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Artificial Intelligence Tools that Enhance Engineering Education

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Abstract

Personalized and electronic learning has been on the rise in recent years and is expected to continue growing. This approach to education has revolutionized the way engineering concepts are taught by making it more immersive and interactive for students. In engineering education, several Artificial Intelligence (AI) tools are used, including virtual simulations, machine learning models, artificial intelligence algorithms, and computer-aided design software.

AI chatbots are also available to answer questions and provide conversational responses. Additionally, an AI tool called "Image Creator" generates images based on the text typed in by users. This paper will discuss how these AI tools can be used to enhance student learning in engineering education.

Some of these tools have been used in classrooms and shown to assist students in understanding complex theories, simulating real-world scenarios, and problem-solving. By incorporating some of these technologies into the classroom, educators can enhance their learning experiences and prepare students for the challenges of the 21st century in the engineering industry.

This paper illustrates a few case studies on integrating these tools in the classroom. This paper also explains the outcome of the student's perspective in using them. In addition, the paper also covers other programs using these tools that may encourage critical thinking, stimulate real-world scenarios, and solve problems more effectively. Overall, using these tools should provide students with valuable skills and knowledge that will benefit them in their future careers and be in tune with the new technology that the industry offers.

Introduction

“AI” is a method of making a machine, a computer, a computer-controlled robot, or a software think like the human mind with intelligence. The cognitive process involves obtaining information, processing it, and storing it in the memory to be accessed again. AI is accomplished by studying the patterns of the human brain and by analyzing the cognitive process. Artificial intelligence has contributed to various fields including agriculture, finance, manufacturing, security, pharmaceuticals, academia, and others. But now AI has become more of an interdisciplinary entity.

Impact of AI Tools on Engineering Education

AI-powered tools have been in development for several years in different forms, which humans are well-aware of. For instance, word processors can suggest better-sounding sentences and words while writing an essay or report. Similarly, spreadsheets have formulas and function modules that facilitate the calculation of various arithmetic operations. The use of mobile phones introduced AI tools such as touchscreen features to enhance the speed of working with different

aspects of communications. Now the students can have access to the lessons posted online by the Professors on various “Learning Management Systems” platforms.
Engineering education is a constantly changing field that strives to sustain the latest technological advancements and meet the changing needs of the engineering industry. One exciting development in the field of engineering education is the use of generative artificial intelligence technology, such as ChatGPT developed by the OpenAI Corporation.

AI tools used by students

AI tools used by students can be broadly categorized as either for writing text or problem-solving purposes. The AI-powered tools that can assist students in writing include essay and report writing software, as well as tools for critical reviews. Similarly, some students use math programs to solve homework problems given by their instructors.

ChatGPT

ChatGPT stands for “Chat Generative Pre-training Transformer” and is the latest useful tool available to the public currently. This program can help write business reports, write essays for school-going students, higher education artwork, creating fine arts, and it acts as a semi search engine. Based on my personal experience in the "Construction Management" class, I have learned that some students at Pennsylvania State University are already using ChatGPT to write their semester-end reports. Additionally, some of my graduate students have also been using it to complete their theses or paper reports.

A research study was conducted to understand the experiences of 200 students using ChatGPT in their learning process. The students were asked to fill out a questionnaire through an online survey. Additionally, 30 students participated in semi-structured interviews to share their thoughts about using ChatGPT in their studies. The results of this research revealed that the students are pleased with the application of ChatGPT in their studies. According to the students' opinions, ChatGPT has several benefits, including saving time, providing information on various subjects, offering personalized tutoring and feedback, and facilitating the process of reflecting ideas in writing (Thi Thuy, 2023).

There were some barriers to using ChatGPT were identified, and several solutions were suggested for the improvement of using ChatGPT in learning processes. There were some concerning issues for students while using ChatGPT and they were listed as 1. The inability to assess the quality and reliability of sources, 2. The inability to cite sources accurately, and 3. The inability to replace words and use idioms accurately. To address these concerns, some potential solutions can be implemented; for example, verifying ChatGPT’s responses with reliable sources; using ChatGPT as a reference source or a consultant tool; providing guidelines for use; and promoting academic integrity to ensure ethical uses of ChatGPT in an academic context (Thi Thuy, 2023).

