ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Paper ID #49558

Assessing the Impact of Artificial Intelligence on Undergraduate Mechanical Engineering Education

Dr. Randall D. Manteufel, The University of Texas at San Antonio

Dr. Randall Manteufel is an Associate Professor of Mechanical Engineering at The University of Texas at San Antonio (UTSA). He has won several teaching awards, including the 2012 University of Texas System Regents Outstanding Teaching Award and the 2013 UTSA President's Distinguished Achievement Award for Teaching Excellence, the 2010, 2014, 2018 and 2019 College of Engineering Student Council Professor of the Year Award, 2008, 2022, 2024 College Excellence in Teaching, and 2005 Mechanical Engineering Instructor of the year award, 1999 ASEE-GSW Outstanding New Faculty Award. His teaching and research interests are in the thermal sciences. In 2015-2016, he chaired the American Society for Engineering Education Gulf Southwest section and in 2018-2019 he chaired the Academy of Distinguished Teaching Scholars at UTSA. He is a registered Professional Engineer in Texas.

Assessing the Impact of Artificial Intelligence on Undergraduate Mechanical Engineering Education

Randall D. Manteufel
Mechanical Aerospace and Industrial Engineering Department
University of Texas at San Antonio

Abstract

Since the introduction of ChatGPT in November 2022, Artificial Intelligence (AI) has been poised to significantly impact engineering education by enabling real-time problem-solving assistance, personalized learning experiences, and automated grading systems. The potential uses of AI are extensive, particularly in generating detailed responses to specific queries based on its training data. Ongoing investments and rapid advancements in AI are anticipated to drive breakthroughs in adaptive learning, real-time performance feedback, and enhanced simulation tools for engineering education. Despite widespread discussions about AI's role in engineering education, its practical applications in mechanical engineering courses remain limited and largely confined to isolated activities. For example, few courses integrate AI tools into their syllabi, and most use cases are confined to optional student-driven projects or experimental course modules. Current applications are mostly observed in report writing, such as generating content drafts, paraphrasing sections, and formatting citations, and in computer programming for debugging, code optimization, and script generation. This paper highlights the need for more examples demonstrating AI's potential to enhance student learning and critical thinking in engineering courses.

Introduction

Artificial Intelligence (AI) is increasingly being integrated into engineering education, offering both promising benefits and notable challenges. On the positive side, AI tools have the potential to significantly enhance student learning by providing personalized and interactive educational experiences. These tools can adapt to individual learning styles and paces, thereby improving engagement and comprehension without adding to the instructor's workload [1]. For instance, AI-driven platforms can automate routine tasks such as grading and feedback, allowing educators to focus more on teaching and mentoring [2,3]. Early AI features in grading software streamline assessment by grouping student answers and enabling rubric-based grading to improve uniformity [4].

While AI's impact on engineering education is promising, its thoughtful implementation is critical to mitigate known risks [5]. AI can foster authentic human-machine synergy in classrooms, enhancing emotional intelligence and engagement [6]. Studies suggest that AI can support faculty in rethinking assessment methods, promoting a paradigm shift in evaluations [7]. Evaluations of AI tools like ChatGPT highlight both their capabilities and constraints in engineering reasoning, emphasizing the need for careful integration [8]. Moreover, AI's potential in practical applications, such as

thermodynamics, goes beyond traditional textbook coverage [9]. Research into students' use of AI tools for engineering reports reveals benefits and risks, emphasizing the importance of clear guidelines to ensure academic integrity [10]. By addressing these challenges, educators can harness AI's potential to enhance learning outcomes while upholding academic standards.

Recent studies explore AI's transformative potential in engineering education. For example, AI-powered intelligent tutoring systems increase student learning and engagement. AI techniques also optimize resources and improve educational institution operations, highlighting the importance of integrating AI thoughtfully [11].

Group Interviews

Twenty-two senior-level mechanical engineering students were interviewed in the Fall 2024 semester. The interviews were conducted in two groups of eleven students each. About 50% of the students were finishing the BSME program that semester and the others anticipated finishing in Spring 2025 or shortly thereafter. All students described how they would be starting their engineering career after graduation and none intended to pursue graduate studies. The students were interviewed in groups since group discussions often triggered additional comments from students which may have been missed if the interviews were individual. Group discussions fostered synergy, encouraging more students to share their observations and experiences.

