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AI in Engineering Curricula: Adoption, Challenges, and Ethical Considerations Among Engineering Students

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***Abstract*—As Artificial Intelligence (AI) continues to transform the engineering setting, its integration into engineering education emerges as a critical element in equipping future engineers. This paper presents a survey study aimed at evaluating the adoption and impact of AI tools and methodologies within engineering curricula among engineering students at the University of New Haven. It investigates engineering students' perceptions regarding the role of AI in their education, the challenges encountered with its integration, and the ethical concerns related to AI applications in engineering. Utilizing questionnaires, this study collects data from a diverse cohort of engineering students, aiming to uncover shortcomings in current educational methods and to suggest improvements. The findings are expected to contribute to the ongoing discussion on enhancing engineering education, ensuring students are well-prepared with essential AI skills and ethical insight for their professional careers.**

***Keywords*—Artificial Intelligence (AI), Gen AI, Engineering Education**

I. INTRODUCTION

The integration of Artificial Intelligence (AI) into educational frameworks represents a significant shift in the way engineering education is approached, with Generative AI tools like ChatGPT leading this transformation. These tools are not only reshaping curriculum design but are also enhancing the way educational content is delivered and interacted with by students. While the benefits of such technologies are numerous, they inevitably introduce complex ethical and integrity challenges that require constant supervision.

Generative AI has drastically altered the educational setting by automating tasks and generating new content, which can significantly aid in educational processes. According to Guillén-Yparrea and Hernández-Rodríguez (2023), these tools are being widely adopted across higher education institutions due to their ability to improve operations and enrich educational content. However, they caution about the risks to academic integrity as AI-generated content may often blur the lines between student originality and automated output.

This concern is recalled by Miranda et al. (2021), who note that while AI tools can enhance personalized learning experiences and adapt educational content to the changing needs of the industry, they also require new pedagogical strategies to ensure they are used appropriately.

While generative AI, offers transformative potential in engineering education by personalizing learning experiences and creating realistic simulations, it also raises significant ethical concerns. These include the risk of fostering dependency on automated systems and diminishing the development of critical thinking skills. Educators must navigate these challenges carefully to fully utilize the benefits of AI while preparing students to critically engage with the technology (Qadir, 2022).

The complexity of modern engineering problems demands that students not only possess technical knowledge, but also advanced problem-solving skills. AI tools can be instrumental in developing these skills by providing simulation and modeling capabilities that allow students to engage with real-world scenarios in a controlled environment. This integration of AI can support a more dynamic and interactive learning

experience that is aligned with industry demands (How & Hung, 2019).

AI technologies can profoundly influence the design of curricula in engineering education by providing tools that align learning outcomes with industry demands. Intelligent systems are employed to enhance the delivery of course content and to facilitate a more personalized learning experience. This strategic integration supports the development of essential engineering competencies, preparing students for the challenges of the fourth industrial revolution (Pillay et al., 2020).

To effectively integrate AI technologies within engineering education, educators must stay updated on technological advancements and develop proficiency in their application. This need for skill enhancement is not restricted to the use of the technology itself, but extends to understanding the implications of AI on the learning environment (Johnson et al., 2023).

Additionally, the work by Miranda et al. (2021) suggests that to fully harness the potential of AI, the core components of Education 4.0, including competencies, learning methods, technologies, and infrastructure, must be strategically realigned. This realignment will ensure that AI tools are not only implemented effectively, but also resonate with the broader educational goals of preparing engineering students to succeed in a highly dynamic and technologically driven workplace.

Nevertheless, deployment of AI technologies in education raises significant ethical concerns, particularly regarding data privacy and the potential for reinforcing biases (Zhang & Aslan, 2021). As AI systems are trained on large datasets, there is a risk that these systems might continue existing biases present in the data they are trained on, which could lead to unfair or unethical outcomes. This issue is particularly applicable in the context of educational assessments where AI-generated biases could influence student evaluations.

Furthermore, as highlighted by Neumann et al. (2023), the disruption introduced by ChatGPT and similar technologies in higher education requires urgent discussions on how these tools are integrated into curricula. It is crucial that educational institutions establish rigorous frameworks to manage the use of AI tools, ensuring that they augment rather than compromise educational values.

