Evaluation of the Utilization of Generative Artificial Intelligence Tools among First-Year Mechanical Engineering Students

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Abstract

Generative artificial intelligence tools, such as ChatGPT, are freely available to anyone, including college students. Some perceive these tools as a game changer for higher education because they can enhance student learning experiences in various ways. The integration of generative AI tools in higher education has the potential to revolutionize teaching and learning, making education more accessible, efficient, and effective for students, like the introduction of the calculator. However, there are concerns that generative AI tools can also be misused and lead to unethical behavior. For example, students could use these tools to plagiarize essays, cheat on assignments and exams, and thereby devalue the learning experience for themselves and others.

A mixed-method survey was developed to answer the following research questions:

1. How many first-year ME students use generative artificial intelligence tools?

2. How do first-year mechanical engineering students utilize generative artificial intelligence tools?

3. What are the perceptions of first-year mechanical engineering students about the utilization of generative artificial intelligence tools?

A survey was given to first-year mechanical engineering students at the California Polytechnic State University, San Luis Obispo. The response rate to the anonymous survey was 69%. The results reveal that 42% of first-year mechanical engineering students are already using generative AI tools, with 75% planning to use generative AI tools in the future. The primary uses by students include idea generation, educational support, and writing assistance. While 61% acknowledge AI's potential for facilitating cheating, 70% believe these tools can enhance learning when used appropriately. The prevailing view among first-year mechanical engineering students is that generative AI, when employed responsibly, can enhance the learning process. This emphasizes the necessity of using generative AI technologies responsibly and adaptably when creating teaching strategies to ensure that they promote academic integrity and learning rather than acting as a barrier to it.

Keywords: Generative Artificial Intelligence, Student Perceptions of AI, First-Year Engineering Students

Introduction

The primary goal of this study is to investigate the usage, application, and perception of generative AI tools among first-year mechanical engineering students at the California Polytechnic State University, San Luis Obispo. Specifically, this study aims to determine the prevalence of generative AI tool usage among first-year mechanical engineering students, how these students are utilizing these tools in their academic work as well as explore the students' perceptions and attitudes towards the use of generative AI tools in their education.

A report published by the education technology firm Anthology presents the results of a survey investigating the perceptions and realities of AI among university leaders and students [1]. Based on the results presented, 62% of students in the US use generative AI in some form. However, only 10% of students use generative AI at least once per week, while 38% use generative AI monthly. The report also states that “more than half of students in the US expect that their use of generative tools will increase in the next six months." The results of what role artificial intelligence will play in higher education in the future show that 46% of the students answered that “they feel AI will enhance student engagement and interactivity." 38% of students hold the belief that AI “will be supportive in helping to generate ideas”, while 38% consider it to be revolutionary in terms of “teaching and learning methods." 26% of students said that AI has the potential to “increase efficiency with tasks and activities." 24% of participants indicated that AI may “provide personalized learning experiences." When asked about the use of generative AI in higher education, “about one in six students feels that generative AI specifically is unethical and should not be allowed in higher education."

Another survey was published by Chegg, an American education technology company [2]. Based on their survey results, 20% of US students have used generative AI for their studies in higher education. When asked about how US students “use AI for school/university work”, 57% answered they use it to understand a concept or subject, 48% check their homework (37% use AI for step-by-step homework help), 43% to generate ideas, 42% to write or edit assignments and essays, and 36% for exam/quiz preparation. Asked why students use generative AI for their university studies, 56% said it helps them learn faster, and 53% said it frees up more of their time. When asked about their view on whether universities should promote, limit or ban the use of generative AI, 38% said universities should promote generative AI, 53% said it should be somewhat limited, and 10% are for a ban. About half (52%) of US students believe universities should change the way they assess students, and when asked how, 54% said to have “better guidance on acceptable use of GenAI tools in assessments." The top three concerns among US students about the use of AI are: “Students could use it to cheat” (52%), “receiving incorrect or inaccurate information” (50%), and “data privacy” (39%). When asked how the use of AI has improved their learning, US students' top three answers are: “My writing skills have improved” (44%), “My grades have improved” (43%), and “My ability to compete[sic] course assignments has improved” (40%).

The results of both surveys—considering the results of answers from US students only—show that US students use AI in many ways, which supports the idea that there is not just one use for AI in the classroom. Based on the results of both surveys, AI could improve many parts of the educational learning and teaching process. Addressing ethical considerations in the creation and application of AI tools in education is, of course, crucial. The findings of the Chegg poll

highlight the necessity for universities/colleges to have open policies that instruct students on the responsible and productive use of artificial intelligence (AI) in the classroom.

A study by MIT researchers examined the productivity effects of generative AI technology in the context of mid-level professional writing tasks [3]. In their experiment, they assigned writing tasks to college-educated professionals and randomly exposed half of them to ChatGPT. Their results show that the use of ChatGPT raised productivity: "The average time taken decreased by 40% and output quality rose by 18%. Inequality between workers decreased, and concern and excitement about AI temporarily rose. Workers exposed to ChatGPT during the experiment were 2 times as likely to report using it in their real job 2 weeks after the experiment and 1.6 times as likely 2 months after the experiment." The study reveals that AI technologies such as ChatGPT can improve productivity, quality, and inequalities in professional jobs. As a result, engineering education at the collegiate level should incorporate AI-related coursework, address ethical concerns, and cultivate an adaptive attitude to equip students for the evolving technology world in their future professions. This should include generative AI training to prepare students for the growing reliance on such technologies in the workplace, allowing future engineers to effectively harness generative AI tools to boost productivity and output quality.