The following research was done by conducting interviews with graduate students and faculties to understand ChatGPT's abilities by providing the output on the topic of how AI and GPT will impact academia and libraries. This research explores how graduate students are using the

ChatGPT and can be used to improve various research capabilities. ChatGPT can be used to improve research and scholarship in academia in several ways. The breakdown of ChatGPT's uses by graduate students for their research is listed as follows. Based on the student's given topic or keyword, ChatGPT can help the researchers in identifying relevant literature by generating summaries of articles or providing a list of relevant papers. It can create text in a particular way or tone, letting the researchers produce draft versions of research papers, grant proposals, technical reports, and any other written materials easily.

ChatGPT can assist researchers in analyzing large amounts of text data, such as social media posts or news articles, by providing insights and identifying patterns in the data. It can be used for language translation via machines, allowing researchers to access and understand research materials in multiple languages. ChatGPT can be used to automatically summarize scientific papers, reports, or other documents, making it easier for researchers to stay up to date with the latest developments in their field. ChatGPT can be fine-tuned to provide answers to domain-specific questions, making it a powerful tool for scholars to find answers quickly and efficiently. These capabilities can help researchers save time and effort, allowing them to focus on the more creative and analytical aspects of their work (Lund et al., 2023).

There are several ethical and privacy implications to consider when using ChatGPT or other large language models in academic settings. One concern is the potential for bias in the model's responses, as it may reflect the biases present in the training data. Additionally, there are concerns about the privacy of individuals whose data was used to train the model, as well as the potential for the model to be used for nefarious purposes. It's also important to consider the ethical implications of creating highly realistic synthetic text or speech, as it could be used to impersonate or deceive others. On the other hand, ChatGPT's invention can significantly reduce the time and effort required to generate written content. With its capability to produce coherent and well-structured text on any subject matter, students and educators can save time and concentrate on other aspects of their work (Yan, 2023).

Grammarly

One of the AI-powered writing assistants that helps students improve their writing skills is a popular one used by instructors. It is called "Grammarly". It can detect and correct mistakes in grammar, spelling, punctuation, and style in real-time. Students find this tool very useful for their academic writing components which involve writing essays, term papers, technical reports, and other academic assignments. One of the important basic understandings of the functions of the Grammarly tool is to check for errors in written English. Its purpose is to keep spelling mistakes and typing mistakes out of context. Therefore, one can conclude that the "Grammarly" application controls or maintains the flow of writing appropriately so that no one can find any more errors in the text (Qassemzadeh & Soleimani, 2016).

Grammarly also provides writing assistance to correct grammar errors and word spelling and is free from plagiarism. This tool can also detect lousy behavior among academics, such as plagiarism, by looking at and checking other written data available online. So, this software Grammarly compares with other online-based data detecting to see similarities. Then Grammarly did, and it is based on the experience they like to check writing style. It will support writers such

as automatic editing with real-time live-in feedback, which makes skip tags like is understand communication very well. Sometimes, the Grammarly application corrects errors, and then yes, it adopts a specification model or writing style for what the author is doing. So academic or business writers can choose the style and purpose of writing. All destinations as selected are up to the writer. It all depends on what the user has set to be professional or personal, such as writing language for email and other social networking (Zhang, 2020; Manullang & Satria, 2020).

A research study aims to discuss the impact of the "Grammarly" online application in improving technical writing through the experience of reviewing published papers. The researchers at this institution reviewed several types of literature and listened to the experiences of other academics published in various international journals. A descriptive qualitative content analysis was picked for the research.

"Qualitative content analysis" involves an in-depth analysis of each expert's experience with an exploratory intentionality approach. The researchers involved a coding analysis system to critically evaluate the content of the text and ensure that the results are valid and reliable. For the literature sources, they sought the help of "The Google Doc" application, Eric Publications, Google Scholars, and other online literature sources. The researchers followed the guidelines of descriptive qualitative studies experts in academic writing and application technology. Study results reflect most of the academicians' view that the Grammarly online application is very suitable for use by writers because its usefulness is beneficial in tracking writing errors (Perdana, 2021).

