# Navigating the Impact of AI in Engineering Education: Enhancing Learning Outcomes and Addressing Ethical and Assessment Challenges

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### Abstract

The integration of artificial intelligence (AI) in engineering education is transforming learning methodologies, enhancing engagement, and reshaping assessment strategies. AI's growing influence in engineering education enhances learning by providing instant feedback, improving problem-solving skills, and personalizing student experiences, yet it also complicates the evaluation of independent work and critical thinking. As students use AI in varying degrees, from refining their work to full reliance, this evolving landscape necessitates reassessing grading methodologies to ensure fair and accurate assessment. This study examines AI's impact on student learning outcomes and ethical considerations through a survey of 105 students across three engineering programs at the University of North Texas. Results highlight AI's role in improving research efficiency, conceptual understanding, and writing support while raising concerns about over-reliance, academic integrity, and disparities in access. Students express mixed perceptions, with some viewing AI as a valuable learning aid and others seeing it as a risk to independent critical thinking. This study also explores students' perspectives on integrating AI into future curricula and highlights their suggestions for its responsible and effective adoption in engineering education.

# Introduction

The rapid advancements in artificial intelligence (AI) are reshaping the education sector. Engineering education has long been at the forefront of adopting technological innovations, reflecting the field's dynamic and solution-driven nature. AI tools such as ChatGPT, Copilot, Grammarly, Claude, Gemini, Wolfram Alpha are becoming indispensable to enhance learning experiences<sup>1,2</sup>. From automated routine reminders to facilitating deeper conceptual understanding with personalized and adaptive learning<sup>1,3–5</sup>, these tools hold an immense potential. For students, these tools often act as virtual tutors, and even motivators, adapting to individual learning needs<sup>3–6</sup>.

AI tools can help students with adaptive learning platforms that can analyze students' performance, provide tailored feedback and dynamically adjust content to match individual needs. Interactive tools such as virtual/augmented reality can promote critical thinking and problem-solving skills. These tools can also tailor content aligned with students' perceptions and interests. Moreover, AI tools can connect students with a wealth of global knowledge. With intelligent search engines and resource recommendation systems, students can tap into diverse perspectives and ideas.<sup>3–5,7–9</sup>

Yet, with great potential comes significant complexity. The use of AI tools brings a range of challenges. The accuracy of AI-generated information remains a critical concern, accompanied by challenges such as over-reliance, ethical dilemmas, emotional disengagement, and performance anxiety<sup>3</sup>—all of which can contribute to increased stress levels among students. Students may find

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themselves in a position where the boundaries between legitimate assistance and misconduct are blurred. Additionally, disparities in access to advanced AI features can aggravate existing inequalities among students<sup>3</sup>. These challenges raise critical questions. What impact do they have on academic performance, engagement, and skill development? Moreover, do these benefits come at the cost of ethical concerns or diminished critical thinking?

To explore these issues, this study delves into the impact of students from different engineering disciplines using AI tools based on a survey of 105 students.

## **Survey Design and Methodology**

A survey was developed and conducted to understand how students utilize AI tools for academic purposes, assess how they intend to integrate these tools into future curriculum, and identify the concerns and challenges associated with AI usage. The survey comprised 105 students from three majors: Mechanical Engineering (11.4%), Engineering Management (43.8%), and Mechanical Engineering Technology (44.8%). The participant group was evenly divided between undergraduate (49.5%) and graduate (50.5%) students.

The survey featured a combination of multiple-choice and Likert-scale questions focused on four main areas: first, the survey explored usage patterns and engagement with AI tools with questions focus on how students interact with AI tools, the various applications of these tools in their studies, and the perceived engagement and efficiency benefits; second, the survey assessed the effectiveness and impact on learning using questions that assess the perceived effectiveness of AI tools in improving learning outcomes and academic performance. Third, the survey questionnaire addressed the perceptions and attitudes towards AI tools to explore students' overall perceptions and attitudes towards the usability, integration, and potential of AI tools in education. Finally, questions about concerns and ethical considerations sought to address the potential drawbacks, ethical concerns, and challenges associated with using AI tools.

Despite offering valuable insights, the survey had some limitations. The participant pool was restricted to students from three engineering disciplines from the same mechanical engineering department at the University of North Texas (UNT), which may not fully represent perspectives across all engineering fields. Furthermore, as the data relied on self-reported responses, it may reflect subjective perceptions.