There is some concern about the availability of generative AI tools and that students might misuse it, for example, to cheat. The term Algiarism is new and means plagiarism using generative AI tools [4]. New software tools claiming to detect the use of AI tools in a submission are not currently reliable. For example, ZeroGPT marked the text of the United States Constitution as "92.15% AI/GPT generated" [5]. Even a school submission by my own son, written in his own words, was marked as 100% AI generated by the software the school district uses. Since detection of AI generated content is not reliable, engineering faculty and institutions need to focus on fostering critical thinking, originality, and the ethical use of generative AI tools, rather than relying solely on detection software.

Methodology

The presented study took place during the Fall 2023 term. The participants are first-year mechanical engineering students taking an introduction to mechanical engineering course at the California Polytechnic State University, San Luis Obispo. The course is based on the "Design Your Process to Become a "World Class" Engineering Student" (DYP) program [6]. The DYP program is a comprehensive intervention aimed at helping students develop self-regulation and success skills. It focuses on goal setting, community building, academic development, and personal development. The program covers student development topics in a first-year engineering course/lab/seminar, and students are asked to design their own process for success and write a reflective, comprehensive report. For the Fall 2023 term students were asked to write four reflective homework assignments (~1000 words per assignment) and a reflective comprehensive report (~4000 words). Since there is no institution wide policy regarding generative AI use in courses, the following syllabus statement was used:

The Use of AI such as ChatGPT, Google Bard etc.

You can utilize AI technologies to help brainstorm assignments or your final report, or to revise your own previously produced material. I want you to explicitly identify what text was generated

by the AI tool when you submit your assignment or final report (e.g., AI-derived text appears in a different colored font, is quoted directly in the text, or uses an in-text parenthetical reference). You should also explain how AI tools influenced your approach and the final result, including how you validated any AI-generated citations that the AI may have developed.

How to cite generative AI:

"Text of prompt" prompt. [generative AI used], version, [company], Date, link.

Example:

"Tell me about confirmation bias" prompt. ChatGPT, version 3.5, OpenAI, 9/18/23, chat.openai.com/chat.

In addition to the guidelines outlined in the syllabus, a brief 10-minute lecture at the course's start covered the usage of AI tools. The syllabus statement's intent was not to promote or discourage the use of AI tools, but rather to establish a transparent policy.

Since there is no prior data available at this institution regarding how students use generative artificial intelligence tools in a first-year introductory mechanical engineering, a survey instrument was developed to answer the following research questions:

1. How many first-year ME students use generative artificial intelligence tools?
2. How do first-year mechanical engineering students utilize generative artificial intelligence tools?
3. What are the perceptions of first-year mechanical engineering students about the utilization of generative artificial intelligence tools?

The survey instrument comprises a total of 13 questions. Table 1 displays the item prompts and the available response options. Figure 1 is a flow chart illustrating the logical structure employed in the survey. For instance, if a participant responded with "Yes" to question #2, questions #2a, #2b, and #2c were displayed to them. If a respondent responded with "No" to question #2, it makes no sense to ask them questions #2a, #2b, or #2c because they have already indicated that they did not utilize any AI technology. The same reasoning applies to questions #3 and #3b.

Overall, this survey aims to understand first-year mechanical engineering students' engagement with AI tools, their perspectives on the ethical implications and potential benefits of AI in education, and the support they need to use these technologies effectively and responsibly.

Table 1: Survey Instrument

#	Item Prompt	Response Option
1	Agreement to voluntarily participate in the research survey	Yes/No
2	Did you use any form of AI such as ChatGPT, Google Bard etc.?	Yes/No
2a	Which AI did you use, click all that apply: Bard, Bing Chat, ChatGPT, Claude, DALL-E, Jasper, Lumen5, GitHub Copilot, Wordtune, QuillBot, Other	Checkboxes Other: Text Input
2b	Describe how you used AI in this course (e.g., using AI to generate writing ideas, summarize text, prepare for quizzes, etc.)?	Text input
2c	Describe your experience using AI in this course. What are the pros and cons of using AI from your point of view?	Text input
3	Do you plan to use any form of AI such as ChatGPT, Google Bard etc. in the future?	Yes/No
3b	Describe how you plan to use AI such as ChatGPT, Google Bard etc. in the future.	Text input
4	What are your thoughts on the potential of AI to improve higher education?	Text input
5	Do you believe that AI could make it easier to cheat on academic assignments? Cheat in this context means to use AI when the instructor or course policy explicitly do not allow the use of AI.	5-point Likert scale; strongly agree to strongly disagree
6	The use of AI tools can, when allowed and properly used, enhance student learning.	5-point Likert scale; strongly agree to strongly disagree
7	Do you believe your institution has adequate policies and procedures in place to ensure the ethical and responsible use of AI?	5-point Likert scale; strongly agree to strongly disagree
8	What additional support or resources do you think would be helpful for students who are interested in using AI in their work?	Text input
9	Please share any other thoughts or experiences you have related to the use of AI.	Text input

