

Teaching Scientific Writing in the Era of ChatGPT

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Abstract

Generative AI (gen-AI) tools such as ChatGPT have very quickly become widely accessible as well as embedded into a wide range of existing software. The early iterations of these technologies so far have produced impressive outcomes in terms of their ability to produce generic writing, leading to the question - will the teaching of writing skills become obsolete? A number of studies show that there are niche areas within engineering that gen-AI tools have not garnered enough specificity in information to produce written reports that are technically accurate enough for students to pass off as their own work. In spite of this, research shows the growing trend of students using gen-AI tools to complete their assignments without understanding the shortcomings of the technology when applied to their engineering discipline, particularly problematic with first-year engineering students. The Integrated Engineering Programme (IEP) was introduced to University College London in 2013/14 as a means of embedding transversal skills-based education into the curriculum. This presentation aims to outline the steps taken on the IEP to maintain the standards of writing competence and how gen-AI tools have shaped how we teach scientific writing and best practice when embedding their use into the curriculum.

Keywords: Generative AI, Teaching Scientific Writing, Engineering Education

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Introduction

Generative artificial intelligence (gen-AI) is very quickly transforming the way in which educators and students teach and learn. These technologies, which include the use of large language models (LLMs), video generators and diffusion model imaging offer educators and students extensive access to information and enable the creation of innovative educational materials with great efficiency. Of all the gen-AI technologies, LLMs (such as ChatGPT, Google Bard etc.) have been in popular demand as they have the capability to generate natural language text for a variety of purposes, including summarising research papers, ideation for essays and proof-reading (Menekse, 2023).

It is believed that engineering education has a lot to gain from incorporating gen-AI to enhance teaching material, learning environments, alleviate staff workload and offer a more personalised and engaging learning experience for students. An example of this has been presented in Bearman, Boud, & Ajjawi, 2020 where students were provided with different learning activities and practice problems tailored to different levels of difficulty based on their problem areas.

In studies by Jesse, 2023, Leung, 2024 and Mlocka, 2023 it was found that gen-AI has been particularly useful for neurodivergent students such as those with autism. Typically students that display the most common forms of autism tend to have the following struggles with in-class activities:

- Staying focused when reading large amounts of text
- Creative ideation whilst experiencing executive dysfunction
- Articulating and structuring thoughts

It was found that ChatGPT was able to assist in breaking large blocks of text into succinct bullet points for ease of cognitive processing, especially when used with tools that allow for speech-to-text programming to aid in structuring and articulating thoughts.

It has been shown that students use AI tools for vocabulary, grammar and spelling checking, sentence structure, corrections in tone, delivery and prose formality, varying writing styles to suit varying audiences, particularly useful for non-native English speaking students. Observations reported by Piatek, 2023 state that ChatGPT as a tool gave these students ‘more confidence’ when writing in English and many used it to simultaneously translate their written essays from their native language into English and correct their grammar and spelling. Whilst the use of AI in this way is not problematic, it may compound more fundamental language problems. A study by Wang, 2023 looked into the efficacy of ChatGPT when used by non-native English speaking students to translate their work. They found a number of inaccuracies in translation due to students’ unfamiliarity with the English language, concluding that students’ lack of proficiency with English language skills would only be exacerbated by ChatGPT.

Whilst it is apparent that gen-AI could and does currently provide many advantages to engineering education, there are equally just as many concerns, particularly around student learning. The most commonly reported concerns around generative AI in education are the rise of academic misconduct and the propensity for the tools to provide incorrect or misleading responses (Mubaroq, Kamalia, & Zenico, 2024).

In engineering disciplines such as Electronic Engineering and Computer Science, it has been found that students have indulged in AI-assisted cheating to generate code for assignment submission. A study by Moturu & Nethi, 2023 described how ChatGPT was being used by students in foundational programming courses and similar findings were discussed in a study by Lau & Guo, 2023. The prevalence of its use in scientific writing is also on the rise. The Higher Education Policy institute surveyed more than 1000 UK undergraduates on their use of gen-AI in writing essays and reports. Over 50% admitted to using AI to generate work for summative assignments without fact-checking and 5% admitted to copying and pasting directly from AI-generated text straight into their assignment (Adams, 2024).

