

Uses and Misuses of AI-assisted writing in Engineering Reports

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Uses and Misuses of AI-Assisted Writing in Engineering Reports

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Abstract

Artificial Intelligence (AI) is becoming more widely used by engineering students especially with writing reports. This paper focuses on the use of AI writing assistance tool, ChatGPT, in mechanical engineering reports. Instructors have noticed various levels of AI-assistance in reports often by observing “non-natural” word choices which are not consistent with the way the student communicates verbally. It is often difficult to confirm the level of AI-assistance in a report. This paper summarizes findings of AI-assisted writings in reports, and concludes with a summary of the challenges based on recent observations.

Introduction

Engineering faculty have been faced with the reality that students are using Artificial Intelligence (AI) tools to complete writing assignments which are often submitted for grades as part of the academic process [1]. Many faculty and universities are playing catchup since the AI tools are new and AI has experienced rapid adoption by students [2]. The most widely used AI tool is ChatGPT, which was released in November 2022 [3]. Engineering faculty organized national conference panel discussions to help their communities understand the impacts of ChatGPT [1]. Concerns about Scholastic Dishonesty (SD) as well as optimism about the possibilities of increased student learning are being discussed [4]. SD concerns are widely anticipated where AI tools can write sections of reports so that traditional plagiarism detectors will not flag the work [5]. The potential negative impact of AI-assisted writing is more widely recognized than the potential positive impacts. Positive impacts are being discussed with possible adaptations of pedagogy to leverage the strengths of AI tools [6]. Creative faculty continue to innovate pedagogical activities and some have students use AI openly, with acknowledgment given to where and how it was used. Technical writing has been taught in engineering curriculum for many years and appears well suited for AI assistance because it needs to convey quantitative results and minimize the possibility of misunderstanding. Engineering writing often follows a template or structure so the reader can find the information with minimal effort. AI-assistance has more potential to assist technical writing compared to poems or novels.

The Writing Assignment

A writing assignment was given in Spring 2023 semester which is similar to assignments given in previous semesters. The focus was sustainable energy. The learning objectives of the assignment

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were broader than the objectives of typical homework and exams covered in the course. Using ABET [7] terminology, most of the course is devoted to student outcome (SO) #1: “an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics”. The faculty use work-it-out problems to assess student learning, especially on homework and exams. Upper division engineering classes often have additional student outcomes, like SO#4: “an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts”. Reports have been used to gauge student mastery of SO#4. In the Spring 2023, students were asked to review the 2030 Agenda for Sustainable Development adopted by the United Nations (UN) in 2015. <https://sdgs.un.org/goals> Goal #7 is “Ensure access to affordable, reliable, sustainable and modern energy for all” [8]. Students were asked to review the UN goals and do research that is then summarized in a paper. The title of the paper was to be “Sustainable Electricity Generation in __blank__, where the student picks a city, state, country or location. Students were encouraged to pick locations like New York, Hawaii, United States, Japan, etc. The assignment required students to summarize how electricity is currently produced in their chosen location, typically using coal, natural gas, oil, nuclear, hydro, solar, biomass, etc. The report also identifies trends in changing electricity generation and plans for future generation out to around 2050. The paper was to have a section summarizing environmental, economic and societal considerations which align with ABET expectations for SO#4. The paper was to have a section summarizing the roll of an engineer, considering ethical and professional responsibilities. Students were directed to the National Society of Professional Engineers (NSPE) Code of Ethics for Engineers [9]. A suggested outline for the paper was provided in addition to a detailed grading rubric. The detailed instructions were intended to minimize the possibility of missing part of the report or misunderstanding the expectations.

Analysis of Reports

Students were allowed to use ChatGPT to help with the report in the Spring 2023 semester. Because the AI Chatbot was so new (less than 6 months after release), most students had no experience with the tool. Given the highly prescriptive nature of the report, it was observed that students had little trouble using ChatGPT to quickly help write reports that were found to be of relatively high quality. Sentence structure and paragraph cohesion were significantly above average compared to previous semesters without AI. The following paragraph in a report on “Sustainable Electricity Generation in Florida” is given as an example:

When considering environmental impacts, continued efforts to reduce greenhouse gas emissions and mitigate the impacts of climate change are taken into account, due to the adoption of renewable energy technologies and policies that promote energy efficiency and conservation. When considering potential economic implications, a balance between cost effectiveness and social equity is required to

ensure affordable and accessible energy for all Florida residents. It is also important to ensure that renewable energy costs are not **disproportionately borne** by low-income households or communities. Societal concerns require community engagement, transparency, as well as social acceptance. All in all, sustainable energy projects should be developed with the involvement of local communities and stakeholders.