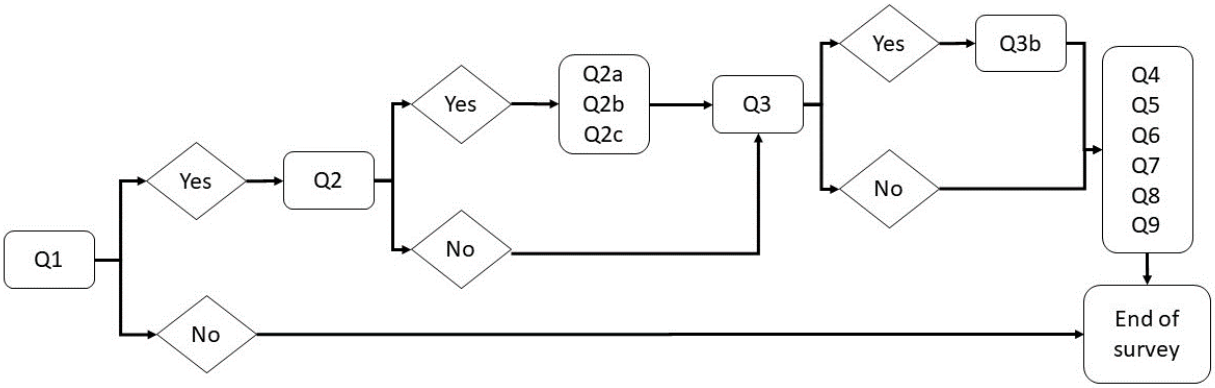

Figure 1: Survey Instrument Logic

The survey instrument was made available to all first-year students (N=244) via in-class announcement and on the learning management system (LMS). The script used during class and the notice posted on the LMS are as follows:

[Name of Instructor] is conducting a research project investigating the use of generative AI tools in first-year ME courses. Here is the link to the survey which is part of the research project:

[link to survey]

Please note that your participation is completely voluntary, and the survey will not ask for any identifiable information (anonymous survey). [Name of Instructor] will not know if you filled out the survey and whether you decide to fill out the survey or not has no impact on your grade in [course name]. It should take you less than 15 minutes to fill out the survey. Further information can be found by clicking on the link above, the first page of the survey has a consent form with more information, please read it carefully. By clicking "I agree to participate" you will be forwarded to the survey, or you can click "I do not agree to participate" (you won't be participating in the survey).

The survey instrument was available to students for the last four weeks of the fall term. In the consent form presented at the beginning of the survey instrument, students are informed that their participation is entirely voluntary, with no penalties or loss of benefits for choosing not to participate. Students will neither be penalized for non-participation nor rewarded for participation in the survey. Grades were assigned independently of the survey and prior to any research analysis. Students had the option to leave any survey questions unanswered.

Data Analysis and Discussion

The results of the survey instrument can be broken down into two categories: quantitative results (survey questions #2, #2a, #3, #5, #6, #7) and qualitative results (survey questions #2b, #2c, #3b, #4, #8, #9). The survey instrument was made available to all 244 students taking the introduction to mechanical engineering course. There were 186 students that opened the survey instrument, and out of them, 169 decided to participate, while 17 did not accept to participate (question #1). Therefore, the total number of students who participated in the survey and filled out the questionnaire is N=169. The results of the survey's quantitative sections will be presented first, followed by the results of the qualitative analysis.

Quantitative Analysis

A two-part question framework, questions #2 and #3, was employed to assess the current and future engagement of students with AI tools. The results are shown in Table 2.

Table 2: Responses to questions #2 and #3 - current and prospective usage of AI tools

#	Item Prompt	Yes	No
2	Did you use any form of AI such as ChatGPT, Google Bard etc.?	42% (N=71)	58% (N=98)
3	Do you plan to use any form of AI such as ChatGPT, Google Bard etc. in the future?	75% (N=126)	25% (N=43)

The responses to question #2 reveal that 42% of the students have already incorporated AI tools into their practices, while a majority of 58% have not yet engaged with such technologies. Interestingly, when queried about their future intentions regarding AI tool utilization, a

significant shift in response was observed. A substantial 75% of respondents indicated a positive inclination towards employing AI tools in the future, demonstrating a marked increase in the prospective adoption of AI tools. This contrasts with only 25% of participants expressing a lack of intent to use AI tools going forward.

A deeper analysis of the data reveals insightful trends among different respondent groups. Among the subset of participants who are current users of AI tools, an overwhelming majority of 95.8% (68 respondents) expressed their intention to continue using these technologies in the future. Conversely, among those who have not used AI tools to date, more than half the students, 59.2% (58 respondents), expressed a willingness to engage with AI tools in the future.

Overall, the survey results from questions #2 and #3 suggest a notable trend towards increased acceptance and intended use of generative AI tools, both among current users and those who have yet to incorporate these technologies into their practices.

The results from question #2a—which generative AI tool students used—are shown in Figure 2. The survey results show that ChatGPT was the most used AI tool, with 94.3% of the students indicating that they used it. Bing Chat was the second most used AI tool, used by 14.3% of the students. 8.6% of the students utilized Bard, an additional AI tool, ranking it third in terms of frequency of usage. Analyzing multiple mentions of AI tool usage, it was found that 20% of students who reported using an AI tool utilized more than one tool.