By integrating a comprehensive and ethically guided AI strategy into educational frameworks, institutions can create a nurturing environment that addresses the academic needs of students and equips them with the critical thinking and problem-solving skills necessary for the modern engineering era.

II. METHODOLOGY

This study employs a survey methodology to assess the perceptions and impacts of AI integration in the engineering curricula at the University of New Haven. The survey aims to gather data on students' views regarding the adoption of AI tools, the challenges faced during their integration, and ethical concerns arising from their use in educational settings.

Survey Design and Population

The survey is designed with a structured questionnaire, comprising mostly closed and one open-ended questions to capture comprehensive insights from the participants. Table I, illustrates the survey questions.

TABLE I. Survey Questions

Section	Survey Questions
1. Demographics	What is the email address?
	What is your major within the engineering department?
	What year are you currently in?
	Have you taken any courses that include AI tools or methodologies?
2. Adoption of AI in Education	On a scale of 1 to 5, how often do you use AI tools or methodologies as a student?
	On a scale of 1 to 5, how often do you use ChatGPT in your studies?
	In which area of your studies have used AI?
	Which of these AI tools have you ever used in your studies?
3. Perceptions and Impact	On a scale of 1 to 5, how effective do you think AI tools are in enhancing your learning experience?
	What benefits have you observed from the integration of AI in your education?
	On a scale of 1 to 5, how essential do you think learning AI methodologies is for your future career?
4. Challenges Encountered	What challenges have you faced with the integration of AI in your education?
	On scale of 1 to 5, how sufficient do you think the support from the faculty is learning and using AI tools?
	What type of support do you feel is lacking?
5. Ethical Considerations	Have you had discussions about the ethical implications of using AI in engineering?
	On Scale of 1 to 5, how fair do you find it for a student to use AI to achieve better grades?
	On a scale from 1 to 5, how fair do you find it to consider AI as plagiarism in your courses?
6. Open-Ended Question	Do you have any suggestions on how AI adoption in the engineering curriculum could be improved?

The survey is distributed to 582 undergraduate and graduate engineering students at the University of New Haven, specifically excluding majors closely associated with extensive AI use, such as Data Science, Computer

Science, Computer Engineering, Cybersecurity, and Information Science, to avoid outlier data from students who are already familiar with AI technologies. These majors will be studied in the next phases of this research, and the results between these two groups will be compared.

A. Data Collection

The questionnaire link is emailed directly to potential respondents, with reminders sent to encourage participation. Participation is voluntary, with an emphasis on anonymity and confidentiality to ensure genuine and unbiased responses. The survey remains open for three 10 days, during which 87 students participate, providing a diverse range of insights into the role of AI in engineering education.

B. Data Analysis

Responses are quantitatively analyzed for closed-ended questions using statistical software to determine frequencies and trends. Open-ended responses are qualitatively analyzed to extract themes and direct quotes that illustrate students' perceptions and experiences with AI in their education. The mixed-methods approach allows for a richer interpretation of how AI tools are perceived across different aspects of their academic journey.

C. Ethical Considerations

The study is conducted following the ethical guidelines, ensuring that all participants are informed of the study's purpose and their rights as participants. Consent is obtained prior to participation, and data is handled with strict confidentiality.

III. RESULTS AND ANALYSIS

The results of the study are grouped and analyzed in the following six sections.

Section 1: Demographics

The survey included responses from 87 engineering students across multiple disciplines, with the highest representation from Construction Engineering and Management, M.S. (24 students, 26%) and Civil Engineering, M.S. (23 students, 22%). Undergraduate programs such as Civil Engineering, B.S. (19 students, 18%) also had strong participation. Other programs, including Chemical and Biomolecular Engineering, Electrical Engineering, and Environmental Engineering, M.S., had lower representation, each accounting for fewer than 7% of respondents. Notably, Mechanical Engineering and several other programs had no respondents, indicating possible limited engagement with AI or lower student numbers in those fields. These groups are illustrated in **Fig.1**.