Notion

Notion is one of the AI tools that is used as an aid to writing. However, it can be used as an all-in-one workspace that allows students to organize and manage their tasks, notes, and projects. It combines the features of note-taking, task management, and project planning into a single platform. Students can use "Notion" to create to-do lists, take class notes, collaborate with classmates, and stay organized throughout their studies. There are two "Notions" used for students' learning. "Notion" as a platform application can be used as an overall learning management tool. There is another form of Notion as "Notion AI" which is an embedded writing assistant that edits and generates content (Barrot, 2021).

Notion and Notion AI combined can help learners promote self-regulation, receive scaffolding, and enhance noticing. (Scaffolding is an instructional practice where a teacher gradually removes guidance and support as students learn and become more competent. Support can be for content, processes, and learning strategies.) However, there are limitations to this use. Beginners may find it difficult to notice the gap from the AWCF (Automated Written Corrective Feedback) generated from Notion AI since it only provides a rewrite without any suggestions or reasons for the revisions, something that other AI assistants usually offer. Thus, teachers should encourage learners to reflect on the AWCF or scaffold their writing processes if necessary. In addition, given the rapid development of other large language models (e.g., GPT-3.5 and GPT-4), Notion's linguistic output quality should be examined continuously to ensure that learners receive appropriate AWCF in writing (Lee, 2017).

VERA, a Virtual Experimentation Research Assistant & Teaching Assistant

From “Georgia Institute of Technology”, researchers have developed an AI-powered socio-technical system for making online learning in higher education more affordable, accessible, and achievable. In particular, they have developed original and interweaved AI technologies such as VERA, a “Virtual experimentation research Assistant” for supporting inquiry-based learning of scientific knowledge, and Jill Watson Q&A, a virtual teaching assistant for answering questions based on educational documents including VERA’s user reference guide.

“VERA” helps learners build conceptual models of complex phenomena, evaluate them through simulation, and revise the models as needed. VERA’s capability of evaluating a model by simulation provides a formative assessment of the model; its support for the whole cycle of model construction, evaluation, and revision fosters self-regulated learning (Goel, 2020).

Feedback on these AI-powered tools is encouraging. VERA enhances ecological knowledge and is freely available online. Jill Watson Q&A has been used by more than 4,000 students in 12+ online classes and saved teachers more than 500 hours of work. These innovative technologies help make online learning simultaneously more affordable (Teachers’ time saved), accessible (by making materials available online), and achievable (by fostering student engagement and providing learning assistance).

The results are positive: (i) VERA enhances ecological knowledge and is freely available online; (ii) Jill Watson Q&A has been used by more than 4,000 students in 12+ online classes and saved teachers more than 500 hours of work; (iii) Jill Q&A a promotes learner engagement, interaction, and community. Put together, these innovative technologies help make online learning simultaneously more accessible (by making materials available online), affordable (by saving teachers’ time), and achievable (by providing learning assistance and fostering student engagement) (Gonzales, 2019).

Gradescope

Any learning process has two important parts such as evaluation and assessment. Providing individualized feedback to students can be very time-consuming for faculty and teaching assistants. Hence, it is important to appropriate feedback to students is provided by the faculty and teaching assistants and it can be accomplished by using a virtual agent (online software). One such tool that can tackle the feedback issue is called “Gradescope” and it provides students with an accurate assessment of their grades and constructive feedback.

Some of the advantages of using the “Gradescope” are

1. Many instructors or teaching assistants can grade the same exam paper or write-up and give feedback to the same student.
2. Progress checking can be done by instructors concerning which questions are graded by whom?
3. Image upload or one PDF document upload is possible by student submissions.

4. Grades can be exported as a spreadsheet file (Reck, 2019).

ClassPoint

The work culture around the World has been changing since the COVID pandemic ever hit humanity making the shift from in-person to online. World Economic Forum released a report in 2018 saying that the "Law profession" will suffer a jobless situation (World Economic Forum, 2018). In 2020, the World Economic Forum published a report containing unprecedented crumbling of the future skills that are needed for the future world of work (Whiting, 2020).