Other reported concerns include the possibility that generative AI may hinder attempts to improve students' analytical thinking. Literature indicates that some educators argue that there is a possibility that AI will lead to a downgrading of human skills and knowledge and have likened this phenomenon to the invention of the calculator and its impact in reducing the need for basic arithmetic skills (Munger, 2024). However it is believed that AI poses a bigger threat to creativity and critical thinking, giving rise to an important question - how will educators ascertain whether students have acquired the fundamental understanding of a topic?

In response to the AHISA survey, education establishments reported additional concerns regarding ethical issues that include inherent bias, data privacy and intellectual property rights, as well as the detection and management of outputs from generative AI tools (Duncan, 2023). However with the evolution of these tools, a number of measures are being taken to adapt current teaching practices to allow for the incorporation of AI into engineering education.

Honig, Rios, & Oliveira, 2023 describe the way in which their teaching of coding for computer science students has been adapted to intentionally use ChatGPT to assist learning. Rather than students being asked to produce code, activities were framed such that AI was an unreliable participant and hence students were tasked with debugging and finding errors in coding. Nweke, Banner, & Chaib, 2023 describe how assessment mark schemes and rubrics could be amended in engineering assignments to reduce the likelihood of ChatGPT generated work achieving a pass mark. It was shown that generally, increasing the percentage of marks allocated to sections that necessitate critical thinking and analysis, and subsequently decreasing the marks allocated to sections that are descriptive or introductory meant that when assignments were generated by ChatGPT and marked against the modified rubric, they scored lower marks compared to when these same assignments were marked against the original rubrics. An article by Edmond, 2024 looked into scientific writing and detailed how they amended their teaching and assessment practice relating to engineering ethics where the assignment was an ethics essay. In this assignment, students were asked to declare where and how they used AI (non-punitively). The most common findings were that students used AI tools such as Scribblr to generate references and find a source's citation information and used ChatGPT to proof-read their work. The author used this information to incorporate more teaching on referencing and citations and the impact of academic misconduct.

Written communication skills have been shown to be one of the most coveted skills by engineering employers (Perkins, 2019), however research shows that scientific writing is particularly problematic for engineering students and has been exacerbated by the introduction of AI tools, highlighting the need for enhanced efforts in this area (Imran & Almusharraf, 2023). To address this, in 2023 UCL introduced a three-tiered categorisation system designed to specify (at the instructor's discretion) the extent of AI usage on a

particular assignment. The 3 categories are as follows: (1) Cannot use, (2) Can use for assistive purposes, (3) AI has an integral role. Whilst categories 1 and 3 are more straightforward to implement, category 2 can have a number of interpretations in its application, and if not well-specified, may breed a whole host of issues with written assessments.

In order to better define the scope of AI usage in a category 2 assignment, it is important to first ascertain how students are using AI on their scientific writing assignments. The Social Impact report (submitted individually) and Team report were the two assignments chosen for this study. These assignments were selected as they are among the first scientific writing assignments that students are exposed to in their first year of undergraduate studies at UCL Engineering on the Integrated Engineering Programme (IEP) (Mitchell, Nyamapfene, Roach, & Tilley, 2019; Truscott, Tilley, Roach & Mitchell, 2021).

Methodological Approach

Teaching

The study was conducted with first year undergraduate students from the Faculty of Engineering at University College London (UCL). Engineering Challenges is a very large and complex core module for between 900 and 1000 students from across seven departments within the Engineering Faculty at UCL, UK. It is an interdisciplinary team-based project module taken by a majority of the first-year students within the faculty in term 1 and is central to UCL's teaching framework. As the first team project experience for our undergraduate students, it aims to introduce them to how projects work and the skills needed to collaborate with others; the module focuses on what engineers do rather than what they know. Due to its placing within the curriculum, teaching was added to this module focused on the application of Artificial Intelligence (AI) in academic practice. The aim was to inform students about both the advantages and limitations of using AI tools, ensuring they understood the importance of maintaining academic integrity while leveraging technological advancements. The teaching was packaged with teaching on referencing and the reliability of sources as a way of indicating to students that this was a key writing practice.

Data Collection

To gather data on students' use of AI tools, two assessments from the module were selected, an Individual Social Impact Report and a Team Report, and the data was pooled. Students were asked to include a coversheet at the beginning of each assessment. Completion of this coversheet was optional, and no penalty was given for non-completion. The coversheet included two questions designed to record detailed information about the students' experiences and opinions regarding AI tools:

- Which AI tools have you used when writing? This includes spelling and grammar checkers as well as text predictors.
- How have you used these tools?

