

Education in the Era of Artificial Intelligence

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ABSTRACT

This comprehensive literature review aims to identify the benefits and drawbacks of using AI for students and teachers. AI can serve as a tool for many students if used correctly. A common utilization of AI is through a chatbot, which uses human language to communicate. One of the main ways that students could do this is through a personalized tutor to help teach and answer student questions. Writing and idea generation are other ways that students have used AI, mainly with essays or research. Teachers also use AI to make their teaching more personalized for students. However, teachers also believe that AI could be harmful or detrimental. Since AI is such a powerful tool, students may become over-reliant on it, and in the process reduce their critical thinking skills. AI could also become biased, leading to faulty answers called hallucinations. Many educational companies have already started using AI, such as Khan Academy's AI Khanmigo, and Byju's AI suite called Wiz. I recommend students use AI sparingly, as to avoid over-reliance. Teachers should also use AI to promote personalization but with the caution of not using it too much.

Introduction

As Artificial Intelligence (AI) makes its impact through various facets of our lives, its impact on education becomes a focal point of interest due to its potential for personalization and empowerment for users (Ouyang & Jiao, 2021). AI can generate responses to user queries within a few seconds, being able to replicate human intelligence (Glover, 2024; Khan, 2021). One of the most common uses of AI is a Chatbot like ChatGPT since it can speak in a way that a human can understand (Zemčík, 2019; Wollny, 2021). This is why students often use a Chatbot as a personalized tutor, since it can replicate a human being, but with the knowledge of an expert on any topic (Gong et al., 2016). With a personalized learning experience, students are able to customize AI to their requirements and needs (Alam, 2021). AI can also simulate the real world with VR, by being able to provide support to students (Luckin, 2016). This way students can view a much more advanced simulation of the real world with the usage of AI, which would benefit many occupations. However, AI isn't always beneficial to students, since AI could also give faulty answers, which are called hallucinations. A false answer from an AI for a student would mean a cascading effect of learning the wrong concepts, possibly permanently affecting a student's learning. Hallucinations are caused by a variety of things, mainly from training factual data with fictional data (Susarla, 2023). Students also may become over-reliant on AI, leading to students thinking like robots rather than learning new information (Ahmad et al., 2023). Educational companies have already started to make use of artificial intelligence in their apps. For example, companies like Khan Academy and Byjus have already released AI models to aid in education, and other educational companies like Duolingo have used AI to create questions and personalize feedback. AI's potential allows for students to learn much quicker and easier too, and knowing how it positively or negatively impacts a student can tell users how to take advantage of it. The purpose of this comprehensive literature review is to identify if AI is fully benefiting students and teachers, examine how AI is currently being utilized, and if it is effective enough for students to utilize on a day-to-day basis.

Types of AI and its Educational Use

AI has no common definition. The phrase “Artificial Intelligence” can mean a variety of things to different people (Wang, 2008). Most references to AI are interchangeable with machine learning, however, machine learning refers to the way that AI is trained (Du-Harpur et al., 2020). Machine learning is a subset of AI, and it is the basis of AI. AI, simply, is a way for computers to simulate human intelligence in a matter of seconds (Glover, 2024; Khan 2021). AI can do this because it is trained based on prior human data. AI can train from a given dataset and is able to make a proper decision all by itself (Khan, 2021; Zhao & Flenner 2019). This way, once it is trained enough, it’ll be able to answer any inquiries a user may have by being able to predict based on prior data.

Many people use AI in their everyday lives. One of the most common uses of AI is as a personal voice assistant such as Siri or Google Assistant. In a study conducted by Garcia et al. in 2018, it was found that in all of the countries studied (US, Germany, Brazil, Chile, UK, Argentina, and Spain), the majority of the respondents claimed to use a voice-activated virtual assistant almost daily (Garcia et al., 2018). A voice assistant, simply, is a way of interacting with computers by being able to talk to them (Hoy, 2018). Consumers mainly use voice assistants to not only conduct sources but to also complete tasks, such as playing music or setting reminders (Hoy, 2018; Malodia et al., 2021; Burbach et al., 2019). In addition, voice assistants can be programmed to interact with other programs, such as being able to call an Uber or order a Starbucks (Hoy, 2018). However, the limited use of mainly just tasks could be because users can become discontented if an error occurs when the AI is trying to recognize what the user said (Burbach et al., 2019). Overall, the appealing feature of a voice assistant is its convenience. Being able to summon an AI that can access the web with just a simple “Hey Siri” or “Hey Google” is applicable in daily life due to its convenience and for looking up quick information.