### Results

### **Usage Patterns: A Multifaceted Approach**

Among the surveyed students, 65.7% indicated that they rely on AI tools for research and information collection. Conceptual understanding (58.1%) and brainstorming (57.1%) emerged as other prevalent uses. Writing assistance is utilized by 46.7% of respondents.

Interestingly, fewer students (37.1%) reported using AI for problem-solving, and only 34.3% employed it for test preparation. This suggests that students are leveraging AI more for exploratory and preparatory tasks rather than direct problem-solving or exam-related activities. However, this also indicates concerns about the tools' accuracy or effectiveness in this area.

### **Effectiveness: A Catalyst for Growth**

Students generally view AI tools as effective in enriching their learning experiences. Nearly 44% of respondents found these tools "quite effective," while 14.3% deemed them "extremely effective." The impact extends beyond immediate learning outcomes; 62.9% reported that AI tools moderately

improved their academic performance, with 16.2% noting significant improvement as shown in Figure 1.

The tools' influence on students' confidence in tackling complex topics is another key takeaway. Over half (54.8%) of the students felt a moderate increase in confidence, and 9.6% experienced a significant boost. Most students believe AI can benefit their educational experience than traditional learning methods by providing immediate access to information (64.4%), instant doubt clarification (52.9%) and feedback (48.1%). Students can also benefit from customized learning paths (35.6%) and expanded access to learning materials (46.2%).



Figure 1: a) Effectiveness of AI tools usage, b) Impact of AI tools usage on academic performance, c) Improving confidence in understanding complex topics without assistance.

### Perceptions and Attitudes: Mixed Opinions on AI Integration

64.7% either agreed or strongly agreed that AI tools are user-friendly, opinions on their role in the learning process are more nuanced. While approximately half of the students agreed or strongly agreed that AI tools provide quick and effective answers (59%) and make studying more engaging (49.5%), opinions are mixed on AI tools developing critical thinking skills. 68% are either neutral or disagree that AI tools can help develop critical thinking skills. The general perception of AI tools usage is tabulated in Table 1.

Students are also divided on the broader integration of AI into education. Although 37.9% of the

surveyed students' population support greater integration of AI tools in higher education, only 17.5% strongly endorsed this idea, and a significant minority (18.3%) strongly disagreed with the notion of replacing traditional learning methods entirely. A large portion of the students want AI tools to be integrated in the education system as supplementary resources (63.1%) and personalized learning plans (40.8%) (see Figure 2). Only 20.4% of students want AI tools to be integrated for automated grading and feedback. This low level of enthusiasm may stem from the potential performance anxiety triggered by instant evaluations<sup>3</sup>. Few students (22.3%) prefer collaborating with AI tools for projects. On the other hand, 32% of the students want minimal or no integration at all, which is a relevant datapoint.



Figure 2: Integration of AI tools in future curriculum and concerns associated with that.

| Statements                       | Strongly | Disagree | Neutral | Agree | Strongly | Median |  |  |  |  |
|----------------------------------|----------|----------|---------|-------|----------|--------|--|--|--|--|
|                                  | disagree | (2)      | (3)     | (4)   | agree    |        |  |  |  |  |
|                                  | (1)      |          |         |       | (5)      |        |  |  |  |  |
| AI tools are easy to use.        | 1.9      | 1.9      | 31.4    | 42.2  | 22.5     | 4      |  |  |  |  |
| AI tools provide quick and       | 2.0      | 5.0      | 34.0    | 50.0  | 9.0      | 4      |  |  |  |  |
| effective answers.               |          |          |         |       |          |        |  |  |  |  |
| AI tools make studying more      | 2.9      | 12.6     | 35.0    | 35.9  | 13.6     | 3      |  |  |  |  |
| engaging.                        |          |          |         |       |          |        |  |  |  |  |
| AI tools can sometimes provide   | 2.0      | 1.9      | 16.3    | 45.2  | 34.6     | 4      |  |  |  |  |
| misleading or incorrect          |          |          |         |       |          |        |  |  |  |  |
| information.                     |          |          |         |       |          |        |  |  |  |  |
| AI tools help me understand      | 1.0      | 4.9      | 29.4    | 46.1  | 18.6     | 4      |  |  |  |  |
| complex topics better.           |          |          |         |       |          |        |  |  |  |  |
| AI tools should be more          | 4.8      | 9.7      | 30.1    | 37.9  | 17.5     | 4      |  |  |  |  |
| integrated into higher           |          |          |         |       |          |        |  |  |  |  |
| education.                       |          |          |         |       |          |        |  |  |  |  |
| AI tools can replace traditional | 18.3     | 25.0     | 24.0    | 23.1  | 9.6      | 3      |  |  |  |  |
| learning methods.                |          |          |         |       |          |        |  |  |  |  |
| AI tools can help develop        | 7.8      | 24.3     | 35.9    | 26.2  | 5.8      | 3      |  |  |  |  |
|                                  |          |          |         |       |          |        |  |  |  |  |

