
Generative AI tools *could* autonomously produce writing.	10%	58.2%	19.1%	9.1%	3.6%
Generative AI tools *should* autonomously produce writing.	5.5%	18.2%	35.5%	32.7%	8.2%
Generative AI tools *could* assist writing programming code.	24.5%	53.6%	14.5%	6.4%	0.9%
Generative AI tools *should* assist writing programming code.	17.3%	38.2%	35.5%	5.5%	3.6%
Generative AI tools *could* autonomously produce programming code.	11.8%	54.5%	20.9%	9.1%	3.6%

Statement					
Generative AI tools **should** autonomously produce programming code.	7.3%	30%	33.6%	20.9%	8.2%
Generative AI tools **could** improve efficiency	43.6%	43.6%	9.1%	0.9%	2.7%
Generative AI tools **could** assist the researching process	0.9%	43.6%	11.8%	4.5%	2.7%
Generative AI tools **could** assist the data searching process	33.6%	50%	13.6%	1.8%	0.9%
Generative AI tools **could** be used as a replacement for in person teaching	10.9%	14.5%	16.4%	30%	28.2%
Generative AI tools **should** be used as a replacement for in person teaching	6.4%	5.5%	12.7%	30%	45.5%
Generative AI tools **could** help with the understanding of difficult concepts	25.5%	47.3%	17.3%	6.4%	3.6%
Generative- AI tools **could** have a negative effect on students' creativity	20.9%	33.6%	29.1%	15.5%	0.9%
Generative AI tools **could** have a positive effect on students' creativity	9.1%	40%	36.4%	10.9%	3.6%
Generative AI tools **could** be used to produce inaccurate information such as fake news.	31.8%	44.5%	19.1%	1.8%	2.7%
Generative AI tools **could** affect the quality of future academic publications	21.8%	45.5%	23.6%	5.5%	3.6%
Generative AI tools will disrupt existing higher education models.	9.1%	41.8%	31.8%	15.5%	1.8%
Access to Generative AI tools **should** be limited for students	4.5%	16.4%	31.8%	29.1%	18.2%
Access to Generative AI tools **should** be limited for academic staff	2.7%	10.9%	31.8%	33.6%	20.9%
Students who use Generative AI tools for their assignments **should** receive lower grades	7.3%	18.2%	33.6%	24.5%	16.4%
Generative AI tools **could** assist in assignments marking	5.5%	47.3%	28.2%	11.8%	7.3%
Generated AI information can be trusted?	4.5%	19.1%	50%	22.7%	3.6%

Table 3 shows that most participants think these tools can help with tasks like writing and programming (around 80% agree or strongly agree). However, fewer support the idea of these tools working on their own (around 60% agree or strongly agree). While many believe these tools can make tasks more efficient (around 87% agree or strongly agree), there's worry about using them in place of traditional education (around 75% disagree or strongly disagree with replacing in-person teaching). Some are also unsure about limiting access to these tools for students and academic staff (around 60% are undecided). Overall, people see benefits but are cautious about trusting (50% unsure) and using Generative AI in education and limiting access.

3.2 Qualitative Findings

In addition to quantitative findings participants were also asked whether they think Generative AI tools are useful or not. Out of 110 participants, 61.8% said Yes, 5.5% said No and 32.7% of participants elaborated further on their reasons, which are discussed below in more detail.

3.2.1 Positive and Negative Elaborations

These written responses were split into *positive* and *negative* remarks. The three main *positive* reasons for the use of AI were to improve efficiency and ease of completing work (15 references), idea generation (11 references) and to improve the quality of their work (4 references). With regards to the efficiency and ease of work completion, one student stated: "*AI tools gives you a precise answer without any extra effort*". Whilst other students stated: "*It does it for you*" and "*Makes work easier*". With regards to idea generation, students provided very similar feedback. One student stated: "*They allow ideation that we might not be able to see*". Whilst another student stated: "*It makes ideas easy to come by so as to build on those ideas in limited time*". Many of the comments regarding the improvement of work related to spelling and grammar checking and included statements such as: "*It allows me to see*

my grammar mistakes and how to phrase things properly", *"Really helps fix spelling mistakes in my academic writing"* and *"sometimes elevates the writing technicality"*. There were a few *negative* comments surrounding the use of AI with students stating: *"I don't believe that using generative AI is acceptable in academia, because all the AI learning is done through other people's work and the use of AI makes it impossible to credit them"*, that [AI] *"lacks creativity when asked for names and ideas"* and they do not use it as *"I like to understand exactly what I'm writing about"*. Other references in the student feedback state that AI commonly support their understanding of concepts and helps find references for the work.

3.2.2 General Feedback

Students were also given the option to provide any additional comments at the end of the survey. Some comments reiterated the comments given in relation to idea generation previously by stating that: *"AI could help you in brainstorming"* Comments were also made in respect to limiting AI should for use in just supporting learning by stating: *"Generative AI, in my opinion, should only ever be really used as a support and not a replacement, it is well-known that the data it produces is not always accurate and its use should always take heed of this. It is not perfect, it is literally 'learning"*, *"It should be used as a supporting tool only"* and *"It's a useful tool – but should not be fully relied upon"*. One student also commented on the issue of AI hallucination whereby the AI generates incorrect or invalid information and responded by stating: *"There should be another option giving a brief understanding of AI hallucination"*. However, others felt that AI was more important and responded by saying: *"All people must and should learn the AI"*, *"I think it's none the less a valuable tool, whether you agree with it or not"* and *"AI can be used as a second brain, to structure and provide information that otherwise would never have been found"*.

4 CONCLUSIONS

The results of the survey show a surprisingly strong preference and level of support towards AI from students particularly in respect to their existing use of AI and their opinions on the benefits of AI in respect to its capabilities to support their writing, programming, research, and their efficiency. This aligns with the findings from the literature, which also highlights diverse attitudes and uses of AI tools among students, categorizing them into different types using cluster analysis [3].There was a distinct difference in the results however, between assistive and autonomous use, suggesting a conscious recognition of the distinction between an AI service that is viewed as a natural extension of a search engine and a tool that autonomously produces content. Thankfully students largely don't see AI as a replacement for in-person teaching ('our jobs are safe' and/or 'they like us') but students were surprisingly open to the use of AI to assess their work. However, the fact that 50% of students feel as that AI will disrupt, HE models and 50% were unsure (neither agreeing nor disagreeing) whether generated AI information could be trusted are key findings. This latter finding casts many of the other findings into reasonable doubt, mirroring concerns raised in Chan and Hu study [4] about the impact of AI on personal development and the ethical implications of its use. This point is particularly pertinent given that in the present study, over 80% of participants report having used AI. This uncertainty of the accuracy of the AI information provided could also explain the distinction between the **could** and **should** responses from the students in respect to its use for writing and programming. Furthermore, as educators it sheds light perhaps on our role in response to the proliferation of AI tools, to teach students to use them effectively and be able to critically review, consider and translate AI generated content. Giving students the tools and skills to discern between correct and incorrect AI responses and enabling them to become more discerning of AI use and recognise and understand the errors and causes of errors in data and information more generally, not just in relation to AI content.

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