Data Analysis

The responses collected from the coversheets were manually transferred into an Excel spreadsheet for organisation and preliminary examination. To facilitate analysis, a Python script was developed and employed to clean the dataset. This script handled tasks such as

identifying non-responses, standardising text formats (and accounting for misspelling of AI tools), and categorising answers for easier interpretation.

The cleaned data was then analysed to identify patterns and trends in the students' use of AI tools. Quantitative analysis was performed to determine the frequency of use of various AI tools and their perceived usefulness. The insights from these analyses provided a comprehensive understanding of how engineering students at UCL are integrating AI into their academic writing processes, highlighting both common practices and individual variations.

Statistical Analysis

To understand the correlation between AI usage and grades, data was tested for normality with a Shapiro-Wilk test. If the data was normal, a One-Way ANOVA was run. If data was not normally distributed, a Kruskal-Wallis was performed followed by a Dunn's test. Statistical significance was set at $p < 0.05$.

Findings and Discussion

Response Rates

Data from 1056 assessments was extracted, with 855 (80.97%) students including and responding to the questions on the coversheet (see **Error! Reference source not found.**). From these, 170 students (19.88%) reported using no AI tools, and the remaining 685 students (80.12%) used one tool (521; 60.94%), two tools (139; 16.26%) or three or more (25; 2.92%) within the assessment. No statistical difference in grades was observed between students that used AI and those who did not.

The high response rate showed a significant level of engagement among the students. However, the voluntary nature of the coversheet meant that approximately 19% of students did not participate. In future assessments, requiring mandatory completion of the coversheet or integrating the questions more seamlessly into the assessment templates might increase the response rate. Additionally, considering a separate, dedicated questionnaire for collecting data on AI tool usage could provide more comprehensive insights.

Quantity of reported tools	n (students)	% (students)
0	170	19.88
1	521	60.94
2	139	16.26
3 or more	25	2.92
Total	855	100

Table 1. Quantity of Reported Tools.

Use of AI Tools

The reported AI tools were divided into four main categories: generative AI, spelling and grammar, AI translators, and others (see **Error! Reference source not found.**). There were 426 (50.35%) instances of generative AI use, 361 (42.67%) of spelling and grammar AI, and

51(6.03%) of AI translators. Additionally, 31 answers reported use of non-AI tools (e.g. MyBib, Google, Plagiarism Checker, Wikipedia).

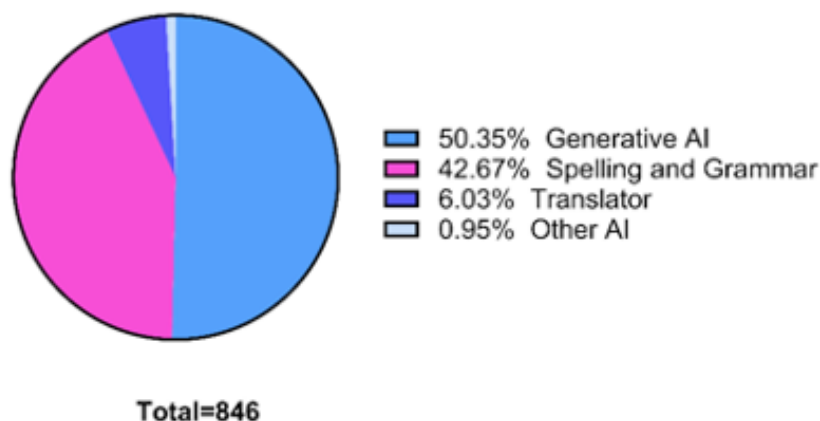


Figure 1. Pie chart showing AI tools divided into categories. Generative AI was the most commonly used tool, followed by spelling and grammar, and translator tools. Responses that disclosed the use of AI but did not mention specific software were classified as Other AI.

It became clear in the analysis of the data that while most students used AI tools (80.12%), there was still confusion regarding what constitutes AI. Some students mistakenly included non-AI tools such as Wikipedia and referencing software. This highlights a need for more thorough education on what AI tools are and how they differ from other digital resources. Despite this confusion, many students demonstrated adaptability in using AI tools for generating ideas and improving spelling and grammar, which are foundational aspects of writing.

