

A Survey of Opportunities and Risks of AI Systems in Education



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1 Introduction

Artificial Intelligence (AI) systems have made significant inroads into the education landscape, promising enhanced learning experiences, improved efficiency, and personalized educational pathways. As the deployment and research of AI technologies in education continues to gather momentum, it is essential to acknowledge that the impact of these systems extends far beyond their immediate advantages and drawbacks [1]. Engaging in a meaningful and informed discourse about AI in education is imperative to ensure the fair and responsible implementation and development of AI systems in an education setting. In addition, a survey of the Pew Research Center revealed, that a growing share of people are concerned about the development and deployment of AI systems. This includes the fear of potential job loss, privacy concerns and the loss of human connection [2]. In this work, Opportunities and Risks are shown based on current state-of-the-art AI systems while addressing, widespread concerns, as well as showing potential problems which should be addressed in the current rapid development of such systems.

2 Approach

In this work, the Opportunities and Risks of AI systems in Education will be discussed in two focus topics:

1. Teaching
2. Assistive Technologies

First, the current state of adoption of AI systems in these categories are laid out. Then, the opportunities of such systems are presented based on real world examples and their future potential. Then, the risks of AI systems and current research in the context of education is discussed, and possible solutions are presented.

3 The current state of AI and Technology in Education

In this section, the current state of AI and Technology is presented. First, the current technologies used in Teaching are laid out. Then, the assistive technologies deployed at schools are presented.

3.1 Current Technologies in Teaching

Quantifying the actual usage of technological advances in teaching is hard, as it is very subjective to the teacher, as well as the teaching environment. Since 2013, the International Association for the Evaluation of Educational Achievement (IEA) conducts the International Computer and Information Literacy Study in a cycle of 5 years. This study has been designed to capture the current state of how well students and teachers alike are prepared for study, work and life in an increasingly digital world [3]. Its latest evaluation cycle has been conducted in 2018 with the next one starting in 2023. The study, as well as a German counterpart, showed, that the availability of Technology and digital devices vary greatly between schools, students and teachers [4]. In 2018, most teachers and students didn't have their own portable device for school usage. These circumstances got better over the course of the pandemic. However, still around 60% of teachers claim to not have access to their own portable digital device for teaching [4], with 30% of schools not providing Wireless internet access to teachers or students. This goes inline with the usage numbers for Information and Communication Technology (ICT) during lessons, only 43% of teachers use word processing or presentation software programs, with 32% using digital content to supplement school materials [3]. Besides availability, most teachers claim, that missing confidence in the usage of digital devices and tools is one of the main reasons for the missing integration of ICTs. This applies especially for the usage of learning management systems or Education cloud software such as Moodle or ILIAS [3]. As a result, the usage of such systems remains very sparse for in presence lectures. An exception is given, for gamification software, e.g. Quizlet or Kahoot, as 60% of schools report frequent use and good availability [3]. Because of these circumstances, it comes at no surprise, that the use of photocopiers, paper and overhead projectors are still the most used technologies in teaching [5].

3.2 Assistive Technologies in the Classroom

The use of assistive technologies in the classroom is key to achieve an inclusive and fair environment, where students with learning disabilities have the same opportunities and chances as students without disabilities. Learning disabilities can range from visual impairment, such as red-green weakening or colorblindness, over learning disorders, e.g.: Dyslexia (reading disability) or Dysgraphia (writing disability) to listening related issues [6]. With that, the field of possible learning disabilities is quite vast and can have a large effect on a students' ability to follow a lesson. Assistive technologies can mitigate the effects of a students disabilities, by enhancing students basic skills, however, they can't replace them and thus can only provide maximal assistance if they are integrated into the educational process [6]. At the same time, for students with disabilities, they are an essential work tool as a pen might be for others and are thus needed, so that a disabled student can participate equally with their learning peers in an educational environment.