Table 1 shows the general perception of AI tools usage.

| critical thinking skills.       |     |      |      |      |      |   |
|---------------------------------|-----|------|------|------|------|---|
| AI tools can sometimes distract | 7.7 | 31.7 | 28.8 | 27.9 | 3.9  | 3 |
| me during study sessions.       |     |      |      |      |      |   |
| AI tools help improve my        | 3.9 | 4.9  | 32.4 | 43.1 | 15.7 | 4 |
| efficiency in completing        |     |      |      |      |      |   |
| assignments.                    |     |      |      |      |      |   |
| Do you believe that students    | 9.6 | 23.1 | 34.6 | 24.0 | 8.7  | 3 |
| who use AI tools like ChatGPT   |     |      |      |      |      |   |
| for assignments receive an      |     |      |      |      |      |   |
| unfair advantage in grading?    |     |      |      |      |      |   |

# Challenges and Concerns: The Other Side of the Coin

A recurring concern among students is the accuracy of AI-generated information, with 68% expressing reservations about its reliability (see Figure 3). This issue is compounded by fears of over-reliance (27.2%), as 51.5% worry that excessive dependence on AI could undermine their learning ability and 37.9% believe AI tools can create lack of critical thinking practice.

Ethical concerns also loom large. Over half (55.3%) of the respondents identified academic dishonesty as a significant risk associated with AI tools shown in Figure 2. The potential for misuse, whether intentional or inadvertent, raises questions about fairness and integrity in assessments. Moreover, privacy concerns (16.5%) and the cost of advanced AI tool features exacerbate inequities, making these tools less accessible to low-income students. 34% of the students deem subscription costs a major challenge in using AI tools. Some students also faced technical issues (26.2%) and difficulties in understanding the response provided from the AI tools (20.4%). However, students also find AI tools can bring benefits to their educational experience shown on the left-hand side of Figure 3.



Figure 3: Benefits and challenges of AI tools usage.

Two-thirds of the students (65.7%) never discussed using AI tools with their teachers, while 35.2% do not want to discuss ever. The rest of the students occasionally discuss with their teachers. 73.5% of respondents emphasized the need for instructors to clearly define acceptable uses of AI in coursework, ensuring that its application aligns with academic integrity standards. Nearly half (48%)

highlighted the importance of promoting the evaluation of AI-generated content for accuracy, bias, and relevance, viewing it as an opportunity to develop critical analytical skills. Additionally, 35.3% want to integrate AI in assignments that allow students to leverage AI for data analysis, brainstorming, or creative problem-solving while emphasizing the importance of independent thinking. 33.3% stressed the need to incorporate AI literacy to use AI tools effectively, including understanding their limitations and potential biases.

## Conclusions

This study highlighted the students' perspective about the use of AI tools in engineering education, providing insights into their usage, effectiveness, and the challenges they present. It is evident that AI has the capacity to enhance learning experience and improve academic performance. Many students appreciate the accessibility and usability of AI tools, as they leverage the tools for research and brainstorming, thereby streamlining their academic efforts and sometimes boosting their confidence. However, issues such as over-reliance, ethical dilemmas, and unequal resource distribution underscore the need for a balanced approach. While AI can democratize education by providing tailored resources to students from diverse sources, these benefits must be weighed against potential drawbacks, such as reduced critical thinking ability and increased risks of academic dishonesty.

The findings of this research emphasize a thoughtful integration of AI tools into the educational framework. Educators and institutions must address concerns about accessibility, ethics, and responsible use while leveraging AI's strengths to create more engaging and effective learning environments. Training students and faculty to navigate these technologies responsibly is paramount, as is developing policies that ensure equitable access and ethical practices.

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With two years of teaching assistant experience, Sakib is deeply passionate about teaching and is dedicated to improving engineering education and enhancing learning experiences for students.

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