Amongst other forms of work skills, the future skillsets include analytical thinking, innovation, critical thinking, active learning, and problem-solving. During the pandemic, online lessons can be used to deliver lectures by the Professors. Particularly, "ClassPoint" was adopted as one of the ways the learning process was done. A set of researchers conducted a study to assess the effectiveness of the adoption of ClassPoint in August 2020 for the students at Taylor's University and it was found that ClassPoint improves law students' creativity, critical thinking skills, and analytical thinking skills. The law students also felt that ClassPoint improves their abilities to be innovative and it also enables them to use their imagination. The research also reveals that ClassPoint develops law students' evaluation and reasoning skills. Overall, the law students enjoyed the use of ClassPoint as it increased their interactions within the scope of the borderless learning environment (Lawrie, 2017, Malaysian Bar, 2020, Taylors' University, 2021).

AI tools used by instructors

AI tools for instructors are becoming widely popular, affordable, and accessible. With the use of AI in education, the faculty can function (with fewer resources) saving a lot of time while grading the exams and class assignments. Some of those important AI tools for educators are explained below.

Gradescope

Grading is one of the most time-consuming jobs for any professor in education. Fortunately, an online tool called "Gradescope" is available for professors to use. It helps the instructors with accurate grading and constructive feedback.

PowerPoint Speaker Coach

This AI tool (or system) is one of the kinds for helping both students and professors with oral presentations. It helps to evaluate how the PowerPoint slides are prepared and the contents presented. It is an automated oral presentation feedback system in an institution-wide setting. The logistical, technological, teaching, and learning challenges are discussed. The effectiveness of the deployment of this tool and an evaluation of the use points to successful adoption and moderate level of learning advantages, particularly for the students at the low end of the performance. The recording and summarizing of the perception of both instructors and students show a generally positive experience. This tool (or system) has proven that it can automatically

evaluate oral presentation and can provide a detailed report back to the speaker is not only possible but more than sufficient (Dominiguez, 2021).

SlidesAI.io

This tool can integrate with "Google Slides" seamlessly and work for making slides. It is available free of charge if one wants to make a small presentation. Otherwise, it is available for a reasonable price to make decent presentation slides. It summarizes the slide content into easily understandable pieces of information that make it very useful. It also formats slides easily compared to doing it manually.

Professors and students always use "PowerPoint" for the presentation of a project, work, assignment, or report. In place of PowerPoint presentations, different AI tools (such as *Gamma App*, *slidesai.io*, *tome.app*) can be used, because they create not only effective and engaging presentations, but also great documents and attractive web pages by simply specifying the topic of the presentation, without formatting and design work and without even preparing the text. These AI tools can create your document or presentation in just a couple of minutes by identifying the presentation subjects, providing template options, generating the content text, and designing the content based on the template that has been chosen (Tonbuloğlu, 2023).

Education Co Pilot

It is an AI tool that does lesson planning, worksheets, handouts, and assessment generation. Computer Science faculty started worrying about the recently released AI tools such as ChatGPT and Copilot since they gained significant attention from academia and the computer industry. The practitioners from the industry as well as the researchers from the educational institutions found out that these AI tools can create perfect solutions to a variety of software codes and explain those codes accurately. The concern is how the University faculty will adopt these AI tools into their curriculum and yet the students can learn coding of programs. The computer science faculty now started thinking of the right uses for these AI tools. However, until now they have not yet found any right way of including those AI tools (Lau, 2023).

Conclusions

Several AI tools are available for use by faculty and students of educational institutions. They are available for a marginal fee or free of charge so that both students and faculty can use them broadly. Even though some of the cases above point to the use of those tools by various faculty and students of different disciplines or departments, they can be used for "Engineering Education" also. Some of those AI tools can be used for text generation and some of them can be used for computations. Overall, one could say that AI tools can enhance the educational programs for both undergraduate and graduate students.

References

Barrot JS (2021) Using automated written corrective feedback in the writing classrooms: effects on L2 writing accuracy. Computer Assisted Language Learning 36(1): 1–24.

