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Assessing the impact of AI enhanced education on student development

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ABSTRACT

CONTEXT

Universities have the potential to significantly contribute to advancing Sustainable Development Goals (SDG) through thoroughly crafted curriculum, teaching pedagogy and interdisciplinary teaching practices. However, the integration of AI, such as ChatGPT in education in recent years has posed serious threats to academic integrity. While the adoption of cutting-edge technology is unprecedented, it is crucial to foster teaching practices that prioritize quality education by perceiving technology solely as a tool for enhancing student learning.

PURPOSE OR GOAL

Engineering courses need to be structured to prioritize not only knowledge acquisition but also cultivation of lifelong skills, including analytical reasoning and technological competence. This study identifies the teaching strategies employed in the redesign of the Electrical Safety course assignment at the University of New South Wales (UNSW). The redesigned assignment is committed to SDG engagement by embracing an interdisciplinary approach to enhance student knowledge, critical evaluation skills and technological proficiency.

APPROACH OR METHODOLOGY/METHODS

This study investigates a case study assignment integrated with ChatGPT into the Electrical Safety curriculum at UNSW. The assignment required students to analyse electrical incidents and devise solutions accordingly. The primary objective was to harness ChatGPT's extensive knowledge resources and compare its generated solutions with the students' own analytical efforts. Academics thoroughly evaluated the outcomes of 169 assignments to assess student proficiency in utilizing modern day educational technology and their impact on student learning.

ACTUAL OR ANTICIPATED OUTCOMES

The key outcomes of this study highlight the teaching strategies developed to design an assignment to foster critical thinking and thorough analysis in students, alongside technological competence. Instances of effective and ineffective utilization of technology are presented. Based on our analysis, recommendations are provided for enhancing student learning through the utilization of AI, offering valuable insights for future consideration.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

The outcome of the case study assignment revealed that only a mere 6.5% achieved exceptional results, emphasizing the necessity to train students on the appropriate use of technology, steering them clear of over reliance on it. Generative AI holds promise for its potential utility in student education; however, students need to be taught the importance of original thought and responsible use of technology.

KEYWORDS
AI enhanced education, Technological proficiency, Case study assignment

Introduction

Generative AI which was first introduced in the 1990s has gained massive popularity amongst students and academics in the recent years. Results from a recent survey conducted by Amani et al. (2023) suggest that in an education setting, majority of students and academics have used AI in some ways either for asking technical questions or general knowledge questions.

Generative AI has also captured significant attention in the ever-evolving engineering education, where it can be seen as a promising solution for generating and delivering up to date course content efficiently while improving student learning (Yelamarthi et al., 2024). Many engineering academics have explored the potential of incorporating generative AI such as ChatGPT in their academic courses. ChatGPT is an AI based natural language processing system that can communicate in a human like manner (Dempere et al., 2023). It can generate responses to questions and can help in writing emails, generating codes and many more. Since its advent it has set records as the highest growing customer application in history, attracting more than a hundred million users within just two months of its launch (Stankovski et al., 2024). Fatahi et al. (2023) explored the use of the free version of ChatGPT, ChatGPT 3.5 in a Year 2-3 Civil Engineering assessment task. The students perceived the assessment task as positive and appreciated the use of innovative technology within the learning environment. The outcomes of the assessment highlighted the potential of ChatGPT 3.5 in improving critical thinking amongst students. Another work by Livotov and Lemaire (2023) studied the effectiveness of ChatGPT in generating ideas for an engineering problem. Based on results it was suggested that although the initial ideas presented by ChatGPT were often inaccurate or incomplete, with multiple prompts it was able to generate a huge quantity and variety of ideas that were quite accurate.