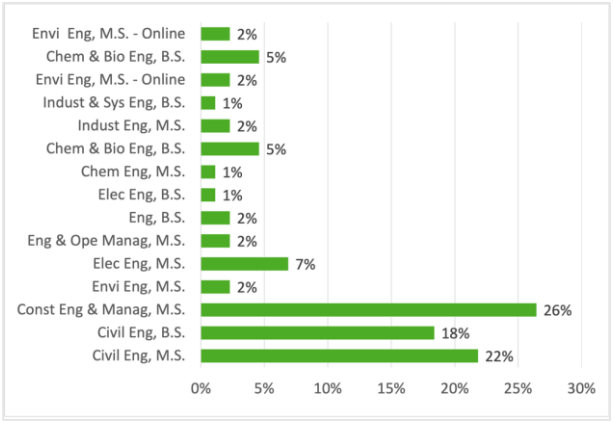

Fig.1. Participant's Majors

A majority of the respondents (74%) were graduate students, with 43 (49%) in their second year and 22 (25%) in their first year of graduate study. Among undergraduates, the largest group was juniors (7 students, 8%), followed by freshmen (6 students, 7%), sophomores (5 students, 6%), and seniors (3 students, 3%). This distribution suggests that AI awareness and adoption might be more prevalent among graduate students, who may have more exposure to AI-integrated coursework. This distribution is shown in **Fig.2**.

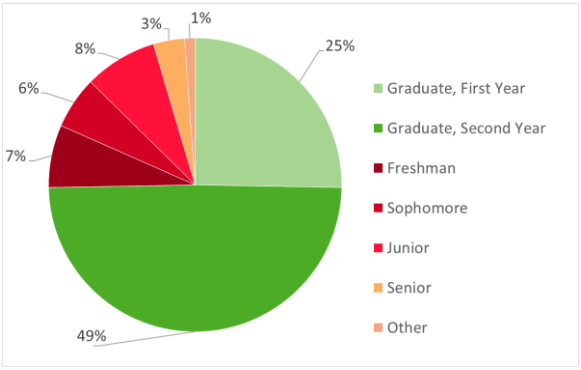

Fig.2. Participants' Study Year

As the last question under section 1, 59 students (68%) have not taken any courses that include AI tools or methodologies, while 28 students (32%) have taken such courses (**Fig.3)**.

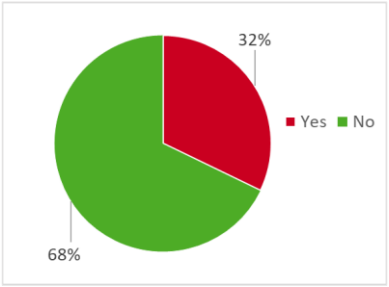

Fig.3. Percentage of Participants Who Have Taken an AI Course

Section 2: AI Adoption and Usage in Education

Out of 87 respondents, students indicated varying frequencies of AI tool usage in their studies. Specifically, 31 students (36%) occasionally use AI tools, while 24 (28%) often do, and 10 (11%) always rely on AI tools for their academic activities. 17 (20%) students have rarely used AI, and the remaining 5 (6%) students have never used AI for their academic tasks (**Fig.4**). The average scale for this question is 3.21, indicating that the majority of students are using AI tools more than often in their studies.

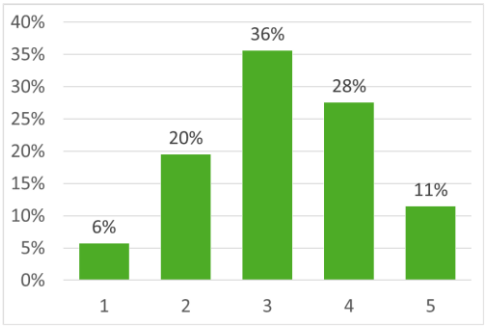

Fig.4. Frequency of Using AI (1 being Never, 5 being Always)

ChatGPT, developed by OpenAI, represents a significant advancement in Conversational and Generative AI. This model, a variant of the GPT-3.5 series, is designed to interact in a dialogue format, enabling it to answer follow-up questions, admit mistakes, and handle a range of interactive tasks. Key to its development was the use of Reinforcement Learning from Human Feedback (RLHF), where human trainers played both the user and the assistant, providing high-quality responses that helped refine the model's accuracy and relevance. Introduced to the public for free during its research preview phase, ChatGPT's capabilities include challenging incorrect premises and rejecting inappropriate requests. However, it also has limitations, such as generating plausible but incorrect answers and being sensitive to the phrasing of questions (OpenAI, 2022).