How AI is Used in Schools and Classrooms

In a classroom, one of the most common usages of AI is Chatbots. A chatbot is a type of AI that communicates with a person or another chatbot to mimic a conversation with a real person (Zemčík, 2019; Wollny et al., 2021). A chatbot makes use of natural language processing algorithms, which have been enhanced by machine learning and artificial intelligence, being able to understand human queries better (Hobert, 2019). Students utilize chatbots, some of the more common ones being ChatGPT and Gemini, to aid them in studying and as an assistant in learning. ChatGPT’s ability to generate accurate answers in the blink of an eye allows students to use its features “...for exam practice. Medical students can use ChatGPT to generate practice questions that mimic the format and difficulty level of the actual exams.” (Amri, 2023). Chatbots are also able to give personalized recommendations for resources, recognize learning gaps, and be able to track progress (Harry, 2023). Being able to notice learning gaps allows students to assess student effort and provide meaningful feedback for a student (Wollny et al., 2021). Chatbots allow students to personalize their learning however they want, facilitating better learning and growth for the student.

Benefits of AI in Education

Personalized Learning

The main use of AI in education is creating personalized learning experiences by addressing the specific needs of each student. In China, a company called Squirrel is utilizing AI to tailor educational content to address student difficulties effectively, where “[t]he target is to determine and treat a student’s difficulties in each topic in the best possible way” (Voskoglou, 2020). By using AI in this way, students can learn at their own pace, fill learning gaps, and progress however they want to without a teacher. Students can create their learning platform which adjusts to their needs and supports them (Alam, 2021). For example, if a student desires to learn a topic using generated questions, a Chatbot

would be able to create personalized quiz questions for the,. With personalized learning comes Intelligent Tutoring Systems (ITs).

Intelligent Tutoring Systems

Intelligent Tutoring Systems are widely utilized in the field of education and are considered the most prevalent application of AI (Holmes, 2022). The purpose of ITs is to replicate human behavior by offering feedback and exercises that are similar to those of a human tutor (Crow et al., 2018). However, instead of being a human, it is a computer that can act as a domain expert on any topic (Gong et al., 2016). ITs can offer customized learning by monitoring students' input, giving suitable assignments, detecting student errors, assisting with a mistake when necessary, and providing effective feedback to the student (Zhai et al., 2021; Gong et al., 2016). This feature renders it a very efficient instrument that kids can utilize independently, without the need for immediate guidance from an instructor nearby. As a result, students can engage with educational material more interactively and intuitively, making the learning process more enjoyable.

Writing and Idea Generation

AI can also be used to assist in writing. With a Chatbot's ability to generate responses to user inquiries very quickly, AI can be used in the planning step, by identifying the topic (Utami et al., 2023). In a study conducted by Amri in 2023, it was found that ChatGPT is able to assist medical students in analyzing academic articles by summarizing the key points that the article mentions (Amri, 2023). Being able to summarize aids in student writing by helping them save time on their work by more effectively incorporating relevant information. Additionally, it allows students to better understand the complex articles and facilitate deeper engagement with the content. AI can also quickly generate a paper draft (Utami et al., 2023). This would allow students to see an overview of how a paper could look. Similarly, AI can add on to what a student has already written. For example, a human could write a paragraph, and an AI could write another paragraph related to it, and so on (Sharples, 2022). This would give a student fresh ideas on where they could expand on their assignment. Idea generation is one of the most common ways that students use AI, according to a study by Schiel et al. in 2023. AI assisted writing tools also offer automated feedback on parts of writing such as diction, organization, grammar, and coherence, which facilitates more effective writing performance improvements. Furthermore, students can enhance their writing development as AI tools help them identify and fix grammatical errors (Song & Song, 2023). One of the more popular AI grammar checking tools is called Grammarly. However, this would raise ethical issues, because if an AI is able to do an assignment or an essay for a student, it may not be ethical for a student to submit a work done by an AI.