Student Feedback

Notable AI tools include ChatGPT, Microsoft Copilot, Claude AI, Google Gemini, and Meta AI. Although the University provides access to Microsoft Copilot [12], most students prefer ChatGPT [13], with 20% subscribing to its premium service. Students expressed dissatisfaction with Copilot, unanimously favoring ChatGPT.

Figure 1 shows the results of the student survey organized by course:

> **Senior Design (SD)**: A two-semester capstone design project in groups of 3 to 5 students.
> **Laboratory Classes (Lab)**: Primarily three required courses: Measurements and Instrumentation, Dynamics and Controls Lab, Thermal-fluids Lab.
> **Technical Electives (TE):** Students choose three from various topics.
> **University Core Curriculum (Core):** Students take around five electives in areas like: Language, Philosophy & Culture; Social and Behavioral Sciences; Politics and Society; American History; and Creative Arts.

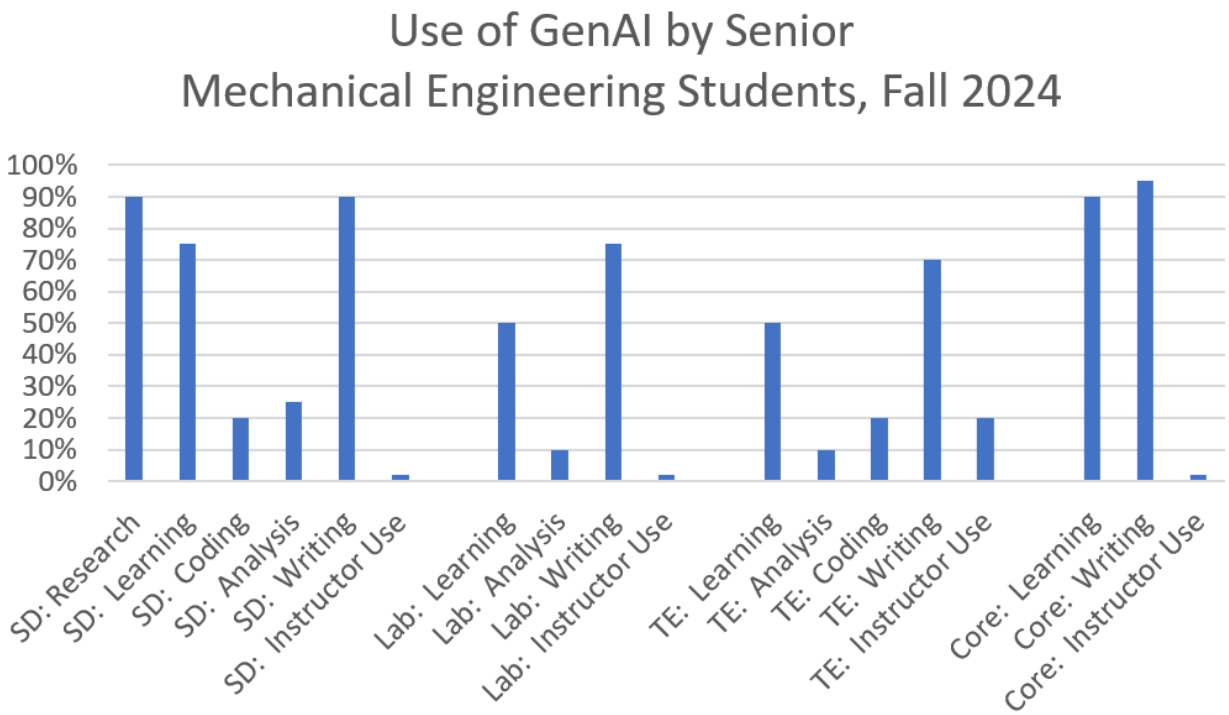


Figure 1. Student Survey on Use of GenAI in Senior Design (SD), Laboratory (Lab), Technical Elective (TE) and University Core Curriculum (Core) courses.