As every student has individual needs, the use of assistive technologies in education needs a lot of collaboration, from both teachers, parents, students and medical personnel, to determine the right tools for a students specific problems [6]. Despite diagnosis and funding, just providing assistive technologies isn't enough, teachers also need to be able to provide assistance, teach the child to use assistive technologies before they are required and need to be technologically trained. Technological training is very important, to provide technological support if needed and to be able to incorporate the students needs in the learning plan [6]. In addition, it is important, that learning plans take assistive technologies and learning disabilities into account from the beginning, so that students with disabilities don't fall behind even before their diagnosis.

As technological training has been determined to be one of the most important factors and the availability of digital devices in schools are sparse, the usage of assistive technologies in traditional classrooms is quite rare. Teachers aren't sufficiently technologically trained to use assistive technologies on a broad scale, as most don't feel comfortable using technology in general regularly in lessons [3]. Instead of using assistive technologies, teachers rely on practices such as [7]:

- the assistance in identifying potential tutors or note-takers
- allow for the extensions on assignments and essays
- allow preferential seating
- arranging additional meetings to discuss specific learning needs
- allow extra time on exams
- provide separate distraction free environments during exams
- allow for the usage of screen enhancement software if computers are needed during lessons

What all of these have in common is, that they are all exclusive and separate a student with special treatment from its learning peers. And as photocopiers and overhead projectors are still the most used technologies during classes, the use of assistive technologies is rarely applicable, without special treatment, such as giving only this student access to a digital device with optical character recognition, as the learning material isn't available in digital form.

3.3 Defining AI in Education

Defining AI itself is complicated. As of today, there is no precise and universally accepted definition of AI available [8]. One way to define AI is as "The activity devoted to making machines intelligent, and intelligence is that quality that enables an entity to function appropriately and with foresight in its environment." [8]. This definition depends on whether a system can be credited to function appropriately and with foresight, which can be very subjective. This can range from accepting simple "dumb" programs such as calculators as AI. In recent times, the understanding of AI has shifted, as machine and deep learning techniques become increasingly available to the public. Today, when talking about an AI, most people think of Computer Vision systems, Large Language Models or intelligent speech recognition agents such as Amazons Alexa or take influence from the entertainment sector [9].

The definition of AI in education builds upon this general definition, by defining AI systems in Education (AIED) as systems, that include "intelligent education, innovative virtual learning, data analysis and prediction" [10]. Intelligent education systems are designed to improve learning value and efficiency by providing timely and personalized instruction and feedback to both tutors and students. They include techniques for learning analysis, recommendation and knowledge understanding and acquirement, which uses sets out to use current state-of-the-art data mining, analytics and machine and deep learning technologies [10].

4 Opportunities & Risks

Artificial intelligence in education is said to have a lot of possibilities. While some suggestions are coming right out of science-fiction, others are already in use or being tested. In this section,

the opportunities and risks of AI stated by different publications are presented and discussed. First, the focus will be on Artificial Intelligence in teaching, followed by a discussion about how AI could transform assistive technologies.

4.1 Teaching

In teaching, AI opens up a plethora of opportunities, from personalized learning experiences, to data and analytics for teachers. AI has the potential to transform the world of teaching, while shining a spotlight onto issues that have been overlooked or ignored for years [11], giving the opportunities to improve on those problems.

4.1.1 Collaborative Learning

In Collaborative learning, students work together in groups to solve a set of problems, which has been proven to be an effective strategy to positively influence learning results [11]. One of the most important processes in Collaborative learning is the group formation process. According to the Belbin theory, all students show behavior, which can be mapped to one of 8 team roles, which facilitate the progress of the whole team. The behavioral pattern of each team role is by six factors: personality, mental ability, current values and motivation, field constraints, experience, and role learning [12]. It has been shown, that it is essential for a group to perform well, to be composed of a balanced combination of the team roles. In order to achieve this, students were asked to take self-tests, resulting in the assignment of a team role and students were then matched based on these results, which results in a high organizational effort and can be biased, as individuals may have a preconceived image of themselves [12]. Artificial Intelligence can be used to solve these problems as shown by Alberola et al. [12], who proposed a team formation mechanism based on student feedback, coalitional structure generation, and Bayesian learning. Instead of self-tests, the mechanism uses an iteratively updated knowledge base consisting of student feedback about their peers most relevant team role. As a result, first the mechanism assigns random groups, and after feedback has been given, uses this information to assign each student a_i to their most probable team role and composes a balanced group. In order to extract information from student feedback, Alberola et al. [12] applied Bayesian learning in order to estimate the probability of a student having team role r' as its most relevant role given the history H of student evaluations, such that:

$$p(\text{role}_i = r'_i | H) = \frac{p(H | \text{role}_i = r'_i) p(\text{role}_i = r'_i)}{\sum_{r \in R} p(H | \text{role}_i = r) p(\text{role}_i = r)} \quad (1)$$

Last but not least, to solve the problem of team formation, they showed, that student team formation can be expressed as a coalition structure generation problem, which aims at partitioning the components of a set into exhaustive and disjoint coalitions so that the global benefits of the system are optimized [12]. This problem can then be solved using linear programming. Such systems, can ensure that each student will be assigned to the most effective group of students possible, increasing the chance of achieving satisfactory results. However, such systems are not able to capture social relationships and only focus on student performance, rated by their peers. As a result, matching students who hate each other might create tension inside the group and hinder progress. In addition, students might also not always act faithful, and fill out the evaluation for students they like and hate differently. However, these circumstances could present students with opportunities to form new social relationships or solve social problems.

4.1.2 Student Forum Monitoring

During the pandemic and after, the usage of learning management systems has increased. One feature of these systems, is a “student forum”, where students can create posts to ask questions. Other students, as well as tutors, can then traverse through these posts to find information or to answer questions posted by others. In a school classroom setting, the student size is quite small and manageable. However, for higher education institutions and distance learning universities, the number of students per course can grow into multiple hundreds [13]. Monitoring and managing forums with such a high number of participants can be challenging, and can lead to unanswered questions and bad student morale. AI poses the opportunities to alleviate this problem, by employing technologies like Large Language Models (LLMs) or intelligent agents, to act as a filter or preprocessor of forum posts [11, 13]. In this setting, AI systems answer simple posts automatically, such as questions like: “When is the submission X due?”, and classify each posts into relevance categories and group them together. A tutor is then only notified about a group of posts, which is only needed to be answered once, or if posts need special attention. This process can also be supported by sentiment analysis models, which monitor each post, in order to reveal negative or non-productive student emotional states [11]. As of now, learning management systems do not employ any of the mentioned techniques, however, recent research has proven LLMs to be effective for content moderation [14]. LLMs have been fine-tuned or prompted to detect online hate speech, which is content that expresses hate or encourages violence towards a person or group based on race, religion, gender, or other identity characteristics [14]. An important factor for such systems, is the ability to generate fitting and meaningful explanations, as to why a specific piece has been flagged. However, many systems lack this ability, except for the latest GPT models [14]. In addition, many LLMs and models suffer from biases and might thus provide misleading and false accusations to moderators. As a result, even though in theory, the application of forum monitoring and moderation systems is argued to have a high potential for both students and tutors, as information is available more quickly, the overall workload is reduced and unconfident teachers are supported, but the practical limitations of current technology make the deployment and integration of such systems difficult.

4.1.3 AI Learning Companions

The desire for students to have their own tutors and personalized learning plans, that focus on their interests, goals, strengths and weakness has been an ever lasting desire. It has also been shown that such personalized learning experience can improve the results of the learning process, because the student has a personal intrinsic motivation [11]. However, current mass education systems struggle to deliver such personalized experiences, especially in the long term. As a result, many have long learning gaps after graduation, due to the lack of structure and motivation to keep studying [15]. This leads to skill decay. AI has the possibilities to counteract this trend and provide a technology that could help learners to identify topics of interests, recommend learning materials, provide instructions and reminders, and guide them through their learning process, while offering targeted feedback and unique personalized experiences [11]. The Institute for Creative Technologies at the University of Southern California, is actively researching such a system, called the Personal Assistant for Life Long Learning (PAL3) [15]. PAL3 aims to deliver engaging, accessible education, on-the-job training and support lifelong learning and ongoing assessment through the usage of tablets. It consists of multiple building blocks [15]:

1. **An embodied pedagogical agent:** A virtual agent, which has been designed to guide the user through their learning journey. It uses state-of-the-Art Natural Language Processing Systems to communicate in voice or text form.
2. **A persistent Learning record:** A personal resumé, which tracks what students have done, their mastery level and their goals.
3. **A library of educational resources:** A collection of curated training resources, ranging from custom content and tutoring systems to web pages and learning videos.
4. **A recommendation system:** A system, that suggests learning resources from the library based on the individuals learning records and interests.
5. **Gamification:** Mechanism to create engaging and motivating experiences, for example through leaderboards or capabilities that are unlocked through persistent usage and progression

Unfortunately, the Institute is very vague about the technical details and thus, it is impossible to judge what kind of AI technologies are used in PAL3. However, as the agent is specifically developed for tablets, it shows that such systems needs to be able to run on small budget friendly devices in an on- and offline setting.

Another system that is often (mis-)used as a learning companion is ChatGPT, a online chatbot based on Large Language Models, specifically the Generative Pretrained Transformer (GPT) [16]. It is served as a simple and user-friendly web interface, where a user can enter prompts or questions in natural language. It is used by many for various different tasks in the context of education. Many use it to solve creative writing tasks, asking questions, paraphrasing, proofreading, resource recommendations etc [16]. With that, ChatGPT provides immediate feedback to learners and is able to explain complex knowledge in different depth and complexity. This makes ChatGPT a very powerful companion. However, it has to be used with caution. The system has no online access and thus only relies on knowledge from its training corpus, which may include false and outdated information. In addition, Large Language Models can hallucinate [17]. Which is phenomenon, where they produce texts consisting of incorrect, nonsensical, or not real information. Shidiq [16], also found, that persistent usage of ChatGPT leads to students challenging the teacher over answers, which changes the role of ChatGPT from a companion to a competitor. He also showed, that overusing the system can lead to a decay of students critical thinking, creative writing or social skills. Besides, both the advantages and drawbacks, systems like ChatGPT, can't run locally on budget devices, as they require a lot of storage and processing power, violating the hardware constraints of a good AI learning companion. This is especially important, if the current status of technology in schools is considered, as most schools don't provide any form wireless internet access for students and not even teachers have access to their own digital devices. This, along with their risks, makes the deployment of AI learning companions difficult. Especially, as their primary goal is to support the learning process and help students by keeping a lifelong learning journey, which doesn't end or gets paused after graduation.

4.1.4 Continuous Assessment

Current educational systems around the world rely on "high-stake" end-of-course examinations. Despite, that there is little evidence for their reliability, validity or accuracy and the fact that psychologists proved that it is wrong to make decisions based upon a single test score, there has been no change in the way students are examined for centuries [11]. This

behavior, resulted in educators all too often teaching content for the test, instead of for the learning experience and the greater outcome of the course. AI driven learning management systems have the opportunity to change this, by providing a continuous Assessment. If AI becomes an always present tool, used by students throughout the process, being as a learning companion, an automatic feedback system or as the backbone of a learning management tool. The captured information about the student throughout its learning process could be used to create a detailed intelligent personal resumé of the students learning experiences, which can be used to assess whether a student has achieved mastery in the course or not [11]. Because this assessment happens in the background, at all times, it is almost impossible to cheat or subvert the system's intention. This would also alleviate the impact of "bad days" or disadvantageous personal situations, as it acts as a moving average over the course of the learning process. It also allows for the early identification of problems by teachers, which can be addressed directly, as they are reflected in the resumé [11]. As of the time of writing, no research in this area could be found, matching with Holmes et al.'s claims, that current research only focuses on "How to make the current examination process safer" [11].

Despite the potential advantages of such a system, it raises serious ethical concerns about data usage, privacy, security, reliability and fairness, which all need to be thoroughly considered and discussed. For example:

- How is data used?
- Where is it stored?
- How is it stored?
- Who has access to what kinds of data?
- What kind of data is considered?
- What biases are introduced in the model?
- How does the model come to a given conclusion?
- How is a given result explained?

