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Impact of AI Tools on Engineering Education

Dr. Sofia M Vidalis, Pennsylvania State University, Harrisburg, The Capital College

Sofia Vidalis is an Associate Professor in the Department of Civil Engineering/Structural Design and Construction Engineering Technology at Penn State Harrisburg. She received her Ph.D., Masters, and Bachelors in Civil Engineering from the University of Florida.

Dr. Rajarajan Subramanian, Pennsylvania State University, Harrisburg, The Capital College

Rajarajan Subramanian is currently serving as an Associate Teaching Professor of Civil Engineering and Construction (SDCET) programs at Pennsylvania State University at Harrisburg. Previously, he worked as Transportation Engineer at Maryland State Highway Administration

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Sofia M. Vidalis, Associate Professor and Rajarajan Subramanian, Associate Teaching Professor
Pennsylvania State University at Harrisburg

Abstract

The rapid advancement of artificial intelligence has led to the integration of chatbots like ChatGPT into various sectors, including education. This study investigates the impact of many AI tools on engineering education, focusing on their potential to enhance learning outcomes and improve student engagement. Literature review on AI-driven educational tools for engineering were reviewed. The literature shows that AI tools have provided personalized learning experiences, aiding in concept reinforcement and problem-solving. They have also simulated real-world scenarios, fostering critical thinking and creativity. This paper also presents a case study based on the experience that students have found using AI tools in their education. Moreover, AI tools adaptability to individual learning styles and the ability to provide personalized feedback demonstrate their potential to revolutionize engineering education. However, concerns regarding over-reliance on AI and data privacy issues must be addressed to fully harness its benefits. This research underscores the need for further exploration of AI-based educational tools like ChatGPT to optimize their integration into engineering curricula, ultimately enhancing the quality of education in the field. Balancing the advantages and challenges is essential for maximizing the benefits of integrating AI in engineering education.

Introduction

Artificial intelligence (AI) is known as a computer-controlled robot from software and hardware tools that imitate intelligent human behavior and thinking. It is built from seven domains, which consists of machine learning, language processing, text to speech, computer vision, robotics, planning systems, and expert systems. (Mukhamediev, et. al., 2022) AI-powered chatbots, such as ChatGPT, use Natural Language Processing to construe what users command and machine learning to automatically convey accurate responses by familiarizing and grouping past interactions. (Rodos, June 2020). Some examples of AI used in our everyday life include voice assistants like Siri and Alexa. AI is also used to customize our daily feeds when we use social media accounts and assisting in our daily life. The next step is how AI can be used in engineering education, in the classroom, and how students can use it to help them in their studies.

Today, educators seek technology to improve teaching and learning. However, the rapid advancement in everyday technology is questionable if it can help in engineering education. Educators currently use AI type of services in their everyday lives such as voice assistance, grammar correcting tools, and live navigation tools. Educators today are exploring AI tools for capabilities in speech recognition for students with disabilities, for multilingual learners, improving lessons, and writing. (US Department of Education, May 2023)

Engineering education plays a crucial role in equipping future engineers with the necessary skills and knowledge to address complex technological challenges. Although AI was first introduced back in 1956, the use of AI in engineering education has gained significant attention in recent

years. (Anyoha, 2017) One of the key advantages of incorporating AI into engineering education is the ability to enhance learning experiences. AI-powered applications can create interactive simulations and virtual environments that allow students to engage in hands-on learning experiences. This aids in developing theoretical knowledge but also allows students to apply concepts in real-world scenarios. By experiencing different scenarios and challenges, students can gain a deeper understanding of engineering principles and develop problem-solving skills.

Additionally, AI can provide personalized and adaptive learning experiences. Learning platforms powered by AI algorithms can analyze individual student's strengths, weaknesses, and learning styles. This enables the system to create customized learning paths and deliver content tailored to each student's needs. Personalized learning not only increases student engagement but also improves learning outcomes by focusing on areas where students may require additional support.