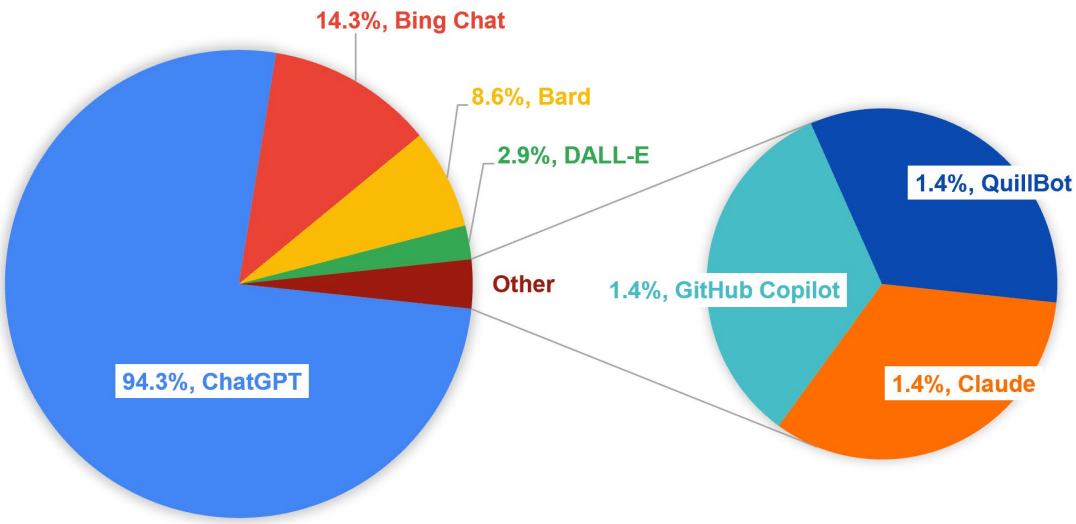

Figure 2: Responses to question #2a – “Which AI did you use, click all that apply”, multiple selections allowed.

The statistical analysis for questions #5, #6 and #7 is presented in Table 3 and Figure 3 shows the frequency distribution for all three questions.

Table 3: Responses to questions #5, #6 and #7 – Student perceptions on AI's potential for academic dishonesty, its benefits to learning when used properly, and the sufficiency of institutional policy for ethical AI use (N=167); 5-point Likert scale, 1=strongly agree, 5=strongly disagree

#	Item Prompt	Mean	Median	Mode	Std. Dev.	Skewness
5	Do you believe that AI could make it easier to cheat on academic assignments? Cheat in this context means to use AI when the instructor or course policy explicitly do not allow the use of AI.	2.33	2	2	1.06	0.49
6	The use of AI tools can, when allowed and properly used, enhance student learning.	2.13	2	1	1.21	0.98
7	Do you believe your institution has adequate policies and procedures in place to ensure the ethical and responsible use of AI?	2.82	3	3	0.85	-0.18

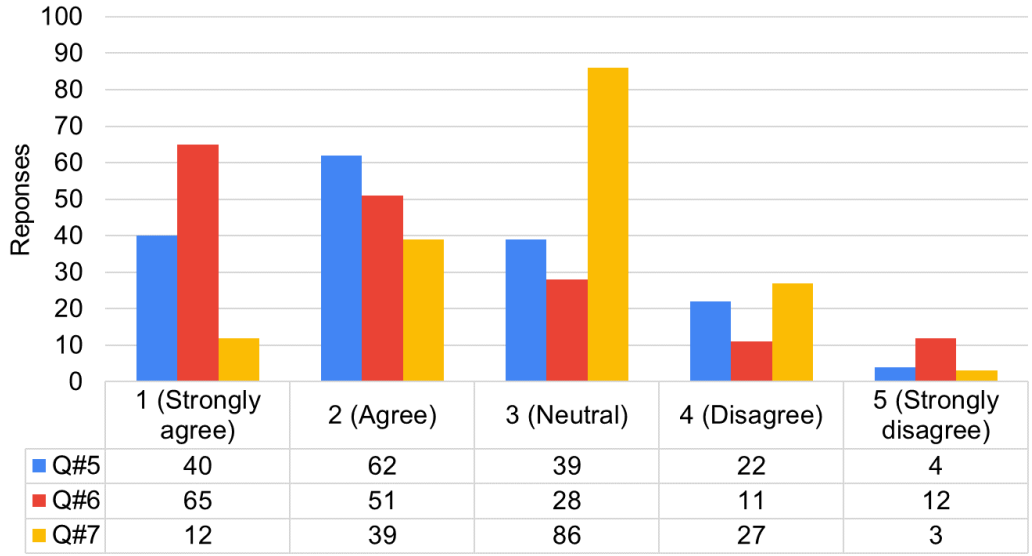

Figure 3: Frequency distribution for questions #5, #6 and #7

Question #5 asked students about the potential of AI tools to be used to facilitate academic cheating. The mean was found to be 2.33, which indicates that, on average, students are closer to "Agree" on the scale regarding the belief that AI could make it easier to cheat on academic assignments. The standard deviation of 1.06 suggests moderate variability in the responses, indicating that while there's a general trend towards agreement, there are still a variety of opinions. The skewness value is positive but less than 1, suggesting a slight skew towards the lower end of the scale (i.e., more agreement than disagreement), but it is relatively close to being symmetrically distributed, as shown in Figure 3. In summary, there is a general trend among the students towards agreeing that AI could make it easier to cheat on academic assignments. The majority of responses fall under agree or strongly agree, which means 61.1% agree or strongly agree that AI tools could be used for cheating on academic assignments.