Figure 1 illustrates the widespread use of AI in senior design projects. Students reported leveraging AI as a subject matter expert to acquire knowledge specific to their unique design needs, such as comparing material properties and evaluating design alternatives. Only a few students used AI for coding or analysis in their projects. Notably, all students expressed skepticism toward AI-generated quantitative calculations or derivations. Nearly all students used AI for writing assistance, particularly in drafting and paraphrasing sections of their senior design reports. Given the report-intensive nature of the course, with multiple intermediate deadlines throughout the semester, students found AI invaluable in managing their workload. With frequent report submissions required—each including an abstract, introduction, analysis, conclusions, and references—students highlighted the challenge of maintaining the expected level of completeness within tight deadlines.

Figure 1 shows the widespread use of AI to assist in "Learning" in many laboratory and technical elective classes. In technical elective classes, a few students shared stories about how they attended lectures regularly but found they learned little from lectures. Lectures allowed them to become familiar with the jargon, but they did not develop an understanding of how to apply the material. Numerous students shared how they used AI to learn the course material, especially as they completed homework and prepared for exams. The students input their questions to the AI tool, and regardless of the complexity of the question, the tool often provided answers which were helpful to the student. The responses were specific to each student's questions and were appropriately detailed for the material. Students often described how they could rephrase and re ask the question until they

understood the material. Compared to the lectures, students found the dialogue with AI more helpful. Instead of reading the textbook or reviewing recorded lectures, or reviewing instructor power point slides, a significant percentage of students reported using AI to get answers to their questions as they studied for exams and/or completed assignments.

Figure 1 also shows how students used AI in University Core classes. The students have many options to fulfill Core requirements, so the discussion was broad in this area. In at least one of the core classes, student reported using AI to learn the material and complete writing assignments. Students share that the answers to their questions could be found in the textbook, or recorded lecture, or professor lecture notes, but it was faster for them to ask the AI tool to get an answer.

Instructor Use of AI

Students reported minimal integration of AI by the course instructors. Most courses were taught as if AI doesn't exist. The exception was a few technical elective courses where a few students described how the instructors embraced the use of AI with some focused activities. In a thermal fluid design class, students were shown Microsoft Copilot since it is provided by the University. Students were allowed to submit reports acknowledging the use of AI to complete the report. Feedback from students was that it significantly reduced the time to complete the report. In a finite element class, students describe how the instructor used ChatGPT to generate code and asked students to critique it. In some cases, the students were able to find errors in the code. Likewise, students were asked to submit their code to ChatGPT to be rewritten to be more structured and to have comments added. Students reported that these exercises were a minor component of the class and were easy to complete. In both of these examples, it is unclear how these activities improved student learning, other than exposing students to the capabilities of AI.

Career Applications

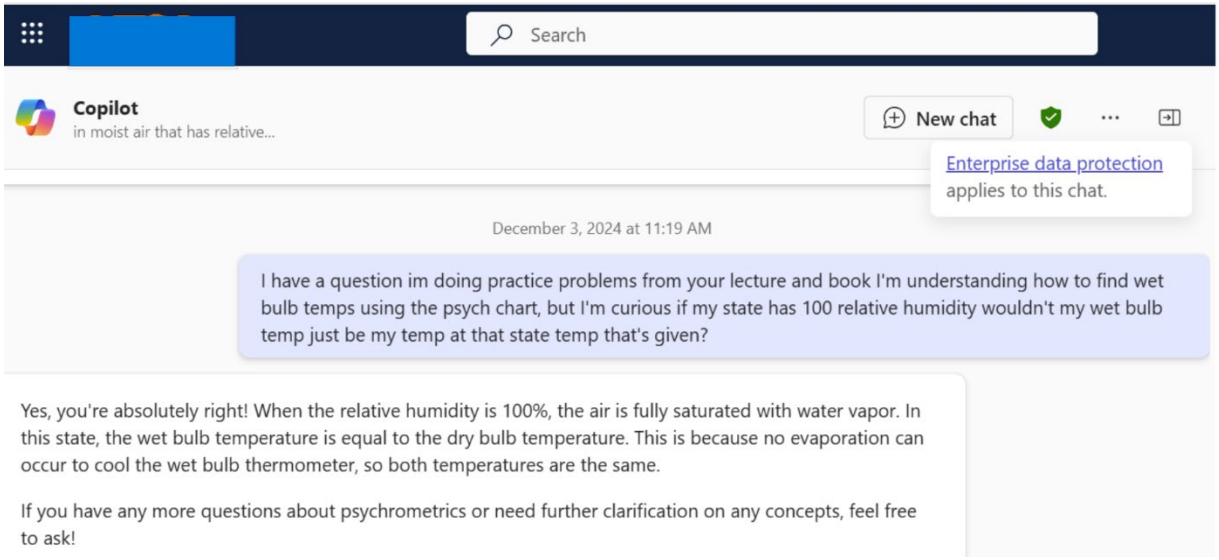
Since many students were actively looking for employment, the topic of how AI was helpful often was brought up by students. A few students discussed how they used AI to generate cover letters to potential employers which were targeted to the particular company. Likewise, some described how they enhanced their resume based on the job postings from a particular company. A few students shared their strong opinion that AI helped them so they were getting better responses from companies. One student shared how the ChatGPT helped the student recall key words which described prior work experiences which the student did not have in an earlier version of cover letter and resume. Key words are very important as companies use scanners to pre-select specific resumes which highlight specific skills of the applicant. As these discussions were conducted in a group setting, it was common for other students to say something like "I didn't think of that" or "I need to fix my resume". This use of AI was not the original focus of the student interviews, but it was a positive outcome that benefited some students who are less AI-savvy. Overall, the instructor conducting the survey found many students have a mature understanding of AI and firm grasp of its strengths in areas beyond the classroom.