Moreover, the integration of AI in engineering education can bridge the gap between academia and industry demands. AI-powered tools and technologies are becoming increasingly prevalent in the engineering field, and it is crucial that students are well-prepared to leverage these advancements. By incorporating AI into the curriculum, educational institutions can ensure that students graduate with the necessary skills to excel in a technology-driven workplace. This can include knowledge of AI algorithms, data analysis, machine learning, and automation, among others.

Methodology

This paper explores the student's point of view regarding the integration of AI in engineering education. A survey on the use of AI in engineering education was distributed to a sample of civil engineering and technology students from various classes. The survey consisted of questions related to their knowledge, frequency, benefits and challenges, and suggestions for future use on AI tools in engineering education. The survey was distributed to junior and senior students in seven different civil engineering courses, a total of 107 students. The civil engineering courses that the survey was distributed ranged from construction management, materials, and transportation. In addition, the students that took the survey also ranged from different concentrations in civil engineering and technology such as: structural, construction management, environmental, and transportation. This questionnaire is imperative to understand the current perceptions and experiences of students in this field and how it has impacted them in their academic studies.

The purpose of this survey was to gather valuable insights regarding the integration of AI in engineering education from the perspective of students. By understanding their attitudes, preferences, and challenges. The students' feedback from the survey can help educators and policymakers make informed decisions about the implementation and improvement of AI technologies in the classroom.

The survey addressed the following 10 questions:

1. Have you used AI-powered tools, such as ChatGPT, for learning in your engineering studies?
2. How frequently do you use AI tools for academic purposes?

3. What advantages do you think AI tools offer in engineering education?
4. How has using AI tools influenced your understanding of engineering concepts and problem-solving skills?
5. Do you believe AI impacted your ability to grasp complex engineering topics?
6. Have you experienced personalized learning through AI tools? Please explain.
7. What challenges have you encountered while using AI tools for engineering education?
8. Do you feel AI tools encourage active participation and critical thinking in your engineering studies?
9. What improvements or additional features would you like to see in AI tools for engineering education?
10. How do you envision the role of AI tools evolving in engineering education in the future?

The first two questions students had to choose from a list of answers such as yes, no, and the other options shown in Figure 1. The rest of the questions were open-ended. This allowed students to freely respond and give insight on what they thought about using AI in engineering education.

It has been almost a year (November 30, 2022) since Chat Generative Pre-Trained Transformer (ChatGPT) was launched. ChatGPT is a large language model-based chatbot that was developed by OpenAI. Therefore, the use of chatbots is still considered new. From then on, many different chatbots were developed, see Figure 2. Figure 2 illustrates 120 types of AI tools in the categories of productivity, video, marketing, chatbot, design, and writing. (Austin, 2023) Having all this information on the tip of our fingers, it was the next step to read all the student responses and see how far ahead or behind they were in using AI tools in engineering education.

Findings and Discussion

Question 1

Students today use technology in engineering education such as software programs, applications, and the internet. It was a surprise that the questionnaire results revealed that 70% of the students have not used AI powered tools in their engineering studies. That finding came as a shock, knowing how tech savvy students are when it comes to new applications.

Question 2

The first question in the survey was consistent with the number of times the students used AI, as seen in Figure 1. Only 4% out of the 134 students that participated in the survey stated that they use AI Chatbots weekly to help them understand topics and problems. The majority of them either use it weekly, monthly, rarely, or never.

Question 3

Most of the students, the ones that never used it, stated that they were not familiar with any advantages or disadvantages in using AI tools. The students that used it a little, mentioned the following as some benefits to AI tools:

- Quick information
- Help explain/understand topics better
- Reduce time in studying
- Problem solving
- Reference for new ideas
- Create better
- Solve problems
- Draft papers
- Easy tool look up
- Checks work
- Ideas for research

People use AI tools for many things. Although it seems that AI tools can be a wining tool for students to use, students mentioned many drawbacks to the program such as:

- Makes students lazy
- Gives false information
- Acts only as a safety net. Still need to check work.