Question #6 asked students about the use of AI tools to enhance student learning. The average response leans towards "Agree," as shown by the mean value of 2.13, indicating that most respondents believe AI tools can enhance student learning when properly used. The median is 2 ("Agree"), and the mode is 1 ("Strongly agree"), reinforcing the tendency towards students believing in the potential of AI tools to enhance learning. The standard deviation is found to be 1.21, showing more variability in the responses or a wider spread of opinions compared to question #5. The skewness is positive and close to 1, suggesting a moderate skew towards the lower end of the scale (more agreement). Summarizing the analysis of question #6, the findings indicate that a majority of students, 69.5%, tend to agree or strongly agree that AI tools, when permitted and appropriately utilized, have the potential to enhance student learning.

For question #7 regarding the adequacy of institutional policies and procedures for the ethical and responsible use of AI, the analysis reveals an average response (mean) of 2.82, indicating a tendency towards neutrality. This suggests that students generally hold a position of uncertainty or have mixed views about the effectiveness of their institution's AI policies. The alignment of both the median and mode at 3, coupled with the skewness value of -0.18 and a standard deviation of 0.85, reinforces this interpretation. This result is not surprising given that the institution has no explicit policy regarding the use of AI tools (at the time the survey instrument was used in this study) and instead relies on instructors to implement course policies pertaining to the use of AI tools specifically.

Qualitative Analysis

A qualitative thematic analysis for questions #2b, #2c, #3b, #4, #8 and #9 was conducted and is presented next.

Questions #2b and #2c are follow-up questions for students who answered yes to the question if they ever used an AI tool. The results of the thematic analysis of question #2b are shown in Table 4. The results of the thematic analysis of question #2c are shown in Table 5. Since the question asked about advantages as well as disadvantages, the analysis was split to evaluate responses which can be categorized as "pros" and responses in the "cons" category.

Table 4: Thematic analysis of question #2b: Describe how you used AI in this course. N=68

Theme	Instances of the Theme	Observations
Writing Support	28	The most common use of AI in the course was for essay writing support. This includes tasks like essay review, grammar correction, and writing assistance.
Idea Generation	15	Students used AI to generate ideas, particularly for the course writing assignments, indicating its role in enhancing creativity and brainstorming.
Study Aid	8	AI was also utilized as a study aid, such as summarizing texts and preparing for quizzes, indicating its role in learning and revision.
Other	17	13 students used AI tools but not specifically for this course.

Writing support emerged as the predominant theme, recorded in 28 instances. Students frequently utilize AI for tasks such as essay writing, review, grammar correction, and overall

writing assistance. Since the course has writing assignments, it is not surprising that students used AI tools primarily for writing support and idea creation for this course. Idea generation was another notable theme, with 15 instances. In this context, students leveraged AI to generate ideas, particularly for course writing assignments. The Study Aid theme, cited in 8 instances, indicates AI's application in summarizing texts and preparing for quizzes (the course also had quizzes about reading assignments).

Table 5: Thematic analysis of question #2c: Advantages of using AI in the course. N=55

Theme	Instances of the Theme	Observations
Idea Generation	19	Students value AI as a significant tool for idea generation, brainstorming, and as an initial step in the creative process.
Facilitating Writing Process	13	Students found AI particularly useful in aiding the writing process.
Efficiency and Time-saving	10	Students perceived AI as a tool for enhancing efficiency and ensuring the accuracy of their work.
Other	13	

Table 6: Thematic analysis of question #2c: Disadvantages of using AI in the course. N=51

Theme	Instances of the Theme	Observations
Technical Limitations	14	Students mentioned technical limitations or constraints of the AI. Common issues included difficulties in finding the right prompts and receiving outputs that were not useful.
Accuracy and Reliability	13	Students are worried about whether the AI provides accurate and reliable information. Students expressed apprehension over whether the AI-generated content could be trusted
Learning and Understanding	9	Students focused on how AI might negatively impact their learning process and understanding. This theme suggests a perception that reliance on AI might hinder deep learning and comprehension.
Misuse and Plagiarism	6	Students raised issues related to the potential misuse of AI for cheating or plagiarism.
Originality and Creativity	5	Students expressed concerns about the impact of AI on originality and creativity. This reflects a concern that AI assistance might not be helpful for personal creative tasks.
Other	8	

In summary, the analysis of perceived “pros” demonstrates that students recognize multiple advantages of using AI in their coursework. AI is praised in particular for its role in generating ideas, assisting with the writing process, and increasing efficiency. On the “cons” side, students identified technical limitations as a concern, with students expressing difficulties in finding appropriate prompts and receiving unhelpful outputs. Concerns were also raised about the accuracy and reliability of AI-generated content. Students also expressed concerns about the potential negative impact of AI on their learning process, as well as issues related to the potential

misuse of AI for cheating or plagiarism. Concerns also emerged about the impact of AI on students' originality and creativity.

Students who answered question 3— “Do you plan to use any form of AI such as ChatGPT, Google Bard etc. in the future?” —with yes, were presented with question #3b, “Describe how you plan to use AI such as ChatGPT, Google Bard etc. in the future.” The thematic analysis is summarized in Table 7.

Table 7: Thematic analysis of question #3b: Describe how you plan to use AI such as ChatGPT, Google Bard etc. in the future. N=122

Theme	Instances of the Theme	Observations
Idea Generation	65	Students show an interest in using AI for creative and conceptual tasks. This includes brainstorming, generating new ideas, and initiating projects.
Educational Support	54	Students plan to use of AI for homework help, studying, understanding assignments, summarizing text, checking their work, or computer code programming.
Writing Assistance	45	Students plan on using AI for assistance in writing, including editing, drafting, and refining essays.
Other	4	

The most prominent theme—with 65 instances—is the interest of students in using AI for idea generation. Students plan to use AI for brainstorming, generating new ideas, and initiating projects. The second most common theme, with 54 instances, revolves around the use of AI for educational support. Students plan to use AI tools for a range of academic purposes, including homework assistance, studying, understanding assignments, summarizing texts, checking work and computer code programming. With 45 instances, the third theme relates to the use of AI in writing. Students anticipate using AI for various aspects of writing, including editing, drafting, and refining essays.