It is common to observe that the sentences generated by ChatPGT are often longer than those written by students. The overall flow of the sentences and paragraph are more coherent than normal, and key words are used throughout the writing. Overall the AI-assisted writing is considered to be excellent. A negative observation is that writing is non-natural for the student. An example of non-natural word choice is the underlined “**disproportionately borne**” which is a phrase not expected in the student’s verbal communication. A student’s writing style and word choices are reflective of their verbal lexicon. If they do not use words and phrases verbally, they would not be expected to do so in their writing, so such non-natural words indicate the use of ChatGPT. Another observation is that the AI-assisted writing can be redundant and vague, but this did not seem to differ from historical student reports to be discriminatorily useful.

An additional remark is that AI tools were weak when it comes to equations, calculations and graphics. Students needed to incorporate equations and graphics manually because ChatGPT often gave incorrect results. Most students copy-and-paste graphics from the internet while using AI to generate the body of the report. One student asked ChatGPT to generate Matlab code to be able to create a graphic. The student request in ChatGPT is:

write the matlab script of a graph showing prospective energy generation per capita in India versus the United States, Europe, Russia, and Japan from 2020 to 2060.

The response from ChatGPT is:

```
matlab
Copy code
% Prospective energy generation per capita in India, the United States, Europe, Russia, and
Japan from 2020 to 2060 years =
2020:2060; % range of years
pop_growth_rate = 0.0115; % annual population growth rate pop_india = 1.366e9 *
exp(pop_growth_rate * (years-2020)); % population projection in India pop_us = 331e6
* exp(pop_growth_rate * (years-2020)); % population projection in the United States
pop_eu = 447e6 * exp(pop_growth_rate * (years-2020)); % population projection in Europe
pop_rus = 146e6 * exp(pop_growth_rate * (years-2020)); % population projection in Russia
pop_jpn = 126e6 * exp(pop_growth_rate * (years-2020)); % population projection in Japan
energy_growth_rate = 0.03; % annual energy consumption growth rate energy_per_capita_india
= 1000 * exp(energy_growth_rate * (years-2020)); % prospective energy generation per capita in
```

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India energy_per_capita_us = 4000 * exp(energy_growth_rate * (years-2020)); % prospective
energy generation per capita in the United States energy_per_capita_eu = 3500 *
exp(energy_growth_rate * (years-2020)); % prospective energy generation per capita in Europe
energy_per_capita_rus = 2000 * exp(energy_growth_rate * (years-2020)); % prospective energy
generation per capita in Russia energy_per_capita_jpn = 4000 * exp(energy_growth_rate *
(years-2020)); % prospective energy generation per capita in Japan

```