Virtual Reality

While not as commonly, AI can also be utilized in teaching through the application of Virtual Reality (VR). VR is defined as a technology which allows a user to be able to engage in a computer-simulated environment, whether that environment be a simulation of the real world or a completely new one (Mandal, 2013). Without AI, VR is able to create an environment that mimics the real world, allowing for students to interact with 3D objects, and gain a greater understanding of concepts in a safe and engaging environment (Al-Ansi, 2023). By incorporating AI into VR, it becomes more capable of enhancing the virtual world, giving it the ability to more naturally respond to a user's action (Luckin, 2016). It could also be used to provide support, or even make learning quests for students to complete (Luckin, 2016). Utilizing AI-powered VR sets can increase engagement for students by placing them in a simulation of a real-life situation.

Effects on Students and Teachers

Impact on Students

In 2023, Crompton and Burke conducted a study of over 138 articles to analyze the most common uses of AI in education. In higher education, AI is being used as a means of automatic assessment and evaluation, seen in 26 of the studies (Crompton and Burke, 2023). This automatic assessment allows for less time spent for teachers to grade an assignment, giving immediate and useful feedback as well. Another common use of AI is as an Intelligent Tutoring System (ITs). In a study conducted by Jin in 2023, in self-regulated learning, around 50% of students believe that AI is helpful for understanding new concepts. This is significant due to the lack of a teacher to aid in comprehension in self-regulated learning. In the same study, 100% of students being observed found that AI provides an easy way to seek help, indicating that students very often use AI as a means of assisting when a student needs help. (Jin, 2023). Due to the small sample size (16) it isn't representative of a full population of students, however it shows a general pattern of what students use AI without the presence of a teacher nearby.

Besides learning, AI is also being used as a way to modify or enhance answers. In a study conducted by Bancoro in 2024, about 83% (244 of the 293 students in Negros Oriental State University observed) use AI when they believe that their response isn't up to par or to their standards (Bancoro 2024). In another study by Malik et al. in 2023, over 35% of the students surveyed strongly agreed that they've used AI to tailor the style of an essay to fit the academic criteria (Malik et al., 2023). Students tend to turn to AI to structure their responses in order to add to their answers.

In online learning, ChatGPT and other chatbots are being used in place of another human to take the role of someone. For example, medical students are using ChatGPT to mimic a patient to practice their communication skills (Amri, 2023). This allows students to gain better practice and personalized feedback from AI. Along with learning, AI is also being used to assist in research. Many postgraduate students right now are using it for adjusting a research topic, paraphrasing sentences, generating new ideas, and saving time in looking for literature that would support their paper (Chauke, 2024). Students are able to save time on the planning process of a research paper due to this. Overall, students are mainly using AI for personalized learning and as a method of understanding a new concept, however it is also being used to assist in writing and research. On top of that, in a study conducted by Schiel et al. in 2023, over 54% of students reported using AI for idea generation in college essays (Schiel et al., 2023). One student reported using AI as a way to get past writer's block in the same study (Schiel et al., 2023).

In a study conducted by Jian in 2023, he selected a sample of 500 students where 250 were in a standard learning environment, while the other 250 were in an AI learning environment. The results of this study showed the group of students using AI to learn resulted in a more significant improvement in their grades, and were more consistent in their performance as opposed to the students in a traditional learning environment. On top of that, the students who used AI to learn found that the AI catered to their individual needs, where they appreciated the instant feedback and tailored content. This study shows the potential of AI to be better than traditional learning methods (Jian, 2023).