AI as 24/7 Tutor

The most promising use of AI currently appears to be in answering student questions which have traditionally been directed to the instructor, teaching assistant, tutor or other students. The AI can be used as a personal tutor when the student has a specific question related to the course material. A

few instructors are beginning to encourage students to submit questions to AI. The AI responses are increasingly correct, even for quantitative engineering questions. The responses are prompt and the student can ask follow-up questions. AI allows students to ask questions freely without fear of negative or judgmental responses. Overall, there are significant advantages for using AI as a tutor or subject matter expert.

This example is shared from a thermodynamics class. A student sent an email to the instructor late on Saturday. Typically, the instructor would respond sometime Monday morning, hours after the student asked the question. To demonstrate the use of AI, the instructor took the question and put it into Microsoft CoPilot, the AI tool provided free by the University for all students. The instructor didn't correct or improve the grammar, nor try to clarify the student's question to make it easier for AI to understand the question. The response was shared with all students in the class:



The AI response is correct and is more thorough than the instructor would typically provide in an email reply. Using AI, the student could ask follow-up questions and more quickly become "unstuck" as they struggle to learn the course material. AI responses have been rapidly improving and are expected to become more reliable in the future. Using AI as a 24/7 tutor is currently the most impactful and widespread use of AI in engineering courses.

Summary and Conclusions

Although the engineering education literature reflects the introduction of AI and highlights its widespread implications, a survey of 22 senior-level mechanical engineering students in the Fall of 2024 shows how little adoption there is of AI in the curriculum. A few instructors have adopted modules or activities that introduce AI to students, but even this modest exposure to AI is limited to only a few courses. AI is primarily used for writing assignments and coding, where it assists in enhancing, streamlining, or reviewing AI-generated code. There was no course-wide implementation of AI to enhance student learning. There are numerous examples of how students are learning using AI, motivated solely by self-directed efforts rather than faculty guidance. Students describe it as the

new “go-to” tool to get help when they are struggling with writing assignments, studying for exams, learning specific topics, or occasionally solving engineering problems. Many describe how they can ask and re-ask questions in a narrow topic area and receive quick responses targeted to their learning needs. It offers a quicker alternative to searching multiple websites and sifting through vast amounts of information.

As instructors explore strategies to integrate AI into their courses to improve student learning, a valuable approach is to first understand how students are already utilizing AI and identify ways to extend these practices to course topics and activities throughout the semester. One of the most promising strategies is to encourage students to seek AI assistance, as it offers round-the-clock availability and increasingly reliable responses.