Generative AI Tools

A total of 426 responses included mentions of generative AI (Figure 2a). The most commonly used was ChatGPT (89.44%), followed by QuillBot (6.10%) and Bing AI (3.52%). Focusing on ChatGPT usage, 322 students (84.51%) did not mention the version used, while 48 (12.60%) used ChatGPT 3.5, and 11 (2.89%) used the paid ChatGPT 4 version (Figure 2b).

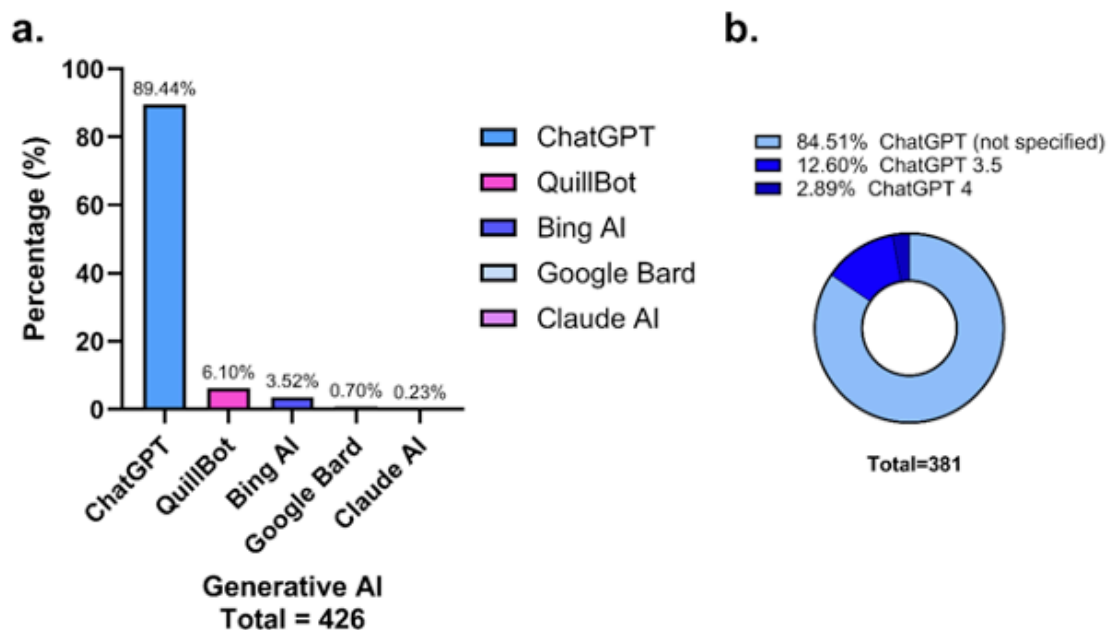


Figure 2. Generative AI tools used by students. (a) Bar chart showing percentage use of each generative AI tool. ChatGPT was the most used tool (89.44%), followed by QuillBot (6.10%) and Bing AI (3.52%). (b) Pie chart showing reported version of ChatGPT.

Spelling and Grammar Tools

361 students reported the use of spelling and grammar AI software. Grammarly was the most commonly used tool (57.89%) followed by Microsoft Word Editor (29.36%). 11.08% of responses included mentions of spelling and grammar checkers but did not specify which tools were used. Google Docs AI powered proofreading was used by 1.39% of students, with ProWritingAid used by 0.27%.