A separate question focusing on ChatGPT usage revealed that 10 students (11%) reported never using it, 28 students (32%) reported rarely using it, while 22 (25%) used it occasionally. In addition, 20 (23%) often use ChatGPT, and 7 students (8%) reported using it always, resulting in an average score of 2.82 (**Fig.5**). This indicates that while ChatGPT is a widely recognized AI tool, it is not yet a dominant resource for most students, and the majority of students use it less frequently than often.

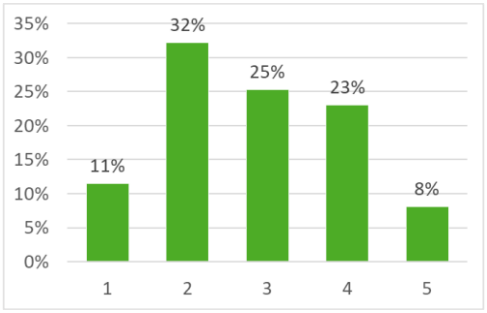

Fig.5. Frequency of Using ChatGPT

Students reported using AI tools for various academic purposes, with the highest usage in “Emails and Communication” (50 students, 51%), followed by “Research and Data Analysis” (45 students, 48%). Additionally, “Papers and Reports” (38 students, 44%) and “Presentations” (35 students, 38%) were common applications. In contrast, AI usage was least reported for “Quizzes and Exams” (5 students, 6%) and “Code Generation” (10 students, 11%). **Fig.6** presents all other applications and their frequencies. This suggests that while AI is used for assisting with research, writing, and communication, it is less commonly utilized in direct academic assessments.

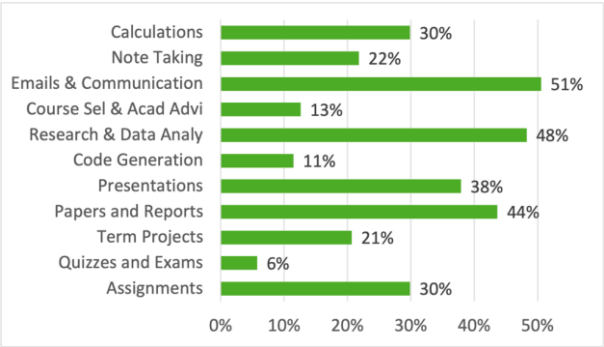

Fig.6. Areas of AI Application by Students

A large variety of AI tools are available to assist students. For example, Tutor AI, Natural Readers, and ChatPDF are niche tools, tailored for educational and document interaction purposes. Notion and BypassGPT serve more specific functions in productivity and content creation. Gradescope and Brainly suggest a focus on educational support, while Otter.ai caters to real-time transcription services. Wolfram Alpha is well known for its computational capabilities, while Perplexity AI, Quiltbot, and Claude are used for enhancing writing and content generation. Google Gemini and Grammarly are two tools for writing assistance and grammar checking. Microsoft Copilot and GitHub Copilot, although similarly named, serve different niches, the former in office productivity and the latter in coding assistance. Lastly, ChatGPT stands out for its conversational capabilities and versatility across multiple domains.

Among these AI tools, ChatGPT was by far the most widely used, with 70 students (79%) reporting its use. Other commonly used tools included Grammarly (44 students, 49%) and Microsoft Copilot (25 students, 28%). In contrast, less frequently used tools included Wolfram Alpha (10 students, 11%), Claude (7 students, 8%), and Tutor AI (7 students, 8%). This trend (**Fig.7**) highlights the preference for general-purpose AI writing and communication tools over more specialized AI applications.