On one hand, ChatGPT has come across as a tool that has the potential of improving learning experience. On the flip side, it poses challenges to the accuracy and reliability of the generated responses (Farmer et al., 2023, Qadir, 2023). As the online resources are readily available, students tend to rely on them heavily to get quick information, which may not be accurate. ChatGPT is also a combination of such online databases and may generate misleading information. Additionally, it presents a risk to academic integrity due to its ability to pass various assessments without the realization of experts (Nikolic et al., 2023). In the past, ChatGPT has shown success and accuracy in completing tasks such as writing computer programs, essays, completing parts of medical licensing exams as well writing fake research abstracts (Nikolic et al., 2023). Currently, there is a lack of availability of plagiarism tools to detect the use of ChatGPT (Eke, 2023, Zhong et al., 2023). However, from its growing popularity it is evident that despite limitations, the field of engineering education will continue to adopt such tools (Qadir, 2023). A survey conducted in July 2023 with students from 100 engineering universities in developing countries revealed that 89.69% of the survey participants had used ChatGPT for educational purposes and believed it to be a “Game changer to the future of education” (Elkefi et al., 2024). Engineering students need to continuously engage with ever-evolving technology that can enhance their efficiency and productivity. ChatGPT is a prime example of such technology in today’s era. Therefore, they must possess AI literacy and be equipped with skills and guidelines on the proper use of AI. Consequently, academics and educational institutions need to address the concerns raised by ChatGPT and redesign assessment strategies and guidelines that advocate for quality education and promote effective utilization of Generative AI. Nine academics from seven different Australian universities came forward to scrutinize their assessments against ChatGPT, to gain better understanding of the strengths and weaknesses of the various assessment types offered in universities (Nikolic et al., 2023). They concluded that ChatGPT was successful in passing most quizzes, however it struggled in tasks involving critical thinking and research related writing. While ChatGPT could produce a passable outcome with correct prompts, proper referencing remains a significant weakness at present.

In this study, the authors aim to contribute to the Sustainable Development Goals (SDG) by investigating the potential of ChatGPT 3.5 in an Electrical Safety course assignment. The redesigned assignment aims to foster critical thinking amongst students and introduce

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technological innovation. The methods used for redesigning the assignment are presented along with assignment outcome and future recommendations.

Electrical Safety Assignment Redesign

The Electrical Safety course is offered at postgraduate level at the University of New South Wales. It is a completely asynchronous distance course, with no scheduled lectures. Instead, all course materials and activities are accessible in the Moodle platform with students having the flexibility to learn and progress at their individual pace. In 2023, 169 students enrolled in the course, with majority being international students. Given the widespread discussion and use surrounding ChatGPT, the authors endeavoured to incorporate ChatGPT 3.5 in the Electrical Safety course. They sought to explore both the limitations and potential benefits of using AI technology for students' course assignments that required critical analysis.

The assignment contributed 10% towards the course mark. It was introduced as an individual 24 hours take home assignment. As part of the task students were given various scenarios of electrical incidents which comprised of incident details. They were required to thoroughly analyse the given incidents and provide detailed Engineering, Administrative, Personal Protective Equipment/ Personal Protective Measures (PPE/ PPM) solutions and standards related to the incident. The idea was to provide solutions that would help mitigate the impact of the incident or completely avoid the incident from happening in the first place. The task required critical thinking and analysis, as well as thorough research to come up with relevant solutions and standards.

Acknowledging that due to the nature of assignment being descriptive many students will seek assistance from ChatGPT, authors decided to include free version of ChatGPT, ChatGPT 3.5 as an integral part of the assignment. Table 1 compares the assignment format in previous years with the redesigned assignment in 2023. As per the redesigned assignment, students were expected to input the given incident details in ChatGPT and attach a screenshot of the proposed answers in their assignment. The main idea was to use ChatGPT as a starting point and then build on the proposed answers using their own understanding of the course material. The primary objective was to harness ChatGPT's extensive knowledge resources and compare its generated solutions with the students' own analytical efforts and to study how well the students were able to adapt to new technology.

Table 1: Comparison of Assignment format in previous iterations and in 2023

Assignment format in previous iterations	Redesigned assignment in 2023
As part of assignment, scenarios of electrical incidents were given to students.	Students were mandated to use free version of ChatGPT for the assignment.
Students were expected to analyse the given incidents and provide Engineering, Administrative, Personal Protective Equipment solutions and standards related to the incident.	They had to declare the use of Chat GPT and attach screen shots of ChatGPT answers in Moodle. Students were expected to evaluate and expand on the responses generated by ChatGPT.
	A grading scale was formulated to provide students with a clear understanding of the expected criteria for using ChatGPT and to outline the elements that were going to be assessed for a strong assignment.

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A grading scale, as shown in Table 2 was devised to clarify to students the appropriate utilization of ChatGPT and to outline the expectations of the course staff for a well-written assignment.