Three prominent themes were identified for the analysis of the responses to question #4, as depicted in Table 8.

Table 8: Thematic analysis of question #4: What are your thoughts on the potential of AI to improve higher education? N=129

Theme	Instances of the Theme	Observations
Conditional Optimism	73	Student express optimism about the potential of AI in higher education, but with conditions or caveats, like the need for proper use, avoiding plagiarism, and ensuring AI adapts to individual needs.
Benefits of AI in Higher Education	58	Students mention how AI can enhance learning efficiency, facilitate studying, support ideation, assist with problem-solving, and serve as a tutor.
Disadvantages and Concerns	11	Students are concerned about AI, including potential misuse, such as cheating, the risk of students not actively learning, and issues related to over-reliance on AI.
Other	7	

There was a degree of overlap in the responses concerning the themes of conditional optimism and the benefits of AI in higher education. If a response addressed both themes, it was counted twice in Table 8. There were 73 instances where students exhibited optimism about the potential of AI in higher education but often included caveats regarding its proper use and the need to avoid negative consequences like plagiarism or misuse. Representative quotes for conditional optimism are:

- "I think AI, if used appropriately, can enhance the quality of higher education. However, if it is abused/overused, it may also discount the value of an education and take away from the learning process since students will be less likely to think independently."
- "AI has a high potential to improve higher education as long as it is used properly."
- "I think it could be very useful for students but can as well be used to cheat."

There were 58 instances in which students discussed the potential of AI to enhance learning efficiency, facilitate studying, support ideation, assist with problem-solving, and serve as a tutor. Representative quotes for the benefits of AI in higher education theme are:

- "I think AI can be very useful to producing ideas when students are stuck."
- "I think AI is a very helpful tool because it can break down certain problems into steps. I have used it in the past for help with studying physics and it provides me with practice questions and then shows steps to solve them."
- "I think that it made studying this quarter more efficient and was really helpful in answering questions I didn't understand in my classes."

When students solely mentioned concerns or disadvantages of AI use, their responses were put into the Disadvantages and Concern category. Eleven students expressed worries about artificial intelligence, including possible abuses like cheating, the possibility that students won't be engaged in their education, and problems with relying too much on AI. Representative quotes for the disadvantages and concerns theme are:

- "I am nervous of the potential of AI to improve higher education because I am not used to using AI so I already feel behind everyone else. It would also be a major change in the way we learn which could be a tough transition for me to make."
- "I don't think AI is going to improve higher education. It will make students lives easier and they won't actually learn to do things by themselves."
- "I think that AI would be more harmful than beneficial for higher education due to the fact that it allows students to complete work without having to do the thinking or going through the thought process during their assignment. Which can be harmful later on."

In summary, the majority of students expressed optimism about AI's role in higher education but stressed the importance of its proper application. Students emphasized AI's ability to improve learning efficiency and aid in studying. Students expressed concerns about the potential for AI misuse, including cheating and the risk of students becoming passive learners. Concerns about over-reliance on AI were also raised.

Question #8 asked students about additional support or resources they think would be helpful for using AI in their work. The result of the thematic analysis is summarized in Table 9.

Table 9: Thematic analysis of question #8: What additional support or resources do you think would be helpful for students who are interested in using AI in their work? N=94

Theme	Instances of the Theme	Observations
Guidance on Proper Use	52	Students showed a desire for AI to be included in formal engineering education. They expressed a desire for guidelines as well as specific AI courses and workshops.
Rules	21	Student expressed a need for clear, well-communicated guidelines and rules about AI use in academic work.
AI as a Supplemental Tool	13	Students view AI as a useful supplement to academic work, utilizing it for initial information gathering, brainstorming, and planning.
Other	13	4 students mentioned specific AI tools, 4 students responded with I don't know, and 5 other unrelated comments.

There were five responses addressing both the themes of guidance on proper use and rules. There is a notable preference by students for guidance on proper use of AI, as indicated by the higher frequency of this theme (52 instances). Students expressed a particular interest in courses and workshops teaching the proper use of AI and other structured learning opportunities and resources related to AI. Representative quotes for Guidance on Proper Use are:

- "there should be a class that teaches students how to use AI effectively"
- "I think that we should educate students on how to responsibly use AI."
- "It may be helpful to have workshops on ways to use AI to enhance learning without replacing learning."
- "Students should be educated on where AI gets its information and how it works in order to understand how it should be utilized properly."

