Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #46722

Work-in-Progress: Leveraging ChatGPT to Support Technical Communication Skills (Writing) in a Senior Chemical Engineering Laboratory Course

Dr. Gautom Kumar Das, University of Maryland Baltimore County

Dr. Gautom Das is an Associate Teaching Professor in the Chemical, Biochemical and Environmental Engineering at UMBC. Prior to joining UMBC, he was a Research Scientist and Lecturer in the Chemical and Biomolecular Engineering at Rice University, and a Post-doctoral Scholar at the University of California, Davis. He earned his PhD in Chemical and Biomolecular Engineering from the Nanyang Technological University (NTU), Singapore. He has worked in research laboratories in the US, Canada, and Singapore; developed nanomaterials for multimodal and deep tissue imaging, and biosensing applications.

Work-in-Progress: Leveraging ChatGPT to Support Technical Communication Skills (Writing) in a Senior Chemical Engineering Laboratory Course

1. Introduction

Artificial Intelligence (AI) tools like ChatGPT (Chat Generative Pre-trained Transformer) have sparked unprecedented interest across various fields since their release in November 2022 [1]. In education, AI is transforming both learning methodologies and administrative processes. The widespread interest in ChatGPT can be attributed to its robust performance across diverse applications, including essay composition, translation, content generation, and text summarization [2-6]. Its unique capability to respond naturally to interactive queries has set it apart from other tools. Recent studies [6] highlight advantages such as accessibility and efficiency, while others have compared traditional and AI-supported teaching methods in areas such as data analysis, teaching materials development, language learning, and plagiarism prevention [7-9]. Studies have explored its role in exam performance analysis, exam question generation and responses [10], and its effectiveness in academic writing, literature review synthesis, and translation [11]. Remarkably, an entire academic article written by ChatGPT (with minor human editing) has also been documented in the literature [12].

The importance of developing writing skills in science and engineering has long been emphasized by the researchers, and the National Academies and ABET [13-15]. The American Chemical Society's Committee on Professional Training also expects graduates to write well-organized and concise reports in a scientifically appropriate style [16]. At author's institution, upper-level courses (400-level) are specifically designed to prepare students for advanced, field-specific writing and the rigors of academic peer review.

Considering the rapid adoption of AI tools in writing raises significant questions for educators. How should our students as future professionals, utilize and perceive tools like ChatGPT? What aspects of the skills traditionally taught in a chemical engineering curriculum can be augmented, supplemented, or even replaced by AI tools? How should educational training and assessments evolve to address these changes? These questions underline the need to critically examine the integration of AI into engineering education.

In this work-in-progress study, we investigated the use of generative AI chatbots in scientific writing in a senior-level chemical engineering laboratory reports. By comparing AI-generated reports with authentic student writing, we aim to understand the potential and limitations of AI in the technical writing contexts. The specific research questions of the study were the followings:

1. How does generative AI impact report writing as evaluated through senior chemical engineering laboratory reports?
2. How do reports that took help from AI compare to authentic student writings in terms of content, depth of knowledge, and overall effectiveness as scientific communication?

2. Methods

2.1 Data Collection

This study was conducted in a senior chemical engineering laboratory course, a regular fall semester offering at the author's institution. The dataset analyzed was from the Fall 2024 semester (N = 24). The course consisted of a 75-minute weekly lecture and a 4-hour laboratory component. During the lecture, faculty instructors reviewed upcoming experiments and discussed various aspects of data analysis, presentation, and scientific writing. The course was co-taught by three instructors; however, the study was conducted by the author of this paper.

Students performed laboratory exercises under the guidance of a faculty instructor and graduate teaching assistants. The course consisted of six laboratory experiments focusing on fundamental concepts of chemical and environmental engineering. For this study, two relatively open-ended experiments were selected:

(i) Dye Sensitized Solar Cells: Students created prototypes of dye-sensitized solar cells and tested them for efficiency.
(ii) Controlled Drug (Dye) Release: Students investigated dye release from alginate beads over time, simulating controlled drug delivery.