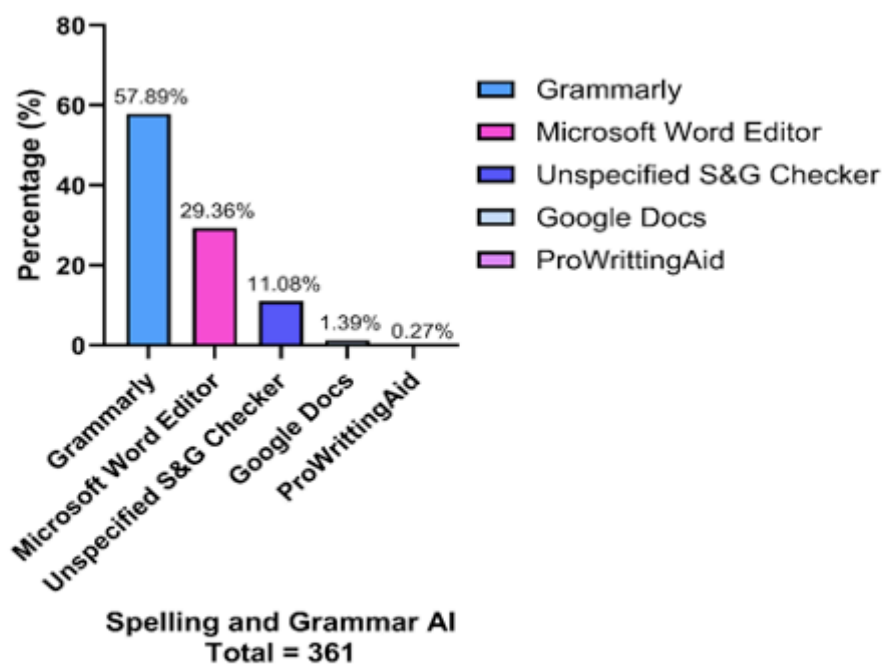


Figure 3. Spelling and grammar (S&G) tools used by students. Grammarly was the most commonly used tool (57.89%) followed by Microsoft Word Editor (29.36%).

Translator Tools

A total of 51 students claim to use translator tools (see Figure 4). DeepL was used by 60.78% of those students, followed by Google Translate (15.69%) and Baidu Translate (11.76%). The remaining 11.76% mentioned the use of translator tools but did not specify the software.

A significant portion of the UCL student body is international, with 54.84% international undergraduate students in 2022-23 (UCL, 2024). The use of AI tools to help with spelling and grammar, and translation was particularly beneficial for these students, aiding them in expressing their ideas more coherently. Tools such as Grammarly and Microsoft Word Editor, which focus on spelling and grammar, and DeepL, a translator, were extensively used, suggesting that these tools play a crucial role in helping students produce clearer and more accurate written assessments. This also benefits instructors in grading, as the quality and clarity of the submissions are improved.

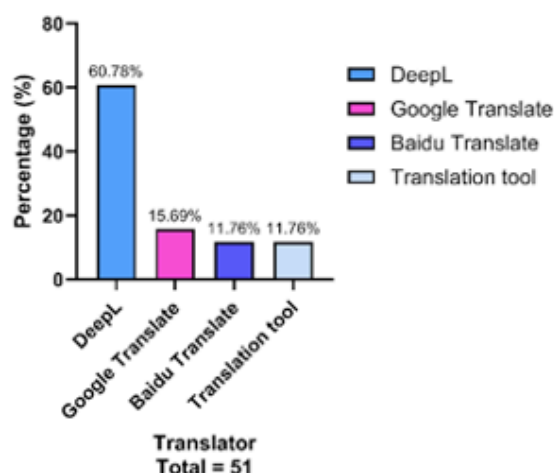


Figure 4. Translator tools used by students. DeepL was most commonly used (60.78%) of those students, followed by Google Translate (15.69%) and Baidu Translate (11.76%). The remaining 11.76% mentioned the use of translator tools but did not specify the software.

How Students Used Generative AI Tools

We additionally asked the students to provide details on how they had used specific AI tools in their work; "how have you used these tools?" We focused on how students had used generative AI in their assessments. From the 426 entries concerning generative AI tools, we classified the responses into two core groups: Writing, which involves language and text processing tasks, and Comprehension, which pertains to information insights and explanation. We further divided these groups into smaller subcategories.

Responses mentioning the use for spelling and/or grammar were categorised under spelling and grammar. Using AI to improve or write sections of text based on prompts was classified as organising and structuring content. Using AI for translating or finding synonyms was grouped into translation and synonym suggestions. These three subcategories were grouped under the umbrella term writing. Using AI for idea generation and brainstorming was categorised accordingly. Mentions of researching topics and related tasks were grouped into research and information gathering. Using AI to explain concepts was categorised under understanding and explaining concepts. Using AI to summarise text, such as research articles, was categorised as summarising content. These four subcategories were grouped under the umbrella term comprehension. Any responses mentioning a generative AI tool without specifying its use were categorised as not specified.