Impact on Teachers

Besides students, teachers and professors also use AI, however AI in education is mainly seen to be used for students (Crompton & Burke, 2023). Many of the benefits of AI for students are also benefits for teachers. For example, teachers also appreciate the benefit of personalization, but while students use the personalization for learning, teachers use it since it provides vast possibilities for assessment, feedback, and by making the teaching-learning more engaging for students (Al-Mughairi & Bhaskar, 2024; Wardat et al., 2024; Celik, 2023). This personalization allows for teachers to be able to teach how the students would like it to be. Also similar to students, teachers see the value of ChatGPT for their enhancement of skills (Celik, 2023; Al-Mughairi & Bhaskar, 2024; Wardat et al., 2024; Uygun, 2024). Being

able to learn from AI facilitates growth for teachers as well. AI also gives the opportunity for teachers to save time on their work (Al-Mughairi & Bhaskar, 2024; Wardat et al., 2024; Uygun, 2024), a similarity for how students use it. However, to be able to best utilize it, it is important that teachers learn how to use AI correctly (Wardat et al., 2024; Celik, 2023). In a study conducted on teachers in Spain by Galindo-Domínguez et al. in 2024, he found that only approximately 1/4 of the teachers studied had prior experience with AI. He also found that secondary school teachers in Spain are most likely to use AI as a way to gain information (Galindo-Domínguez et al., 2024). Knowing how to use AI effectively permits teachers to fully unleash the capabilities of it.

However, teachers also believe that AI can be harmful or inefficient. One of the main concerns was the concern about accuracy (Al-Mughairi & Bhaskar, 2024; Parviz, 2024). One teacher respondent in a study conducted by Al-Mughairi and Bhaskar in 2023 mentioned that they needed to critically evaluate the information given to make sure it is reliable enough. An inaccurate response for a teacher may lead to students learning incorrect material. Another common drawback was an overreliance on AI (Al-Mughairi & Bhaskar 2023; Parviz, 2024). This overreliance on AI would reduce critical thinking and exploration for students, where a school is meant to stimulate critical thinking (Parviz, 2024).

Problems and Concerns with AI

While there are many benefits to AI in education, there are some drawbacks to it. One of the most prevalent ones is the possibility of an AI bias. AI bias can be caused by many things, one of the most often being that the data given to train the AI was biased to start (Silberg & Manyika, 2019). AI can amplify the bias of human beings due to this (Zanetti, 2020; Silberg & Manyika, 2019). One of the main consequences of AI bias is the fact that it could discriminate. Due to AI bias, intelligent tutoring systems (ITs) aren't as efficient in different cultures. For example, both the language and the culture of both the programmers who create the IT and the users who interact with it can introduce biases into the IT, which could affect the way the IT functions (Nye, 2014; Zanetti, 2020). Similarly, Intelligent Tutoring Systems may not be as effective in different cultures due to the differences in language and curriculum content, which could reveal a bias to one culture over the other (Pinkwart 2016; Ogan & Johnson, 2015; Zanetti, 2020). This bias could lead to discrimination between users and in some cases erroneous and faulty responses.

In a similar vein, AI can also give faulty answers, which are called hallucinations. More specifically, hallucinations are loosely defined as an output that is nonsensical or unfaithful to the user input (Filippova, 2020; Maynez et al. 2020). It can occur from being trained on both factual and fictional data (Susarla, 2023). A faulty answer can have a significant impact on a student's grasp on a concept. For example, if a student was using a chatbot to learn and understand a concept, which is a very common use for AI, and the chatbot hallucinates, then the student would incorrectly understand the concept. These inaccuracies could have a ripple effect, leading to many mistakes that are hard to fix in a student's journey. AI hallucination can also occur when trying to predict from a class that it hasn't been trained on (Roselli et al., 2019). For example, if a neural network was trained to identify if a color was red or green, and it was given a color in blue, it would still give an answer rather than saying "I don't know," which would lead to silent mispredictions and further harm in a company (Roselli et al, 2019).

Another crucial issue about AI is the concern about privacy and transparency. Since AI involves machine learning, it involves tracking data that users send to be able to become more advanced and learn more. However, AI sometimes tracks data that people might not want tracked, such as language spoken, race, and biographical data. While AI systems for user consent to collect this data, users often comply without knowing the extent of the information that they are sharing (Akgun & Greenhow, 2021). If the AI's data is leaked, that means someone else has a user's data, which is very dangerous if in the wrong hands. While there is some regulation already, there is still a need for clear standards and practice to ensure data security (Zanetti, 2020). Specifically, data should be minimized such that AI systems shouldn't ask for more data than for their intended purpose, and encryption algorithms should be used, as a way to combat this.