Question 4

The students that use AI tools mentioned that they mostly use Chatboxes to understand topics, better classroom learning, deeper understanding on topics, problem solving, and writing. Students believe that AI tools still have a long way to go to become what they need in problem solving, design opportunities, project feasibility, and to also be taught in class. Only 22% of the students stated that it has influenced their understanding of engineering concepts taught in class. The remaining students have not used it or feel that it is not beneficial like the traditional class lecture.

Question 5

AI tools are supposed to make certain things quick and easy. About 60% of the students that have used it mentioned that it helped them grasp complex topics in engineering. Some positive feedback that students mentioned was that AI tools have helped them in checking answers, checking equations, provide quick answers, and grasp complex topics.

Questions 6

Personalized learning can be different for each student because it is more customized for each student's strengths, skill, needs, and interests. (Morin, 2023) Out of the students that use AI in their engineering education, only 30% have stated that they have experienced personalized learning through AI tools. Some students mentioned that it has answered questions on certain ideas or concepts where it needed to be more clarified. Some students that disagreed mentioned that it does not personalize the learning but instead gives information that is asked.

Question 7

When it comes to technology, it can make life easier but on the other hand pose some challenges. The students that have used AI tools have mentioned the following as challenges that they have encountered while using AI tools for engineering education:

- Not advanced to solve complex problems in math and physics
- Data is old sometimes
- Not always accurate
- Forming the correct question to provide the answer you are looking for
- Cannot differentiate variables in equations for specific problems
- AI uses different methods of solving problems than a professor does, therefore one has to specify which method the AI should use to solve problems
- Forming the right question to ask in order to receive the answer you want
- To graph certain types of graphs
- Not giving an image to help understand the issue

Question 8

About 25% of the students feel that AI tools encourage active participation and critical thinking in engineering studies. Some students mentioned that it helps you think outside the box and understand a topic better. In this case, the student would feel confident enough to participate in class knowing the subject matter better.

Question 9

The students may or may not have had the opportunity to experience more on using AI tools, since it is new, however, the ones that did mentioned that they would like to see the following for improving or having additional features in AI tools in engineering education:

- Classroom use
- Ways to access information such as AI videos
- Help with diagrams
- Solve complex problems
- Engineering specific functions
- Help in lab research
- Visual answers
- Estimating practices
- Need to be more accurate
- Explain complex design concepts and problems
- Use them for exam and reports
- Design opportunities like AutoCAD and Revit
- More input options

Question 10

Technology changes and advances fast these days. The students were asked: How do you envision the role of AI tools evolving in engineering education in the future? Some answers were similar from other questions provided. The following are answers on what the students responded:

- Doing calculations
- Easier access to find information
- Solve challenging situations
- Help with ideas
- More advanced algorithms
- Software used more
- 3-D modeling
- Taking over and replacing jobs
- Improve operation and process of construction
- Make life easier as assistance
- More overall applications
- Optimizing project timeliness and cutting waste
- Calculations and design in seconds
- Writing reports
- Scheduling
- Gives better understanding on topics
- Extra learning experience
- Speeding up report writing and submittals

The student survey findings served as a valuable resource for educators. It highlighted the advantages and disadvantages of students that have used AI tools in engineering education. It provided insights into the areas that need improvement, identified potential barriers to successful implementation, and uncovered opportunities for further exploration. These findings will contribute to the broader discussion on the role of AI in engineering education and pave the way for a more technologically advanced and future-ready engineering workforce.