Table 2: Grading scale for Scenario-based assignment

Grading Scale	Requirements
Excellent (90-100%)	• Demonstrates a comprehensive understanding of the scenario and provides insightful analysis to build on Chat GPT suggestions. • Presents a well-structured and coherent response with clear connections between ideas. Applies relevant concepts and theories effectively to the scenario, exhibiting a deep level of understanding of the course material. • Offers innovative and creative solutions or recommendations. • Shows exceptional critical thinking and problem-solving skills. • Communicates the analysis with exceptional clarity and conciseness exhibiting impeccable grammar and spelling.
Good (70-90%)	• Displays a reasonable understanding of the scenario and provides effective analysis to build on Chat GPT suggestions. • Presents a response with a logical structure and generally clear connections between ideas. • Applies relevant concepts and theories appropriately to the scenario, exhibiting some level of understanding of the course material. Offers thoughtful solutions or recommendations. • Demonstrates satisfactory critical thinking and problem-solving skills. • Communicates the analysis effectively with clarity and conciseness. Grammar and spelling are mostly accurate, with only minor errors that do not impact understanding.
Fair (50-70%)	• Displays a basic understanding of the scenario but lacks in depth analysis. • Presents a response with a somewhat disorganized structure and weak connections between ideas. • Applies limited relevant concepts and theories to the scenario, exhibiting a limited understanding of the course material. Demonstrates limited critical thinking and problem-solving skills. • Communicates the analysis, but there are some areas that lack clarity and conciseness. Grammar and spelling errors are present, but they do not significantly detract from the overall message.

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Grading Scale	Requirements
Poor (< 50%)	• Lacks effective analysis. Provided solution very similar to Chat GPT suggestions. • Presents a poorly structured and incoherent response with disconnected ideas. • Fails to apply relevant concepts and theories to the scenario adequately, exhibiting no understanding of the course material. • Offers inadequate solutions or recommendations. • Shows minimal critical thinking. • Communicate the analysis without clarity, and there are numerous grammar and spelling errors that hinder understanding.

Assignment Outcome

Figure 1 shows the performance of students in the assignment. 35% students demonstrated poor performance, around 58% were average and a small 6.5% achieved exceptional results.

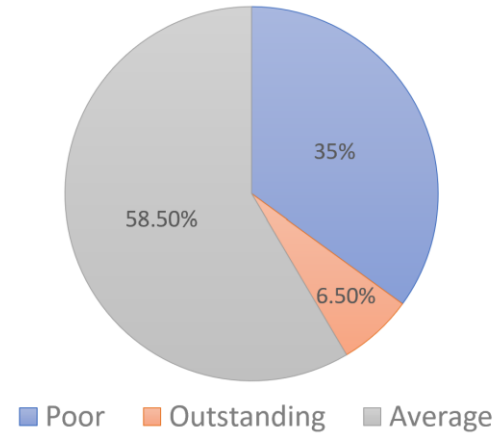

Figure 1: Students performance in scenario-based assignment

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Outstanding Assignments

The students who excelled, demonstrated thorough analysis and commendable problem-solving skills. They used ChatGPT as a foundation only and developed their analysis from there. They applied relevant concepts and theories effectively to the scenario while demonstrating deep understanding of the course material. Also, their responses were well-structured, and the connection between ideas was visible. Figure 2 illustrates an example from the assessment wherein the student evaluates the PPE solutions offered by ChatGPT, followed by proposing their own solutions.

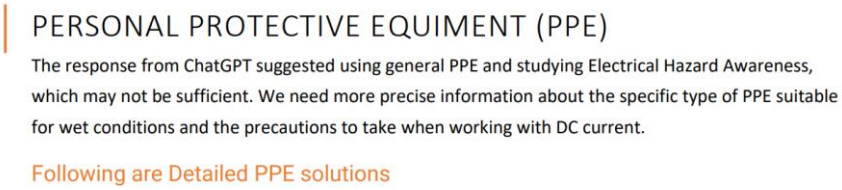


Figure 2: Snapshot taken from an outstanding assignment

Poorly performed assignments

A large percentage of students submitted poorly executed assignments displaying heavy dependence on ChatGPT and did not reflect any critical thinking or effective analysis. These assignments can be categorized into 2 main groups.

The first group of students either directly restated, or rephrased certain concepts from the ChatGPT solution without incorporating their own contributions. Figure 3 displays an example from the first group of poorly done assignments, wherein the student rephrased the ChatGPT solution, showing no comprehensive analysis or original work.