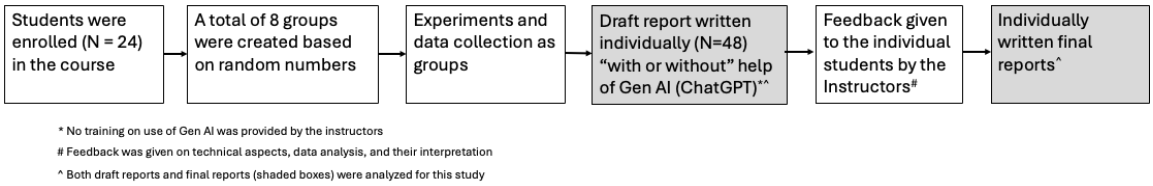

Figure 1. A general schematic of the assessment process for this study

A general schematic of the experiment, report writing, and assessment process is shown in Figure 1. Students discussed their experimental results with instructors and teaching assistants before writing their draft reports. The draft reports were graded using a standardized rubric. If a report received less than 80% of the available points, students were required to revise it, addressing the instructor's comments. The revised report, submitted as the final version, was regraded to determine the final grade.

Students were allowed to use generative AI tools (e.g., ChatGPT) during any stage of the writing process or they could choose not to use them. The following instructions regarding AI usage were provided:

a) **No AI Assistance**: If no AI assistance was used, students were required to indicate in their reports that they were written independently.
b) **AI Assistance**: If AI assistance was used, students were asked to include the following information in the Appendix of their reports for this study:
    i. The prompt(s) used.
    ii. Details on how the AI-assisted content was incorporated or revised.

This information was collected to ensure the accuracy of the report content and the authenticity of references. In addition, it is worthy to note that students were not given any training on generative AI use or crafting prompts. They self-selected the LLM they wished to use.

2.2 Instructor's Assessment

Approximately 80 laboratory reports, including initial drafts and final versions, were evaluated for this study. Reports in which students self-reported the use of generative AI tools were analyzed further for this study.

3. Results and Discussion

The primary goals of this study were to determine how many students used generative AI chatbots while writing their laboratory reports in a chemical engineering course and to compare chatbot-assisted reports with independently written ones. Understanding students' use of generative AI is invaluable for instructors seeking to navigate its influence in academic settings, particularly concerning academic integrity, as these tools increasingly become part of the learning environment. This section presents findings related to two research questions, followed by a discussion of the results and their potential implications.

3.1 Usage Trends and Student Self-Reporting

Two laboratory reports were analyzed in this study. The first report, focused on dye-sensitized solar cells (Report #1), required students to conduct a literature review to contextualize their findings in addition to analyzing the results. The second report involved creating alginate beads to study drug release kinetics (Report #2) and included a literature-based two-compartment pharmacokinetic model.

The percentage of students who self-reported using generative AI tools is shown in **Figure 2**. Only 33% of students reported using AI for Report #1. This percentage increased for Report #2, likely due to the added complexity of the pharmacokinetic model. Nevertheless, a significant portion of the students chose to write reports independently. Note, 8% students did not declare whether they used it or not.