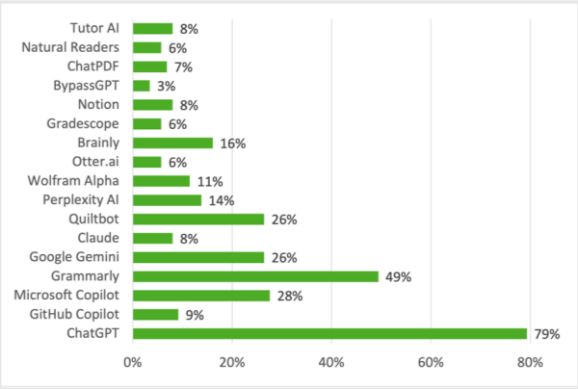

Fig.7. AI Tools Used by Students

Section 3: Perceptions and Impact of AI on Education

Students rated the effectiveness of AI tools positively, with 14 (16%) believing them to be very effective, 30 (34%) finding them effective, and 28 (32%) finding them moderately effective. 3 students (3%) believed that AI tools are not effective at all, and 12 (14%) recognized these tools as slightly effective (**Fig.8**). With an average of 3.47, these responses indicate that the majority perceive AI as an effective tool to their learning experience, enhancing understanding and efficiency in completing academic tasks.

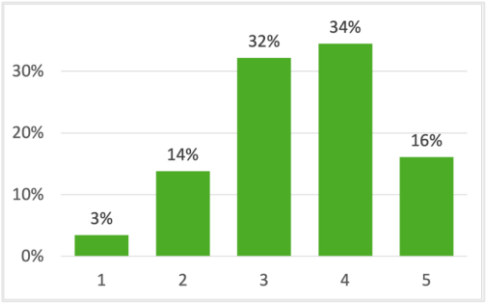

Fig.8. Effectiveness of Using AI

The primary benefits noted from AI integration include “24/7 Learning Support and Immediate Feedback”, recognized by 56 students (64%), and “Improved Academic Writing and Language Skills', observed by 45 students (51%). Several other benefits are reported in **Fig.9**. These benefits include “Increased Accessibility”, “Reduced Workload”, and “Enhanced Personalization”.

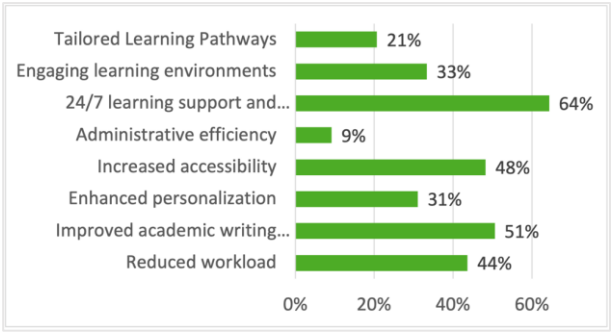

Fig.9. Benefits of Using AI for Students

The respondents also recognize the importance of AI knowledge for their future careers, with 21 (24%) rating it as very essential and 23 (26%) as essential. 27 students (31%) reported the AI knowledge as moderately essential, while 12 (14%) reported it as slightly essential, and 4 (5%) as not essential. The average scale for this question is 2.96, which reflects that the majority of the respondents believe that AI knowledge is somehow essential.

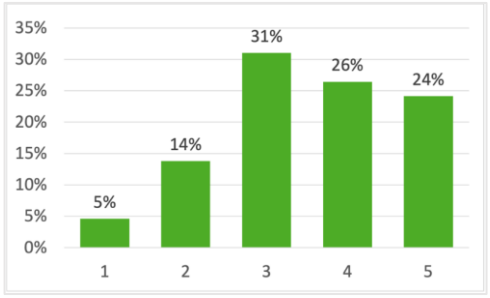

Fig.10. Importance of AI Knowledge for Students' Future Careers

Section 4: Challenges Encountered

Students faced several challenges with AI integration in education, with 'loss of critical thinking' and ‘Subscription cost' being the most reported issue by 36 students (41%). Additionally, 'technical glitches' and 'reduced human interaction' were significant concerns, reported by 32 (37%) and 45 (51%) students, respectively. These challenges emphasize the complexities involved in integrating AI effectively without undermining essential educational outcomes like critical thinking and interpersonal skills.