There were 21 instances where students expressed the need for clear guidelines, rules, syllabus statements and communication from the instructor regarding the use of AI. Representative quotes for Rules are:

- "It would be helpful for teachers to explicitly tell us whether AI is allowed on assignments or not."
- "Clear rules on when it is permitted."
- "Putting up boundaries on what a student can and cannot use AI for, make it so there is no gray area."
- "How to use it in an exeptable [sic] way, as well as adding a section in every syllabus on if they can use this tool"

There were 13 instances where students appeared to view AI as a useful supplement to their academic work. They recognize the value of leveraging AI for gathering initial information,

brainstorming, and planning. However, they also caution that output from an AI tool should be critically assessed. Representative quotes for AI as a supplemental tool are:

- "You want to always verify the work you look up on AI as AI may not be up to date or may provide false/bias information."
- "Use it, but don't just copy and paste the response it gives you. Take that response and build upon it, make it yours, and then if you're not satisfied with the quality of your answer, ask the ai for advice on how to improve your response, and repeat the process until you are satisfied."
- "i think that if students choose to use ai the right way they should not put 100% trust into whatever comes out of ai because its not perfect yet and might still have misinformation. they should use ai to help jumpstart their brainstorming process, not use it to do assignments for them"

In summary, the majority of students expressed a strong interest in integrating AI into formal engineering education, emphasizing the need for structured guidance, AI-specific courses, and workshops. Students also expressed a desire for clear, well-defined guidelines and rules regarding the use of AI in academic settings. A smaller subset of students view AI as valuable for initial information gathering, brainstorming, and planning. However, they advise against over-reliance on AI outputs, advocating for a critical assessment of the information provided by AI tools.

Question #9 is an open-ended question where students could share any other thoughts or experiences they have related to the use of AI. The result of the thematic analysis is summarized in Table 10.

Table 10: Thematic analysis of question #9: Please share any other thoughts or experiences you have related to the use of AI. N=39

Theme	Instances of the Theme	Observations
Learning Enhancement	19	Students view AI as a beneficial tool for enhancing learning and that it can be a valuable supplement to engineering education.
Concerns about AI	8	Students expressed that AI has the potential to be beneficial but also poses risks.
Academic Integrity	6	Students mentioned the need for transparency in using AI for assignments to avoid misuse or cheating.
Other	6	3 students expressed that AI is an inevitable part of the future, and its use will continue regardless of whether universities are willing to embrace it or not, and 3 other unrelated comments.

The majority of students see AI as a promising tool that can enhance learning and creativity when used responsibly. They see its value in assisting with writing, learning quicker, gather information, provide practice problems, and brainstorming. Representative quotes for the theme of Learning Enhancement are:

- “Al has allowed me to be more creative and learn quicker.”
- “I have had good experiences where my thoughts are all over the place but when I use AI I can formulate ideas that formulate more smoothly”
- “Overall, I think AI is a great tool for students and allows for a better learning experience.”

Students expressed that, depending on how it is used, AI has the potential to be beneficial but also dangerous. They emphasize that AI should be viewed as a tool and warn against becoming overly reliant on it, implying that such reliance could harm the learning experience. Representative quotes for the theme of Concerns about AI are:

- “I think that it can be both beneficial and disadvantageous to use AI.”
- “I believe that it can be used to both help and damage the learning experience”
- “I worry that AI will create a higher demand for timed tests and timed writes when, in reality, these kinds of assignments are not useful or practical.”

There were 6 instances where students expressed concern that AI tools can be used for cheating or use it otherwise inappropriately. Instructors should adapt by teaching effective AI use and by creating AI-proof curricula that focus on critical thinking rather than busywork. Representative quotes for the theme of Academic Integrity are:

- “I think that with AI it's probably necessary to design curriculums that are “AI proof.”””
- “From my experience, the majority of people use it to cheat on assignments by looking up the answers of a task or using it to write their papers for them”
- “I think students should indicate for each assignment whether they used ai or not”

Three students mentioned the inevitability of the use of AI tools in education and the professional world in the Other category.

In summary, students highlighted AI as a valuable tool that enhances learning, with specific benefits in creativity, efficiency, and the enhancement of the learning experience. Students articulated their positive experiences with AI in helping them organize thoughts and accelerating their learning process. While recognizing its potential benefits, they also cautioned against over-reliance and misuse, pointing out that inappropriate use of AI could detract from the learning experience.

Limitations and Future Research

The participants for this study were first-year mechanical engineering students at the California Polytechnic State University, San Luis Obispo, who were willing to fill out the survey instrument. Of a total of 244 students, 169 students decided to participate (69% response rate). The fact that 75 of 244 students chose not to participate may have resulted in selection bias. Those who chose to participate may have different experiences or attitudes towards the use of AI

tools than those who did not, potentially skewing the results. Since the survey was conducted anonymously, no analysis could be performed to determine whether there was a difference in learning outcomes between students who used AI tools and those who did not. Demographic information was not collected and therefore results regarding the use or perception of students with different demographic backgrounds cannot be determined.

Future studies should aim to collect demographic information to understand how different groups (e.g., based on gender, ethnicity, and socio-economic background) perceive and use AI tools. This can provide a more nuanced understanding of how various factors influence attitudes and experiences with AI. Longitudinal studies to track changes in attitudes and usage of generative AI tools over time should be conducted. This can help in understanding how exposure and familiarity with these tools influence students' perceptions and learning outcomes. Additional qualitative research methods, such as in-depth interviews or focus groups, should be conducted to gain a better understanding of students' perspectives and experiences with generative AI tools. Interventions, workshops or courses teaching students how to productively and ethically use generative AI tools should be developed and accompanied by research studies to evaluate their effectiveness. Instructors' perspectives could offer further insights into the integration of generative AI tools into the curriculum and their perceived influence on student learning.