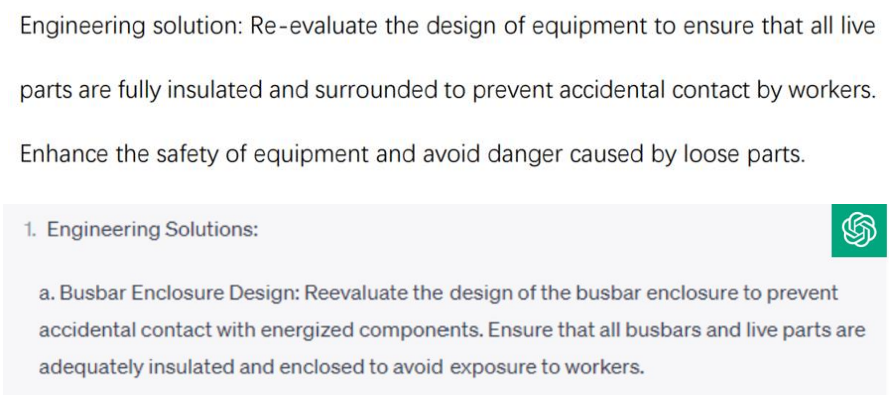


Figure 3: Snapshot taken from Group 1 of poorly done assignments.

The second group of poorly done assignments offered brief, one-line feedback on the proposed solutions from ChatGPT. They failed to provide meaningful analysis, reflective judgement and problem-solving skills. Figure 4 presents an example of a subpar assignment with no thorough analysis involved.

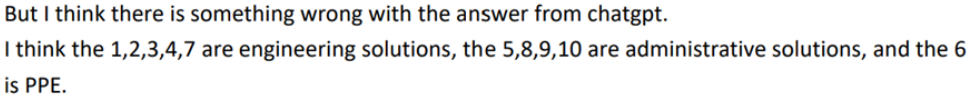


Figure 4: Snapshot taken from Group 2 of poorly done assignments.

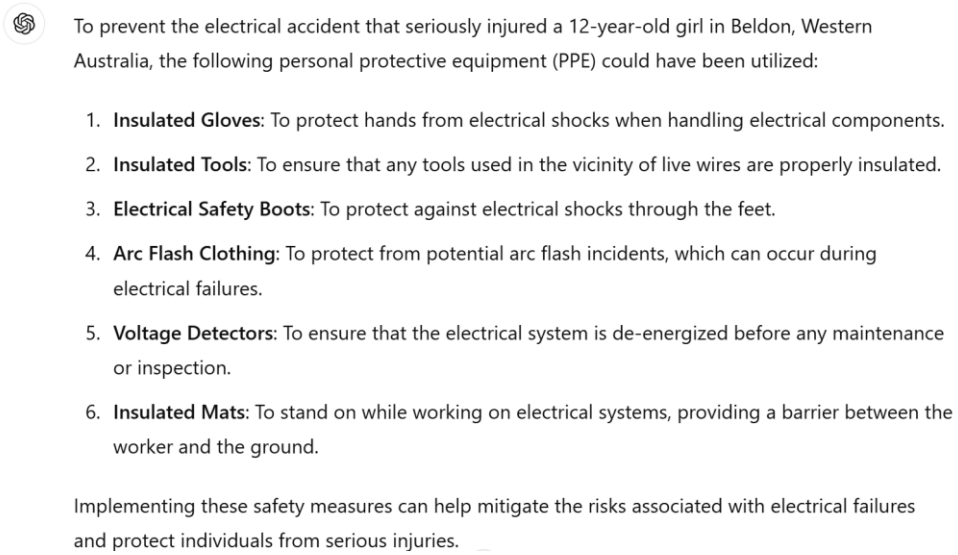
Assessing ChatGPT's problem solving skills

Assignment outcome demonstrated that ChatGPT provided solutions were comprehensive in some scenarios and categories, while in others, solutions were predominantly generic and lacked

specificity tailored to the given incidents. In certain cases, the generated solutions were not even applicable to the given incident.

As an example, students had to find solutions for this given scenario: “Western Australia’s electrical safety regulator has concluded its investigation into the electrical accident that seriously injured a 12-year-old girl at a property in Beldon in March 2018 due to failure of a neutral conductor that formed part of the aerial service cable which supplies electricity to the property; the ‘open circuit neutral’ fault occurred inside the mains connection box (MCB) attached to the roof of the property; the failure of the neutral conductor caused metallic parts connected to the electrical earthing system, including the garden tap, at the property to become electrically live, up to 230 volts; and the neutral conductor of the aerial service cable failed after it was subjected to prolonged heating.”