```

% Plot the data figure; hold on; plot(years, energy_per_capita_india,
'-b', 'LineWidth', 2); plot(years, energy_per_capita_us, '-r',
'LineWidth', 2); plot(years, energy_per_capita_eu, '-g', 'LineWidth',
2); plot(years, energy_per_capita_rus, '-m', 'LineWidth', 2);
plot(years, energy_per_capita_jpn, '-k', 'LineWidth', 2);
title('Prospective Energy Generation Per Capita in Select Countries');
xlabel('Year');
ylabel('Energy (kWh/capita)'); legend('India', 'United
States', 'Europe', 'Russia', 'Japan'); hold off;

```

This script uses exponential functions to project population growth and energy consumption growth in India, the United States, Europe, Russia, and Japan from 2020 to 2060. It then plots the prospective energy generation per capita for each country over time on the same graph for comparison. The resulting graph shows the expected differences in energy consumption per capita between the five countries, reflecting their respective population sizes and economic growth rates.

The student copy-and-pasted the script into Matlab to generate Figure 1, which is unique and would be extremely difficult to show it as being plagiarized. A different student need only modify the year or add/remove countries to develop a new unique graphic for a different report, which again would be difficult to show it as being plagiarized.

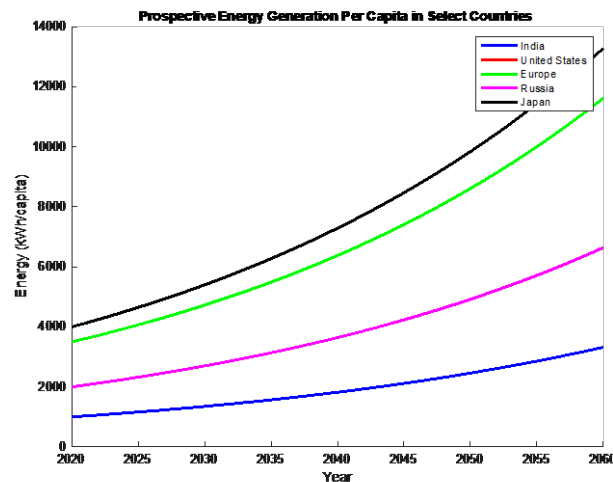


Figure 1. Prospective Energy Generation Per Capita in Select Countries.

Scholastic Dishonesty

The Spring 2023 semester was unique because it allowed AI-assisted writing tools. Since then, there have been a few cases where faculty suspected AI-assistance bordering on scholastic dishonesty (SD), yet the authors of this paper have no experience prosecuting SD cases involving AI assistance. Traditional plagiarism is easier to document and prosecute for SD. Since AI assisted writing is unique, there is no one-to-one comparison of writing. The use of AI-assistance will be challenging if not impossible to prosecute for SD.

Historically, the authors of this paper have been proactive to prevent and/or prosecute SD. These approaches have included paying for accounts on internet websites such as Chegg, which enable students to post problems and have experts provide solutions [10]. These exchanges are public to all with a Chegg account and leave both the initial poster and solution supplier anonymous. While marketed as a study tool, the speed at which the return solutions are posted, typically within a matter of minutes, enables students to cheat on homework and on longer exams. One of the authors of this manuscript once was able to identify a Chegg user cheating during an exam. The instructor had assigned seating and the cheating student had taken a picture of the professor answering another student's question when capturing the exam problem. This allowed the instructor to deduce where the student had been sitting. Another effective method was to embed a unique number in every exam question that was unique to the student, allowing identification of cheating through cross-referencing of Chegg supplied answers. Unfortunately, these approaches are not effective with ChatGPT.

The reports from Spring 2022 were run through the Unicheck plagiarism detector [11] available to instructors at our University. The reports had 3% overall similarity score indicating the software detected little or no plagiarism. Turnitin is the parent company marketing Unicheck and offers other tools for AI authorship detection, but those tools are not currently available at our University.

Summary and Conclusions

More students are using AI-assistance to write or reword sections of reports submitted for academic credit. It is often impossible to distinguish between AI- and student-authorship. In general, the quality of the sentences and paragraphs are improved with AI assistance.

Currently, it seems less common for students to use AI-assistance for mathematical calculations or analysis of quantitative data. The most popular AI tool is ChatGPT, as it is text driven and provides text responses. It is difficult to handle quantitative information or do mathematical manipulations. Calculations done by ChatGPT have been found to be incorrect. Students appear to know this and avoid using it for quantitative manipulations.

AI-assistance in identifying sources of information and references is weak and students quickly learn these are not to be trusted from ChatGPT. Most students checked references. Many make corrections and/or deleted the AI generated reference from the report.

AI-assistance can help generate graphics, but the current process is multistep. The AI tool is used to generate programming code or script. The code is copy and pasted into appropriate software where the graphic is generated. A few students did this to generate unique graphics. Plots and charts are doable using AI-assistance. To date, the authors have not seen AI-generated illustrations in student reports without using this multistep approach.

AI-assisted writing tools are expected to be used by more engineering students in the future. The scholastic dishonesty concerns are valid and engineering faculty will need to be diligent to guard the academic integrity of their classes. Positive aspects of AI-assistance are being realized as helping students overcome writers block and produce reports with fewer grammatical errors. AI-assistance is most often used to rewrite sections of a report. This is similar to modern word processing tools which flag miss-spelled words and grammar errors. A concern is that the student simply cut-and-paste what the AI tool generates so the student's understanding of the topic is weak and below what is reflected by the report.

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