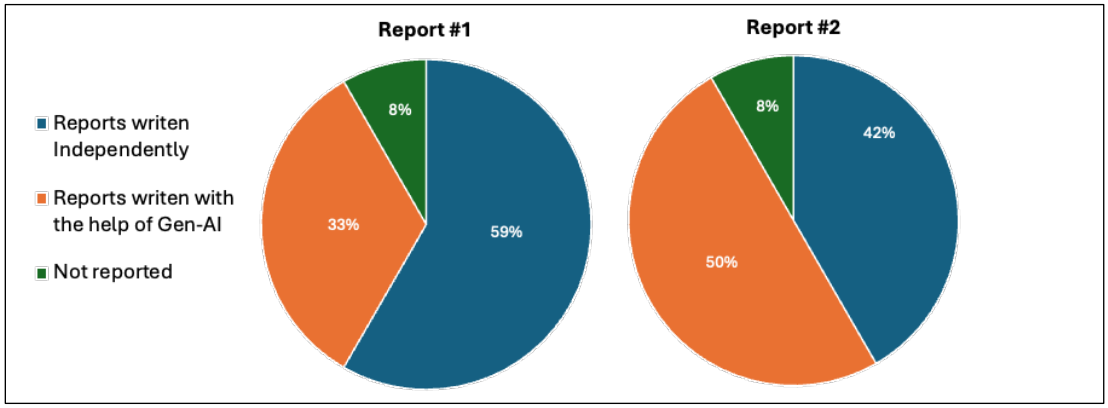

Figure 2. The percentage of students who self-reported using generative AI tools in their reports.

3.2 Types of Generative AI Tools Used

Among the students who reported using generative AI, 70% used the free version of ChatGPT, 15% used the paid version (ChatGPT 4.0), and 15% used Google's Gemini as shown in **Figure 3**.

3.3 Categories of AI Usage

To analyze how students used generative AI, the author input the following prompt into ChatGPT, along with all self-reported students responses. ChatGPT identified several categories, which the author verified for accuracy. These categories are summarized in **Table 1**.

"I am writing a paper on how students used generative AI chatbots in my course. Based on the responses provided by the students, identify: (1) the categories of use, (2) the most frequent category, and (3) the frequency of each category. Following are the students responses. "

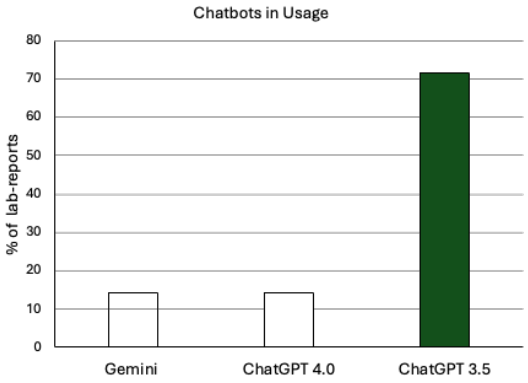

Figure 3. Types of Generative AI Tools Used

Table 1. Categories of AI Usage and Examples

Categories	Examples
Grammar and Writing Enhancement	○ Fixing grammatical errors. ○ Improving flow and organization (e.g., adding transition words, restructuring sections, rewriting abstracts). ○ Converting bullet points into structured paragraphs
Content Clarification	○ Explaining concepts (e.g., mismatch between dye and electrolyte in dye sensitized solar cells). ○ Providing real-world examples or additional context.
Data Analysis and Visualization	○ Generating plots/graphs (e.g., I-V curves, fractional release vs. time graphs). ○ Writing code for data processing and visualization (e.g., MATLAB or Python).
Research Assistance	○ Finding and citing sources (e.g., literature references, highest efficiency for solar cell). ○ Generating research ideas and providing study topics
Report Structuring	○ Organizing specific sections of reports (e.g., methods and materials, results). ○ Structuring lab reports or individual sections cohesively
Generating New Content	○ Creating content for papers (e.g., additional paragraphs, transitions). ○ Developing potential research topics (e.g., topics in drug delivery).

The most frequently reported category was Grammar and Writing Enhancement, with nearly all students using AI for grammatical corrections and improving readability. **Figure 4** presents the normalized frequency of AI usage across these categories, showing a significant portion of students also relied on AI for literature review and report organization.