ChatGPT 3.5 provided the PPE solution for the given incident as shown in Figure 5. Although the provided solution is generally correct, it is not practical for a household situation since no one generally wears arc flash clothing or electric safety shoes, nor do they have insulated mats at home. In this case, the students had to rely on their own thorough analysis and problem-solving skills to devise appropriate solutions relevant to the incident.


To prevent the electrical accident that seriously injured a 12-year-old girl in Beldon, Western Australia, the following personal protective equipment (PPE) could have been utilized:

1. **Insulated Gloves**: To protect hands from electrical shocks when handling electrical components.
2. **Insulated Tools**: To ensure that any tools used in the vicinity of live wires are properly insulated.
3. **Electrical Safety Boots**: To protect against electrical shocks through the feet.
4. **Arc Flash Clothing**: To protect from potential arc flash incidents, which can occur during electrical failures.
5. **Voltage Detectors**: To ensure that the electrical system is de-energized before any maintenance or inspection.
6. **Insulated Mats**: To stand on while working on electrical systems, providing a barrier between the worker and the ground.

Implementing these safety measures can help mitigate the risks associated with electrical failures and protect individuals from serious injuries.

Figure 5: PPE solution provided by ChatGPT for the given scenario.

Similarly, the standards generated by ChatGPT were general and inaccurate. The students are required to do their own comprehensive research to find relevant standards.

Engineering and administrative solutions generated by ChatGPT were often comprehensive, however, it could not very well distinguish between the two categories and provided solutions that were intermixed.

The responses from some students on the use of ChatGPT are recorded below:

“I really enjoyed the ChatGPT assignment. It highlighted the dangers of relying on the AI. For 3 of the 4 questions it provided answers that were outright wrong.”

“In my assignment when using ChatGPT I noticed that ChatGPT provided general answer to my questions, rather than digging deeper into the topic to provide me with a tailored solution for each individual issue. At the same time the information provided by ChatGPT isn’t always accurate and needed to be double checked from accredited sources before using.”

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Discussion and Recommendation

The authors firmly believe that the use of ChatGPT has a positive impact on the student learning experience. Incorporating technological innovation like ChatGPT in assignments will train students on the proper use of AI and offer academics insights into how to refine their assignments to enhance effectiveness while leveraging the benefits of AI.

With essay type assignments usually, it is hard to find where to start. ChatGPT serves as a valuable starting point for students. It is a tool which provides a foundation upon which students can build their ideas. Secondly, it guides students toward unexplored directions in their thinking and offers constructive feedback, playing a crucial role in enhancing overall writing skills.

However, with every innovation comes challenges. Not all information provided by ChatGPT is authentic and may require proper accreditation. This highlights the importance of critically evaluating and verifying the information. Moreover, it is imperative that students are trained to view ChatGPT as a learning aid only, steering clear of overreliance on the tool.

In light of these considerations, there is a need to develop comprehensive policies and procedures for the proper use of ChatGPT in educational settings. Clear guidelines will help ensure ethical and effective utilization of this powerful tool. Furthermore, both direct copying and rephrasing should be considered as plagiarism. This reinforces the importance of original thought and responsible use of technology in our academic pursuits. It is also important that a thorough analysis of current assessment formats is conducted, and they are fine-tuned to improve their effectiveness in today's times.

Conclusion

Attempts were made to study the potentials of ChatGPT in an Electrical Safety course offered at the University of New South Wales. The course assignment task was redesigned to incorporate ChatGPT as an integral part. The aim was to integrate technological innovations in an education setting and to explore the potentials and limitations of ChatGPT. The redesigned assignment required students to analyse electrical incidents and devise solutions across four main categories: Standards, Engineering, Administrative, and Personal Protective Equipment (PPE). The assignment outcome showed that ChatGPT generated solutions were comprehensive in some categories and scenarios. However, predominantly, the generated solutions were general and incomplete that necessitated students to conduct additional research. Around 35% of students showed heavy reliance on ChatGPT generated solutions and provided minimum analysis of their own. Often this reliance led to a shortfall in critically evaluating the suitability of the solutions. However, there was a small subset of students (6.5%) who used ChatGPT as a starting point only and displayed commendable problem-solving skills. Without any doubt, ChatGPT has the potential to improve student learning, however, a change in educational policies and assessment formats is required before we can fully harness the effectiveness of this tool.

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