Summary

This study investigated the usage and perceptions of first-year mechanical engineering students at the end of their first term at California Polytechnic State University, San Luis Obispo. A mixed-methods survey instrument was used to understand first-year mechanical engineering students' engagement with AI tools, their perspectives on the ethical implications and potential benefits of AI in education, and the support they need to use these technologies effectively and responsibly. Of a total of 244 students, 169 decided to participate (69% response rate). Compared to two nationally conducted surveys, [1] and [2], which report 62% and 20% use of generative AI by higher education students, respectively, the quantitative analysis of this study reveals that 42% of first-year mechanical engineering students are already utilizing generative AI tools, whereas 58% have not. However, 75% of all respondents answered that they will use generative AI tools in the future, indicating a trend towards increased acceptance and intended use of generative AI tools. When asked how they plan to use generative AI tools in the future, students are highly interested in using AI for idea generation, educational support (such as homework help, studying, understanding assignments, summarizing text, checking their work, or computer code programming) and writing assistance. Among the subset of first-year mechanical engineering students who are currently using generative AI tools, 95.8% expressed their intention to continue using these technologies in the future. Among those who have not used generative AI tools to date, 59.2% expressed a willingness to engage with generative AI tools in the future. Among the first-year mechanical engineering students who already use generative AI tools, ChatGPT was the most used generative AI tool (94.3%), followed by Bing Chat (14.3%) and Google Bard (8.6%). Twenty percent of students said they utilize more than one generative AI tool. When asked about the advantages of using generative AI tools for their introduction to mechanical engineering course, students value generative AI as a tool for idea generation, assisting with the writing process and increasing efficiency. When asked about the disadvantages, students expressed mainly concerns about the technical limitations of AI, including difficulty in finding prompts, the accuracy and reliability of AI-generated content.

When asked if AI could make it easier to cheat on academic assignments, 61.1% of first-year mechanical engineering students agreed or strongly agreed that AI tools could be used for cheating on academic assignments. On the other hand, 69.5% tend to agree or strongly agree that AI tools, when permitted and appropriately utilized, have the potential to enhance student learning. When asked about adequate policies and procedures in place to ensure the ethical and responsible use of generative AI, results indicate a tendency towards neutrality. This outcome is expected, considering that the institution does not have a clear policy addressing the utilization of generative AI tools (at the time when the survey was conducted for this research). The thematic analysis of the open-ended question regarding first-year mechanical engineering students' thoughts on the potential of AI to improve higher education showed that the majority of students were optimistic about the potential generative AI can play in higher education, but they stressed the importance of appropriate implementation. Students mentioned how generative AI tools can enhance learning efficiency, facilitate studying, support ideation, assist with problem-solving, and serve as tutors. Less than 8% of the students expressed only concerns about AI, including potential misuse, such as cheating, the risk of students not actively learning, and issues related to over-reliance on AI.

The second-to-last survey question asked first-year mechanical engineering students what additional support or resources would be helpful for students who are interested in using generative AI. The majority of students expressed a strong interest in integrating AI into formal engineering education, emphasizing the need for structured guidance, AI-specific courses, and workshops. Students also expressed a desire for clear, well-defined guidelines and rules regarding the use of AI in academic settings. A smaller subset of students views generative AI tools as valuable supplemental tools. However, they advise against over-reliance on AI outputs, advocating for a critical assessment of the information provided by AI tools. The last question of the survey asked students to share any other thoughts or experiences they have related to the use of generative AI tools. Themes such as learning enhancement, concerns about the proper use and the need for transparency in using AI for assignments to avoid misuse or cheating emerged, similar to the previously encountered themes. The majority of students view generative AI tools as tools to enhance learning, with specific benefits in creativity, efficiency, and the enhancement of the learning experience. A smaller number of students (20%) expressed both potential benefits as well as caution against over-reliance and misuse. Another subset of students (15%) expressed concern that AI tools can be used for cheating or used otherwise inappropriately. Instructors should adapt by teaching effective generative AI use and creating AI-proof curricula that focus on critical thinking rather than busy work.

Conclusion

The results show that a total of 42% of first-year mechanical engineering students are already using generative AI tools and 75% will use generative AI tools in the future. The prevailing student view is that generative AI, when employed responsibly, can enhance the learning process. This indicates a clear call for responsible use and adaptability in engineering educational practices to ensure generative AI tools serve as an enhancer rather than a detractor to academic integrity and learning.

Considering the results of this study, colleges and universities are encouraged to establish clear guidelines and policies surrounding the use of generative AI tools. These guidelines and policies

should cover important issues such as intellectual property rights, data privacy, academic integrity, limitations and biases of generative AI tools, and ethical considerations.

Fostering a culture of responsible use of generative AI tools involves more than just guidelines and policies. It also necessitates educational efforts that provide students with the knowledge and critical thinking skills they need to utilize generative AI technologies ethically and successfully. Workshops or courses should be created to cover themes such as generative AI limitations and biases, the importance of verifying and evaluating generative AI outputs, and case studies on questions of ethics in generative AI use. However, workshops and courses may fall short if the content is not continuously evaluated and adapted to keep up with the quickly changing AI field, including professional development for instructors. Furthermore, to foster a culture that emphasizes the responsible application of generative AI tools, it is essential to establish a welcoming environment where students feel comfortable using these tools in accordance with policies and guidelines.

To summarize, generative AI technologies have the potential to enrich engineering education. However, reaching this potential will necessitate a coordinated effort to set clear norms, implement instructional efforts, and foster a responsible use environment. By addressing these aspects, educational institutions can equip their students with the skills and ethical awareness needed to navigate the challenges and opportunities presented by generative AI technologies in their future engineering careers.

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