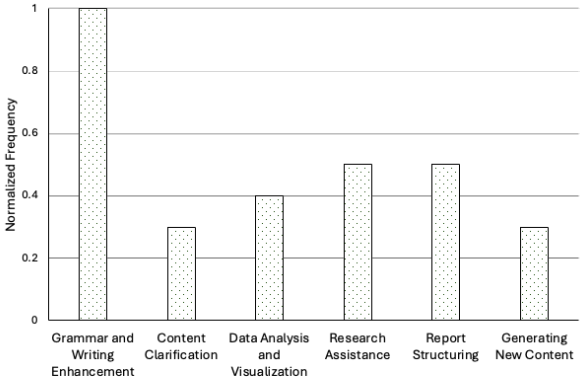

Figure 4. Normalized frequency of AI usage across the identified categories.

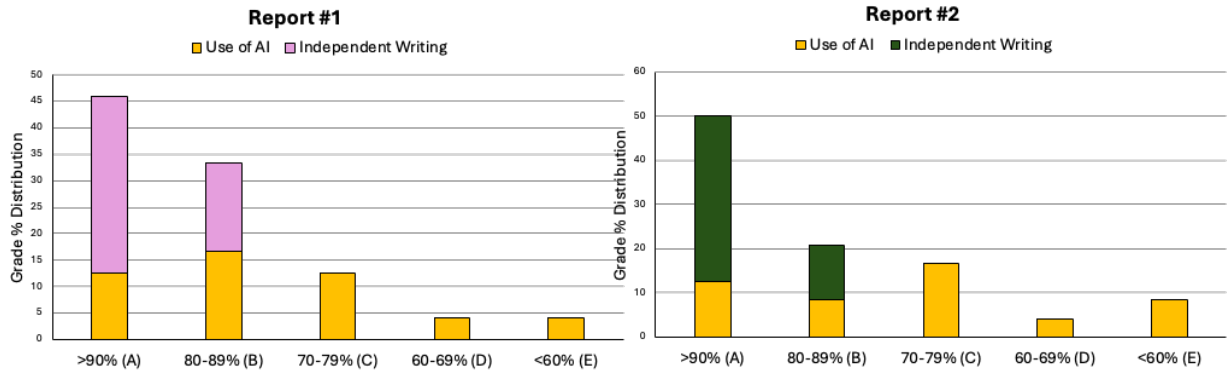

Figure 5. Grade distribution of student reports written with the help of generative AI vs. written independently.

3.4 Performance Analysis

The analysis of the final reports revealed two key findings. **Figure 5** shows the grade distribution of students who wrote reports independently versus those who used generative AI tools (for both Report #1 and Report #2).

1. Among the students who earned an "A," 75% wrote their reports independently without AI assistance.
2. None of the students who wrote their reports independently received grades lower than a "B."

3.5 Key Insights

The results indicate that students with (perhaps) weaker writing or data analysis skills were more inclined to use AI tools. At the same time, analysis suggests that students who received high grades after using generative AI generally employed well-structured and detailed prompts, which positively impacted the quality of the report.

4. Teaching Implications and Conclusions

This study provides a qualitative perspective on the integration of generative AI in a Writing Intensive laboratory course. Despite having the option to use AI, many students relied on their independent writing skills. Poor outcomes were observed when students used vague prompts or lacked understanding of core engineering principles (specific examples are not included in this paper due to space constraints). Also, there is a risk of unreflective acceptance of the answers given by AI, highlighting the need for better student training as noted in prior studies [17].

To maximize the potential of generative AI in education, instructors should offer explicit learning opportunities focused on effective prompting techniques, such as structuring outputs, providing context, and specifying desired outcomes. Research suggests that detailed prompts lead to more effective AI-assisted results. While concerns remain regarding the misuse of generative AI in education, this study suggests that, when used appropriately, these tools can enhance the teaching and learning process.