This survey was consistent with the “five touch points” as guidelines to help students and help faculty members decide if programs like ChatGPT deserve to have a place in engineering education. (Baron, 2023)

The following are the five touch points:

1. Trust: Should one trust what AI writes? The answer is no. A few students did find that it does not always give correct answers. This is true when it comes to giving citations. AI chatboxes may give made-up citations. In addition, some AI-based programs can use poor grammar choices. Therefore, one should not automatically assume that the AI program is always correct. One should double-check information and verify its accuracy.
2. Effort: How much should the AI expand on written material? The one thing that educators feared of was students using AI tools like ChatBox to write their papers. However, AI tools only write up to a point and just give a brief outline. This showed that it has helped students in bringing new ideas in their writing. This can be especially helpful for students that may

have a writing mental block. The AI tool can help by giving an outline, which can allow the student to be more organized in their writing skills.

3. Writing Skills: Would AI improve or weaken them? As mentioned in number two, this can help improve the student's skills in writing by having the AI tool generate new ideas, outline brief summaries of the topic, and cut down in time spent in writing. These are some of what the students also mentioned in the questionnaire. Overall, the students that have used it thought that they became better in writing and more confident in participating in class.
4. Writing Voice: Does AI make written work sound like someone else is writing it? AI tools may write things better ways than what one may have written. Students need to know that AI tools may be beneficial to help one get started but they need to put the writing in their own tone.
5. Commitment: How much does one care about their work? Students should be aware that in academia, they are there to learn and use what they learned in the industry. When a program or tool takes over one's thinking, then personal touch or artistry is lost in the writing.

Based on all these findings, recommendations for improving the integration of AI tools in engineering education were made. These include as follows:

1. Provide more resources and training opportunities for students. This can be done by giving some examples in class so that students can understand how AI tools can be wisely used in engineering education.
2. Do not have AI take over the thinking process. Make sure that students understand that when they are using an AI tool, they should double check its accuracy. AI tools may be beneficial in many ways and may give accurate information, however, information given still needs to be double checked.
3. Promote awareness of ethical considerations. In this day of age technology changes and therefore AI will also change the way humans work. Students should be informed that AI is not always neutral in responses. They can be inaccurate, discriminative, or bias. In addition, new frameworks need to be developed on plagiarism of ones creative work. (Unesco, 2023)

Conclusion and Future Research

In conclusion, this paper highlights the significance of integrating AI tools in engineering education. It emphasizes the importance of providing adequate training and technical support to instructors while addressing concerns regarding the ethical implications of AI in education. The findings from the case study suggest that AI tools have the potential to revolutionize engineering education and equip students with the skills necessary for future technological advancements.

In conclusion, this survey aimed to shed light on the perspectives and experiences of engineering students regarding the use of AI in their education. By understanding the potential impacts, benefits, challenges, and expectations, we can strive towards a more effective integration of AI in engineering curricula. The insights gained from this survey will contribute to the ongoing

discourse on AI in education and help shape the future of engineering education, ensuring that students are equipped with the necessary knowledge and skills to thrive in a rapidly evolving technological landscape.

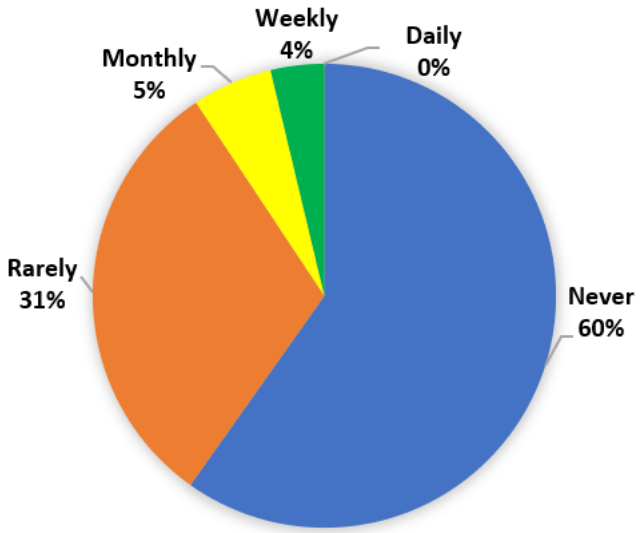

Figure 1: Frequent use of AI Tools in Academia

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