Bias and data privacy are a problem with AI as a whole, however AI in education has its own flaws. One of the most significant ones being an overdependence on AI. Being overdependent on AI is defined as using AI too much to solve problems. With AI being able to solve many problems in the blink of an eye, it is likely that students may get overly dependent on AI, which would result in passive learning, meaning students receive information without being actively engaged in the process (Creely, 2023; Balonwu, 2024). As students use AI more and more, it'll limit the human brain's thinking capacity, removing intelligence capacities and making humans think more and more like robots (Ahmad et al., 2023). This would lead to a loss in critical thinking, minimal engagement, and a reduction in creativity. Students wouldn't be able to learn as efficiently if they rely on AI. Knowing that there is something that will instantly solve problems would discourage students from developing problem-solving skills, something that is vital for academic success and also real-world success. Overdependence on AI doesn't only cause a reduction in critical thinking. Relying on a machine instead of a human to teach a student would lead to a decrease in social and relational skills (Zanetti, 2020). This decrease would cause a student to have difficulty forming meaningful relationships and poor communication among peers, which are associated with succeeding in an academic environment (Goguen et al., 2010; Feldman & Astin, 1994).

Educational AI in the Real World

One of the most impactful deployments of AI at the moment is with Khan Academy. Khan Academy is a website that advocates for "Free, World-class education for anyone, anywhere." and has many positive opinions based on users, highlighting that it is able to increase motivation to learn and similar to a class they already attend (Arnavut et al., 2019). On top of that, it is able to provide immediate feedback, and it gives teachers data about their progress. This facilitates more control over the instruction (Sahlman & Kind, 2012). Now imagine Khan Academy compiled into one AI, where it keeps the benefits of it, while adding more customizability. As commonly seen with AI, Khan Academy's AI Khanmigo acts as a teaching assistant, being able to provide personalized guidance for students, and refreshing teacher's knowledge (Towers-Clark, 2023). Khanmigo is now being used with over 65000 students and teachers across many school districts (Rosenbaum, 2024).

A common app used for learning languages is Duolingo. Duolingo is an app that aims to become like a tutor that could teach any language to the user by feeding them bite sized lessons to do each day. Many students embrace the app, highlighting that it is helping with vocabulary and giving instant feedback, while being motivating and enjoyable (Astarilla, 2018). Duolingo is currently using an AI called GPT-4, where it can be used for creating interactive and personalized learning experiences (Marr, 2023). According to a Duolingo Blog by Parker Henry, an educational content creator for the company, Duolingo uses Large Language Models to create new lessons for the app (Henry, 2023). Using AI to create lessons allows for limitless content and practice for the user, essential for learning a new language. It also could be used to adapt to a user's errors during a previous lesson, tailoring future content to aid in those weaknesses.

In India, another common app is called Byjus. Byjus is an app that caters to almost 300 million students in India, using techniques such as motion graphics and 3-D animation to promote personalized learning for students (Sruthi & Mukherjee, 2020; Tripathy & Devarapalli, 2021). According to the founder, a key reason for Byju's growth was the simplified learning experience that it offers (Tripathy & Devarapalli, 2021). Byju's has since released an AI suite called Wiz. Wiz consists of three different AI models: BADRI, which pinpoints students strengths and weaknesses, MathGPT, a model capable of solving math problems using visual aids, and TeacherGPT, which functions as a teacher's aide (Singh, 2023; Abrar, 2023). This suite of AI is able to accurately predict a student's knowledge state, while finding learning gaps (Abrar, 2023). While teaching, the AI could also appeal to a student's interests to make the learning process much more engaging for them (Singh, 2023). The combination of the three models that Byju's has used gives a student much more control over their learning, benefitting it dramatically.