5. References

[1]. OpenAI. https://openai.com

[2]. Nguyen, N. D. (2023). Exploring the role of AI in education. London Journal of Social Sciences, 6(6), 84–95. https://doi.org/10.31039/ljss.2023.6.108

[3]. Pence, H. E., Hightower, G., Forlenza, J., Leonard, K., McLellan, A., Suero, A., Amoah, B., Mariama Mbow, Borner, S., Castillo, A., & Pence, L. E. (2024). Using Generative AI Systems for Critical Thinking Engagement in an Advanced Chemistry Course: A Case Study. Journal of Chemical Education, 101(9), 3789–3794. https://doi.org/10.1021/acs.jchemed.4c00242

[4]. Kim TW. (2023) Application of artificial intelligence chatbots, including ChatGPT, in education, scholarly work, programming, and content generation and its prospects: a narrative review. Journal of Educational Evaluation for Health Professions, 20,38.

[5]. Buriak, J. M., Akinwande, D., Artzi, N., Brinker, C. J., Burrows, C., Chan, W. C. W., Chen, C., Chen, X., Chhowalla, M., Chi, L., Chueh, W., Crudden, C. M., Di Carlo, D., Glotzer, S. C., Hersam, M. C., Ho, D., Hu, T. Y., Huang, J., Javey, A., & Kamat, P. V. (2023). Best Practices for Using AI When Writing Scientific Manuscripts. ACS Nano, 17(5). https://doi.org/10.1021/acsnano.3c01544

[6]. Lo, C. K. (2023). What Is the Impact of ChatGPT on Education? A Rapid Review of the Literature. Education Sciences, 13(4), 410. https://doi.org/10.3390/educsci13040410

[7]. Sun, L., & Zhou, L. (2024). Does Generative Artificial Intelligence Improve the Academic Achievement of College Students? A Meta-Analysis. Journal of Educational Computing Research, 62(7). https://doi.org/10.1177/07356331241277937

[8]. Cotton, D. R. E., Cotton, P. A., & Shipway, J. R. (2023). Chatting and cheating: Ensuring academic integrity in the era of ChatGPT. Innovations in Education and Teaching International, 61(2), 228–239. https://doi.org/10.1080/14703297.2023.2190148

[9]. Kumar, A., Tejaswini, P., Nayak, O., Kujur, A. D., Gupta, R., Rajanand, A., & Sahu, M. (2022). A Survey on IBM Watson and Its Services. Journal of Physics: Conference Series, 2273(1), 012022. https://doi.org/10.1088/1742-6596/2273/1/012022

[10]. Fernández, A. A., López-Torres, M., Fernández, J. J., & Vázquez-García, D. (2024). ChatGPT as an Instructor's Assistant for Generating and Scoring Exams. Journal of Chemical Education, 101(9), 3780–3788. https://doi.org/10.1021/acs.jchemed.4c00231

[11]. Imran, M., & Almusharraf, N. (2023). Analyzing the role of ChatGPT as a writing assistant at higher education level: A systematic review of the literature. Contemporary Educational Technology, 15(4), ep464. https://doi.org/10.30935/cedtech/13605

[12]. Biswas, S. (2023). ChatGPT and the Future of Medical Writing. Radiology, 307(2). https://doi.org/10.1148/radiol.223312

[13]. Wilson, S. A., & Azarin, S., & Barr, C., & Beckwith, J. K., & Brennan, J., & Carter, T. L., & Karlsson, A. J. (2023, June), *Prioritizing learning objectives for chemical engineering laboratory courses* Paper presented at 2023 ASEE Annual Conference & Exposition, Baltimore , Maryland. 10.18260/1-2—43961

[14]. https://www.abet.org

[15]. National Academies of Sciences, Engineering, and Medicine. (2022) New Directions for Chemical Engineering. Washington, DC: The National Academies Press. https://doi.org/10.17226/26342

[16]. Spring 2015 American Society Committee on Professional Training, Undergraduate Professional Education in Chemistry.

[17]. Tassoti, S. (2024). Assessment of Students Use of Generative Artificial Intelligence: Prompting Strategies and Prompt Engineering in Chemistry Education. Journal of Chemical Education, 101(6). https://doi.org/10.1021/acs.jchemed.4c00212