Federico Dominiguez, 2021, "Scaling and Adopting a Multimodal Learning Analytics Application in an Institution-Wide Setting", *IEEE TRANSACTIONS ON LEARNING TECHNOLOGIES*, VOL. 14, NO. 3, JUNE 2021

Goel Ashok, 2019, "AI-Powered Learning: Making Education Accessible, Affordable, and Achievable", Georgia Institute of Technology's emPrize team's report adapted from an AI competition.

Gonzales, M., & Goel, A. (2019), "Why Are Some Online Educational Programs Successful?: A Cognitive Science Perspective". Poster paper at the 41st Annual Meeting of the Cognitive Science Society, Montreal, July 24, 2019.

Lawrie, G. (2017). How our school is using Virtual Reality to prepare pupils for a future dominated by technology. Retrieved 11 April 2021, from http://www.telegraph.co.uk/education/2017/01/23/school-using-virtual-reality-preparepupils-future-dominated/

Lee I (2017) Classroom Writing Assessment and Feedback in L2 School Contexts. Singapore: Springer.

Lund, B. D. (2023). *A brief review of ChatGPT: Its value and the underlying GPT technology*. https://www.researchgate.net/publication/366809571_A_Brief_Review_of_ChatGPT_Its_Value_and_the_Underlying_GPT_Technology

Malaysian Bar. (2020). Press Comment | Tertiary Legal Institutions Should Enhance the Quality of Legal Training for Students. Retrieved 11 April 2021, from https://www.malaysianbar.org.my/article/about-us/president-scorner/pressstatements/press-comment-tertiary-legal-institutions-should-enhance-thequality-of-legal-training-for-students

Perdana, I., Manullang, S. O., & Masri, F. A. (2021). "Effectiveness of online Grammarly application in improving academic writing: review of experts experience". *International Journal of Social Sciences*, *4*(1), pp. 122-130. https://doi.org/10.31295/ijss.v4n1.1444

Qassemzadeh, A., & Soleimani, H. (2016). The impact of feedback provision by Grammarly software and teachers on learning passive structures by Iranian EFL learners. *Theory and Practice in Language Studies*, *6*(9), 1884 – 1894.

Reck Marie Rebecca, 2019, ASEE Annual Conference and Exposition 2019, Tampa, Florida, Conference Proceedings.

Sam Lau, 2023, From "Ban It Till We Understand It" to "Resistance is Futile": How University Programming Instructors Plan to Adapt as More Students Use AI Code Generation and Explanation Tools such as ChatGPT and GitHub Copilot, ICER '23 V1, August 07–11, 2023, Chicago, IL, USA

Taylor's University (2021) Taylor's Graduate Capabilities. Retrieved from https://university.taylors.edu.my/about-taylors/future-proof-learning/taylors-graduatecapabilities Accessed on 11 April 2021

Thi Thuy An Ngo, 2023, "The Perception by University Students of the Use of ChatGPT in Education", *International Journal of Emerging Technologies in Learning*, Vol. 18, No. 17, 2023. pp. 4 – 19.

Tonbuloğlu, B. (2023). An evaluation of the use of artificial intelligence applications in online education. *Journal of Educational Technology & Online Learning*, *6*(4), 866-884.

Whiting, K. (2020). These are the top 10 job skills of tomorrow – and how long it takes to learn them. Retrieved 11 April 2021, from http://These are the top 10 job skills of tomorrow – and how long it takes to learn them

World Economic Forum. (2018). The Future of Jobs Report 2018 (p. 11). Geneva: World Economic Forum. Retrieved from http://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf

Yan, D. (2023). Impact of ChatGPT on learners in a L2 writing practicum: An exploratory investigation. *Education and Information Technologies*. https://doi.org/10.1007/s10639-023-11742-4

Zhang, X. (2020). The Relationship of Coaching Leadership and Innovation Behavior: Dual Mediation Model for Individuals and Teams across Levels. *Open Journal of Leadership*, *9*(1), 70–83. https://doi.org/10.4236/ojl.2020.91005