Future Uses of AI in Education

One way that AI can aid in education in the future is assisting special needs students. Since 1960, the number of students with disabilities has been slowly increasing at a faster rate than the general population (Hasselbring & Glaser, 2000). Special needs students usually have difficulty learning in classrooms due to cognitive, physical, and sensorial disabilities (Fernández-López et al., 2013). Over time, technologies have developed to support special needs students, such as screen reading software (Laabidi et al., 2014), which aids students who have trouble reading. However, more advanced software such as word prediction has also been used for students. Often, special needs students avoid using longer words to avoid frustration, however with word prediction, it facilitates students to express their words that more closely reflects their thinking (Hasselbring & Glaser, 2000). Assistive technologies have had positive results, such as Co:Writer, a word predictor, was found to reduce misspellings and improve accuracy for most of the students with mild learning disabilities (Wynne et al. 2016). AI's potential to add on to some of the pre-existing technologies could create a whole new atmosphere to learn for special needs students. Having AI-assisted word prediction would be able to take prior data of commonly used sentences or data from the user and make much more accurate predictions. This would enable special needs students, with the right support, to be able to learn in regular classrooms.

AI could be able to aid students emotionally in education. Overall, there is a trend between poor mental health and worse examination performance and drop-out from education (Cornaglia et al., 2015). This means that as a student's mental health gets worse, it is correlated with a worse exam score. A common emotion among students is stress. Academic stress is a stress caused by an increase in class work, expectation of graduation, or even a disagreement among mentors (Yikealo et al., 2018). All students experience academic stress in their academic life (Baskar, 2015; Yikealo et al., 2018). Stress levels can disrupt performance on tasks that require attention, memory, and decision making (LeBlanc, 2009; Yikealo et al., 2018). As AI gets more advanced, it can be able to employ an emotional recognition algorithm to detect subtle changes for students. To assist the student, the AI could offer personalized emotional support to the student by understanding the student's triggers and stressors. In worse cases, the AI could inform a teacher or a counselor about this, which could provide the help needed for students.

As AI makes its way more and more into education, students and teachers should embrace the change and be ready for it, to fully use its benefits to its maximum potential. One of the best ways for teachers to be ready for AI in education is to learn more about it. Many studies have shown the importance of teachers being able to use AI correctly and how currently a lot of teachers aren't equipped with it (Wardat et al., 2024; Celik, 2023; Lindner, 2019). AI's ability to be anything the user wants it to be gives a teacher much more control over pedagogy. Being knowledgeable about it allows for much better results for students, being able to tailor content to a student's needs. Along with that, they would be able to fully utilize the benefits highlighted earlier, such as automation for certain tasks like grading. Most teachers specifically interested in AI only have a general rough idea of the uses of AI (Lindner, 2019), and that knowledge would be much lower for teachers who aren't interested in AI. One of the ways to educate would be through an AI readiness training program (Luckin, 2016). This way, teachers can learn how to maximize AI to make use of its benefits.

Conclusion

AI has made a massive impact in the sector of education. Students have used it in a variety of ways, from personalized tutors that are able to mimic human intelligence, to idea generation in essays and research. Even teachers are able to use AI in many ways, and finding it to be able to save time on many of their tasks. AI has been very effective as a human tutor, shown to be better than regular study methods and show a higher grade increase in a study conducted by Jian in 2023 (Jian, 2023). However AI also has many limitations, from its hallucinations to students over relying on it. Overall, AI is seen as a benefit to education if used correctly, despite all of the drawbacks that it may have. Most of the studies referenced are targeted towards high school and undergraduate students, which leaves the gap of students

below high school students and their utilization of AI. This age group would have much different results, due to the difference in knowledge, which was not addressed in this paper.

Recommendation

With AI's benefit of personalized learning, it opens a new world of enhanced learning for students, which is why students should be taking advantage of it due to its ability to be a personalized tutor and provide new resources for student's learning. Even its ability to generate paragraphs or ideas for potential assignments allows students to save time, however, there is the worry that students become over reliant on it. I recommend students to use AI mindfully, and only to aid in learning rather than generate essays, since with this, it assists student learning rather than giving them the answer, which would avoid the issue of becoming over reliant on it.

Teachers should also consider using AI, especially for personalized instruction. Personalized instruction would allow for students to be able to learn material more effectively by appealing to what a student engages with. On top of that, teachers should also consider using AI to be able to create and generate new assignments, similar to how Duolingo uses AI to create questions. This way, teachers could target a student's weakness to a certain skill, and create unique assignments to cover for that skill gap. However, teachers should learn how to utilize AI to its best potential. Similar to students, teachers can fully benefit from AI through its ability for personalization and quick idea generation.

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