Table 2 displays the responses regarding the use of generative AI tools by students. Responses are separated into specific categories and subcategories, as discussed in the methods. ChatGPT was the most frequently used tool, with approximately 90% of students mentioning its use. This was followed by Quillbot (6%) and Bing AI (3.5%). Google Bard and Claude AI collectively accounted for less than 1%. This was anticipated given that ChatGPT was the first advanced conversational generative AI model released free of charge back in 2022 (OpenAI, 2022). The chatbot reached an estimated 100 million users just two months after launch, making it the fastest-growing consumer application in history (Hu, 2023). Except for Quillbot, all the generative AI tools used by students represent conversational AI models; capable of generating text responses, answering a multitude of questions, and carrying out specific tasks. Quillbot, on the other hand, is explicitly a writing

aid designed for paraphrasing, grammar checking, and summarising text. Unlike conversational AI, it cannot generate ideas or carry out analyses.

	Writing			Comprehension					Total
	Spelling and grammar	Organising and structuring content	Translation and synonym suggestions	Idea generation and brainstorming	Research and information gathering	Understanding and explaining concepts	Summarising content	Not specified	
Bing AI	3	0	0	1	6	3	0	2	15
Chat GPT	38	49	22	116	46	67	8	35	381
Claude AI	1	0	0	0	0	0	0	0	1
Google Bard	0	1	0	0	2	0	0	0	3
Quillbot	12	10	0	0	0	0	0	4	26
Total	54	60	22	117	54	70	8	41	
	136 (32%)			249 (58%)				41 (10%)	

Table 2. Student Usage of Generative AI Tools Across Different Writing and Comprehension Subcategories.

Markedly, 32% of students described using generative AI to help with writing tasks with Quillbot the second most used generative AI tool after ChatGPT, as shown in Table 2. This result is unsurprising given that the engineering course from which this data was gathered has a high number of overseas students, with approximately only 30% being native English speakers. We found that students frequently use chatbots to formulate sentence structures, check for errors, ensure words make sense in context, and generally improve their written language. One student stated, “I send the content I write to it and let it improve my grammar and spelling.” Examples of prompts used by students with the conversational AI tools (not Quillbot), as provided in the questionnaire, include: “Can you help me make the text flow better while correcting all grammar and spelling errors?”, “Check through the paragraph provided and, wherever possible, improve it”, “Can you make this more concise and straight to the point without any loss of information?”, and “Please make the following understandable and clear.” These prompts demonstrate the usefulness of AI in formulating coherent sentence structures with improved readability and clarity, especially for non-native English-speaking students.

Many students refer to using AI for “checking grammar” and improving sentence quality or “making it more concise.” Students often describe writing out paragraphs with their ideas and then running them through the GPT. In the case of ChatGPT, which was by far the most used generative AI platform identified in this study, pasting a paragraph of text into the GPT with a simple prompt such as “check this for grammar” or even “is this ok” results in the AI providing a revised version of the original text that is grammatically error-free. Often, it will additionally substitute words and phrases with synonyms, even without explicit instruction. This is interesting because these prompts are very basic, thus it is as if the models are assuming that the user wants a reworded version that sounds more fluent, as based on its training data. However, if more specific prompts are given, such as “check for spelling and grammar but do not reword any of the text,” the chatbot will do just that.

Comprehension-based use of generative AI accounted for 58% of the responses. This high percentage aligns with our expectations, as the primary appeal of these novel tools lies in providing information insights and explanations. The bar chart in Figure 5 showcases the data split within each category and subcategory for ChatGPT. Idea generation was the largest subcategory, with 116 students using the chatbot to help generate ideas for their assignments. For example, one student provided the prompt, “Can you brainstorm about the political risks of building a vaccination production plant?”, which demonstrates how students are using and interacting with these models, having human-like intelligent conversations. Another student mentioned, “Basically, I come up with a theme, and then the AI gives me a detailed solution,” highlighting a concern that some students may use AI for more than just generating initial discussion points.