These are just a few examples of the topics which have to be considered, before and during the development of such a continuous assessment system. Again, AI systems have a great potential to transform education in the regard of how students are assessed, but they also leave a great amount of questions unanswered, which are essential to ensuring a fair and acceptable result.

4.2 Assistive Technologies

Developing effective assistive technologies and making them widely accessible is key for an inclusive education environment. However, traditional technologies can be limited in its possibilities, especially in the Natural Language Processing and Computer Vision fields. As a result, Artificial Intelligence is considered to be the main driving force for the future of assistive technologies, covering tools for visual, hearing and Communication disabilities [18]. Natural Language Processing and Computer Vision systems, are the main contributors to make education more accessible to everyone. Natural language processing techniques, such as text-to-speech, speech-to-text, image-to-text and language models can help a variety of different students with disabilities. Text-to-Speech systems can read out screen content or

books and papers to visually impaired people. Speech-to-Text can do the same for students with hearing impairments [18]. Image-to-Text models can extend both aforementioned techniques to also process analog, non-digital content, which is especially important as many schools still rely on photocopiers and overhead projectors. All three of these technologies have been incorporated into many of the current most used Operating Systems. iOS for example, can automatically extract text from images, videos or the live feed of the camera directly in the camera app, it has a built in screen reader, which can read out any content on the screen and describes it accordingly. It also has a dictation / transcription feature, which produces accurate text of spoken content in real-time [18].

Another important technology for assistive systems are speech recognition systems. These systems are not only able to transcribe text, but can also be used to build voice-controlled interfaces or voice assistants. Voice assistants, such as Siri or Alexa in particular are a very important technology for audio impaired people, as they can do many of the same tasks using voice commands as people on a normal computer or smartphone would do [18]. Voice recognition systems can also be used to detect speech in loud environments, amplifying it accordingly for their users.

For people with communication issues or dyslexia, as well as cognitive impaired people, Large Language Models can be helpful. They can be used to recommend following words, proofreading or paraphrasing to increase the linguistic quality of a text, so that others may understand it better [18]. LLMs can also be used to process complex information for people with cognitive disabilities, by explaining the information first very broadly and then increasing the depth and complexity of the explanations. At the same time, they enable their users to ask questions in between explanations if topics need additional clarifications, providing an individual learning experience at the users own pace.

However, many of these technologies still raise a lot of privacy concerns, which is especially problematic for not tech-savvy people, as they might not understand the implications of using the technology [18]. In addition, all the aforementioned methods are stochastic, and can produce wrong results.

5 Conclusion

In this paper, Opportunities and Risks of Artificial Intelligence systems in education have been discussed with real world examples. First, the current state of technologies and assistive technologies in education have been presented. Then the opportunities and risks have been discussed with regard to two categories, teaching and assistive technologies. AI systems showed great potential in transforming the world of education through enhancements in collaborative learning, student forum monitoring, AI learning companions and continuous assessment. It was shown, that AI can be used to automatically organize students in the best possible groups to enhance the results of group tasks. In forum monitoring, AI systems could make large amounts of students manageable, while moderating posts and reducing the workload of tutors through summarization techniques. AI learning companions offer the prospect of individual learning experience through personalized learning plans and offerings. Continuous Assessment promises to transform the way performance and course mastery is assessed, by replacing traditional end of course tests with continuously assessing the student in the background, eliminating negative external influence for the final grade. In assistive technologies, AI has proven to be the main driving force for various technologies solving different problems of common disabilities. Especially natural language processing and voice recognition systems have proven to be effective, because of the abilities to transcribe text, read out content or

explain content in different depth levels. All in all, AI can transform the education sector for good. However, all systems showed the same or related risks. The main one being privacy and ethical concerns, such as data usage and storage, as well as biases, which have to be discussed in detail before such systems can be deployed. Nevertheless, AI has the potential to transform education and schools as well as teachers and students should focus on preparing for this change, by incorporating technological training into everyone's learning plans.

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