Lastly, the students interviewed for this work expressed an overwhelming desire to learn more about how AI works, its strengths, limitations, and applications. While students already use AI to assist in writing, coding, and learning, they believe it offers potential in engineering analysis and design. The gap between envisioned possibilities and the realized impact of AI in undergraduate education will continue to narrow. The most promising advancements include adaptive learning platforms, deeper integration of AI tools into engineering curricula, and greater awareness of AI’s practical applications among educators and students.

References

[1] Baltaci, K., & Herrmann, M., & Turkmen, A. (2024, June), Integrating Artificial Intelligence into Electrical Engineering Education: A Paradigm Shift in Teaching and Learning Paper presented at 2024 ASEE Annual Conference & Exposition, Portland, Oregon. 10.18260/1-2—47644

[2] Rivera, E. J., & Calle Müller, C., & Rahat, R., & ElZomor, M. (2024, June), Empowering Future Construction Professionals by Integrating Artificial Intelligence in Construction-Management Education and Fostering Industry Collaboration Paper presented at 2024 ASEE Annual Conference & Exposition, Portland, Oregon. 10.18260/1-2—47247

[3] Harris, H. J., & Kittur, J. (2024, June), Generative Artificial Intelligence in Undergraduate Engineering: A Systematic Literature Review Paper presented at 2024 ASEE Annual Conference & Exposition, Portland, Oregon. 10.18260/1-2--47492

[4] Gradescope. [Accessed December 31, 2024].

[5] Ahmadi, N., & White, L. L. A., & Hammond, T. A. (2024, June), Emotionally Intelligent Machines in Education: Harnessing Generative AI for Authentic Human-Machine Synergy in the Classroom Paper presented at 2024 ASEE Annual Conference & Exposition, Portland, Oregon. 10.18260/1-2—47236

[6] Anakok, I., & Chew, K. J., & Matusovich, H. M., & Katz, A. (2024, June), Paradigm Shift? Preliminary Findings of Engineering Faculty Members’ Mental Models of Assessment in the Era of Generative AI Paper presented at 2024 ASEE Annual Conference & Exposition, Portland, Oregon. 10.18260/1-2--47829

[7] Huang, B., & Lu, C. (2024, June), Evaluating ChatGPT's Engineering-Reasoning Capabilities and Constraints Through Examples from Mechanical-Engineering Education Paper presented at 2024 ASEE Annual Conference & Exposition, Portland, Oregon. 10.18260/1-2—47342

[8] Manteufel, R. D., & Karimi, A. (2024, June), Student Use of ChatGPT to Write an Engineering Report Paper presented at 2024 ASEE Annual Conference & Exposition, Portland, Oregon. 10.18260/1-2—48021

[9] Supan, K. (2024, June), Using Artificial Intelligence Case Studies in a Thermodynamics Course Paper presented at 2024 ASEE Annual Conference & Exposition, Portland, Oregon. 10.18260/1-2--48227

[10] Manteufel, R. D., & Hood, R. L., & Crom, A. D., & Karimi, A. (2024, March), Uses and Misuses of AI-assisted writing in Engineering Reports Paper presented at 2024 ASEE-GSW, Canyon, Texas. 10.18260/1-2—45403

[11] Martín Núñez, J. L., & Díaz Lantada, A. (2020), Artificial Intelligence Aided Engineering Education: State of the Art, Potentials and Challenges International Journal of Engineering Education, 36(6), 1740-1751.

[12] Copilot. [Accessed December 31, 2024].

[13] ChatGPT. [Accessed December 31, 2024].

RANDALL D. MANTEUFEL

Dr. Randall Manteufel is an Associate Professor of Mechanical Engineering at The University of Texas at San Antonio (UTSA). He has won several teaching awards, including the 2012 University of Texas System Regents Outstanding Teaching Award and the 2013 UTSA President's Distinguished Achievement Award for Teaching Excellence, the 2010, 2014, 2018 and 2019 College of Engineering Student Council Professor of the Year Award, 2008, 2022, 2024 College Excellence in Teaching, and 2005 Mechanical Engineering Instructor of the year award, 1999 ASEE-GSW Outstanding New Faculty Award. His teaching and research interests are in the thermal sciences. In 2015-2016, he chaired the American Society for Engineering Education Gulf Southwest section and in 2018-2019 he chaired the Academy of Distinguished Teaching Scholars at UTSA. He is a registered Professional Engineer in Texas.