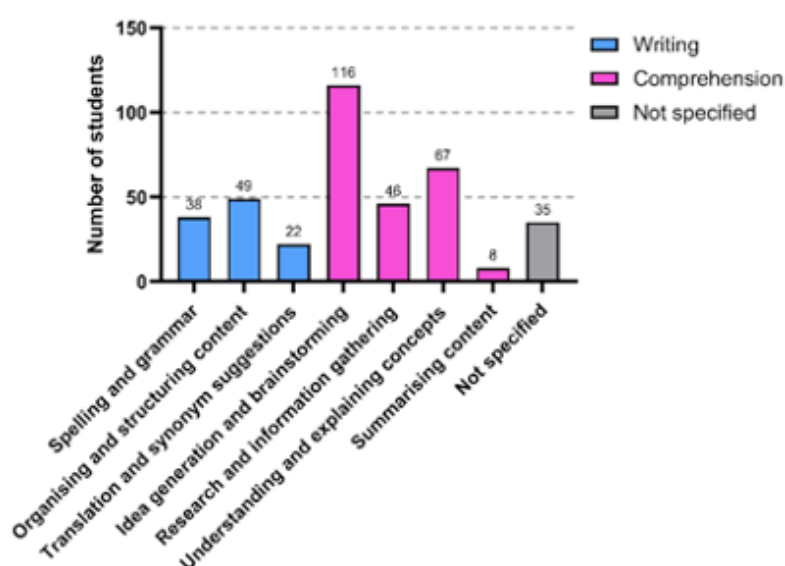


Figure 5. Bar chart of student usage of ChatGPT separated into writing and comprehension subcategories.

Understanding and explaining concepts was the second largest subcategory within comprehension, with 67 students (for ChatGPT). This use was anticipated, as the chatbot can simplify jargon-heavy text from articles or sources into lay terms, a valid and useful application, especially for foreign students who may struggle with scientific terminology. Notably, one student commented, “I find AI better at explaining than Google,” likely inferring that the chatbot is easier to interact with, and understand, compared to searching for answers using a web browser.

Conclusion

Within this study we investigated how first year undergraduate engineering students are using gen-AI tools within their written assessment. The use of a coversheet combined with explicit teaching on how to use gen-AI tools within written assessments proved to be largely successful with very few cases of suspected passing off gen-AI generated work as a student’s own. A significant majority of students (81%) engaged with the coversheet, despite it being optional, but highly recommended. Framing the coversheet as a way to declare the use of generative AI tools, similar to referencing external sources, seems to have created an

atmosphere where students do not feel the need to hide their use of these tools. Of those that completed the coversheet, 80% declared use of some form of gen-AI tool while 20% declared no use. The most popular tool is by far ChatGPT, possibly due to the publicity surrounding it and the versatility of it as a tool. Overall students reported that they were primarily using gen-AI tools for writing support, idea generation or information sourcing.

While these uses are at least somewhat positive in an educational setting it raises questions about where does one draw the line between using AI as an assistive tool for university assignments and when does it cross into territory where the work is no longer representative of the student's own efforts. This is especially thought-provoking given the generative nature of these AI models. While AI for spelling and grammar correction, translation, and synonym suggestions has been integrated into tools like Microsoft Word for years, the rise of generative AI suggests a shift in student reliance on these technologies for written work. The added functionality of generating new text based on specific prompts might lead to greater dependence on generative AI for corrections. Although the core ideas from students are retained after using GPT, the role of AI in shaping the final text warrants careful consideration.

Similarly where students are using AI as a tool to find information, how much are they critically evaluating the information produced by these tools? This is particularly relevant for first year students given their limited knowledge of their degree subject, do they have the information or skills needed to critically evaluate the information AI provides? Students' reliance on the outputs of AI tools and assumption of 'correctness' of these outputs may lead to the inclusion of irrelevant or tangentially relevant material and for them to 'miss the point' of an assessment. This is particularly relevant when working in spaces that are traditionally seen to be outside of engineering, like sustainability or ethics, and where engineering students may feel out of their depth and more reliant on the information from AI tools.

The findings from this study suggest several implications for future teaching practices. Firstly, incorporating detailed instruction on AI tools and their appropriate use in academic writing should be a standard part of the curriculum. Given the widespread use of tools like ChatGPT and Grammarly, it is important to provide guidance on how to use these tools effectively while maintaining academic integrity. Second, the need to discuss the strengths and weaknesses of these tools as well as how to evaluate the information generated and apply that within students' work. Finally, given the fast evolution and uptake of these tools, there is a continuing need to evaluate the potential impact of them within the educational space and engage with how to incorporate their use within teaching in the future.

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