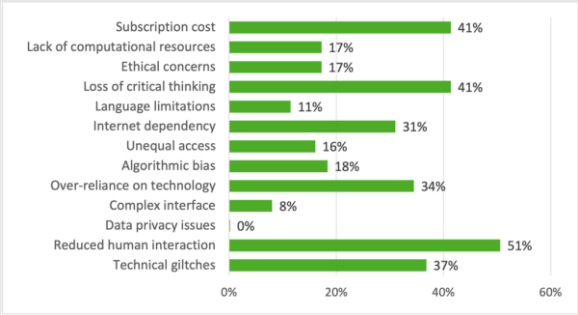

Fig.11. Challenges of Using AI by Students

The perceived sufficiency of support from faculty in learning and using AI tools was rated as sufficient by 37 students (43%). 16 (18%) and 8 (9%) rated it as fair and not sufficient. On the other hand, 15 (17%) and 11 (13%) students rated the support as moderately sufficient and very sufficient (**Fig.12**).

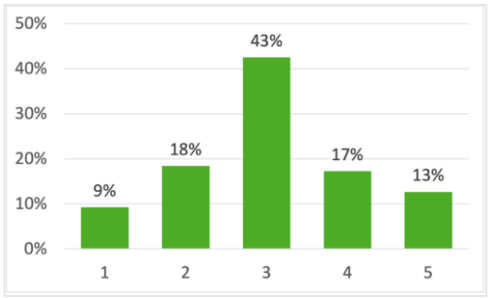

Fig.12. Faculty Support in Learning AI Tools (1 being Not Sufficient, 5 being Very Sufficient)

Students were also asked to select the areas that need more support from the faculty. As shown in **Fig.13**, there is a notable demand for more 'training and professional development', as highlighted by 44 students (51%), and "Technical Support" by 28 students (32%), indicating a gap in current support structures. Other areas of support include "Ethical Guidance", "Feedback Mechanism", and "Curricular Integration", followed by "Hardware and Software Resources", "Legal and Regulatory Guidance", and "Cross Disciplinary Collaboration".

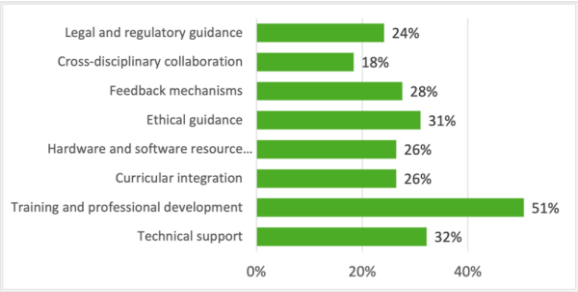

Fig.13. Type of Support Lacking in Faculty Support

Section 5: Ethical Considerations

Approximately half of the respondents (44, 51%) have engaged in discussions about the ethical implications of using AI in engineering, reflecting a significant level of engagement with the ethical dimensions of AI technology in academic settings (**Fig.14**).

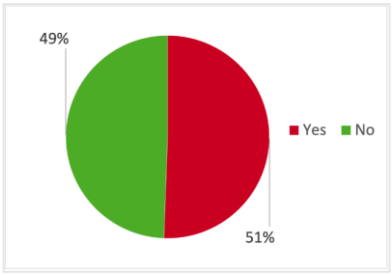

Fig.14. Percentage of Students Who Had Discussion on Ethical Considerations of AI

Opinions on the fairness of using AI to achieve better grades were mixed, with 25 (29%) considering it somewhat fair, and 22 (25%) viewing it as unfair (**Fig.15**). This variation in responses highlights the ethical complexity of using AI tools in assessment contexts.

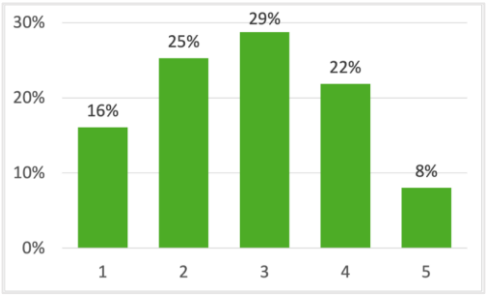

Fig.15. Students' Opinion on Fairness of Getting Better Grades Using AI (1 being Not Fair, 5 being Very Fair)

Similarly, when asked whether AI should be considered plagiarism, 20 students (23%) were neutral, 18 (21%) considered it plagiarism, and 12 (14%) strongly disagreed. 20 students (23%) believed that it is very fair and 17 (21%) selected it is fair to consider AI as plagiarism (**Fig.16**). These mixed responses highlight the need for clearer policies on AI use in academic work.

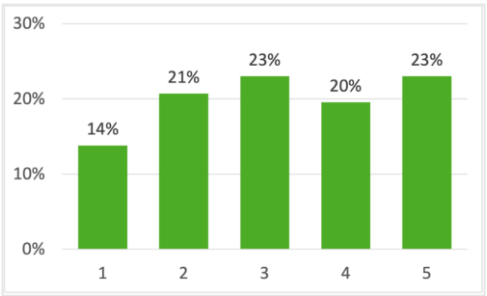

Fig.16. Fairness of Considering AI as Plagiarism (1 being Not Fair, 5 being Very Fair)

Section 6: Open-Ended Question on Improving AI Integration in Engineering Education

A significant number of responses indicated a lack of suggestions or contentment with the status ("No," "N/A"), which may suggest either a satisfaction with the current integration of AI or a lack of engagement or awareness about how it could be further enhanced.

Several respondents highlighted the need for AI to be applied more practically within their curriculum. Suggestions included integrating AI into hands-on training with tools like Building Information Modeling (BIM) and machine learning for smarter design, construction, and project management. This indicates a desire for AI applications that are directly relevant to their engineering disciplines and that enhance practical skills.

Ethical considerations were frequently mentioned, with students expressing a need for discussions and education on the ethical use of AI. Suggestions for ensuring AI is used ethically included providing clear guidelines on when and how AI should be used in coursework and encouraging responsible use to differentiate ethical intentions.

Students expressed a need for more support in using AI tools effectively. This includes providing more training on AI applications, offering workshops, and ensuring that faculty are well-prepared to teach using AI technologies. There is also a call for more resources, such as free courses and better access to AI tools.

Some respondents suggested a cross-disciplinary approach to AI education, proposing that AI principles be integrated into various engineering (and non-engineering) courses. This could help students understand AI's impact across different fields and prepare them for diverse roles that involve AI.

Ideas were shared about using AI to generate ideas, explain basics, and refine writing, suggesting that AI could be used as a tool to enhance learning and not just for completing tasks. This aligns with calls for AI to support, not replace, traditional learning methods.

Concerns were raised about over-reliance on AI, with suggestions that AI should not replace fundamental engineering skills. Students are aware of the potential for AI to diminish critical thinking and problem-solving skills and suggest that AI use should be balanced with traditional learning techniques.

Students are interested in seeing AI integrated into specific software and tools relevant to their fields, such as AutoCAD for drawing and design, and Procore AI, Autodesk, or BIM 360 for project management. This suggests a demand for industry-specific AI applications that enhance their professional skills.

IV. CONCLUSIONS

The survey conducted among engineering students at the University of New Haven has provided initial insights into how AI technologies are currently used within the engineering curriculum. The feedback reveals a careful optimism about the role of AI in enhancing educational outcomes, provided it is integrated thoughtfully and responsibly.

Students recognize the potential of AI to make learning more efficient, improve educational experiences, and provide hands-on applications that are relevant to their future careers. However, there are significant concerns about AI's potential to diminish critical engineering skills such as problem-solving and analytical thinking. There is a strong call from students for a balanced approach where AI supports rather than replaces traditional learning methods.

The need for more guidance on ethical issues and stronger support from faculty in using AI tools suggests a gap that institutions need to address. Students are asking for better access to AI resources and educational programs that include training on how to use AI responsibly. This includes making AI ethics a central part of the curriculum to ensure students use these technologies according to professional and ethical standards.

Furthermore, students suggest making AI education broader, applying it across different fields to prepare for a workforce where AI's influence spans various disciplines. Integrating AI tools into specific applications like AutoCAD for civil engineering, as well as platforms that enhance various aspects of engineering practices, shows students' deep understanding of how AI can benefit their educational and professional development.

In summary, while the integration of AI into engineering education at the University of New Haven is generally positive, there is significant scope for improvement. Moving forward, it will be important to consider these insights from students to develop a more inclusive, practical, and ethically sound AI curriculum. This will not only meet educational standards, but also equip students with the necessary skills and knowledge to succeed in a tech-driven world.

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