CHALLENGES AND LIMITATIONS OF AI TOOLS FOR PERSONALIZED EDUCATION

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Abstract: This paper explores the impact of artificial intelligence on the education system and how AI can personalize learning experiences and improve the efficiency of the teaching process. The paper highlights the efforts made by the European Union to create a solid legal and ethical framework to regulate uses of AI.
Keywords: artificial intelligence, education, ethics, legislation, EU.

1. Introduction

Artificial Intelligence (AI) has permeated nearly every aspect of our modern lives, and education is no exception. This innovative technology is increasingly making its presence felt in classrooms, offering new possibilities to personalize learning, automate repetitive tasks, and enhance the efficiency of the educational process. Furthermore, AI can enhance the efficiency of the educational process by providing data-driven insights [1]. By analyzing student performance data, educators can identify trends and patterns that may inform instructional decisions. For example, AI can help identify students who may be struggling and require additional support, allowing teachers to intervene early and prevent academic difficulties. Additionally, AI can be used to optimize class schedules and resource allocation, ensuring that educational resources are used effectively [2]. While the integration of AI in education offers numerous advantages, it is important to acknowledge potential challenges. Concerns about privacy and data security, as well as the potential for job displacement, must be carefully addressed. ‘’As AI continues to evolve, it is imperative to develop robust frameworks for ethical AI in education, prioritizing transparency, accountability, and human-centered design’’ [4]. Artificial Intelligence in Education: A Review of the State of the Art. OECD Publishing). However, by carefully considering these issues and implementing AI responsibly, educators can harness the power of this technology to create a more engaging, personalized and efficient learning environment [6].

The European Union aims to become a global leader in the development and deployment of safe and ethical artificial intelligence (AI). By adopting a robust regulatory framework based on fundamental EU values and respect for human rights, the EU seeks to create an environment conducive to innovation, where AI can serve as a tool to address society's most pressing challenges. The AI Act, adopted in 2023, represents a crucial step in this direction. This groundbreaking legislation sets clear rules for the development and use of AI systems, aiming to protect citizens and foster trust in this technology. By classifying AI systems based on the level of risk they pose, the regulation introduces specific requirements for each category, ensuring a proportionate and effective approach. In parallel with the AI Act, the European Union has updated its Coordinated Plan on AI, a strategic document that sets out a long-term vision for the development and deployment of AI in Europe. This plan emphasizes the importance of striking a balance between promoting innovation and protecting the fundamental rights of citizens. Additionally, the European Commission has launched a package of measures to support European businesses, especially start-ups and SMEs, in developing innovative and trustworthy AI solutions [7].

2. Benefits of Integrating AI in Education

Integrating Artificial Intelligence into the educational system brings a multitude of benefits for students, teachers, and institutions alike. Among the most significant advantages are:

Personalized Learning: Each student has a unique learning pace and style, and AI can adapt content and teaching strategies to the individual needs of each learner, maximizing the efficiency of the educational process.

Automation of Repetitive Tasks: Administrative tasks such as grading assignments or generating exercises can be automated, freeing up teachers' time to focus on more creative activities. **Instant Feedback:** Students can receive immediate feedback on their performance, allowing them to identify their

weaknesses and improve their learning methods. **Access to Education:** AI can facilitate access to high-quality education for students in remote areas or with limited resources, through personalized online learning platforms. **Early Identification of Difficulties:** AI algorithms can identify early signs of learning difficulties, allowing for timely and effective intervention. **Exploring Interests and Identifying Educational Options:** AI-powered tools can help students explore their interests and identify the most suitable educational options for their future, based on their skills profile and career goals. **Optimizing the Allocation of Educational Resources:** By analyzing individual student data, it is possible to identify the specific needs of each student, allowing for a more efficient allocation of resources such as teachers, teaching materials, and learning time [5].

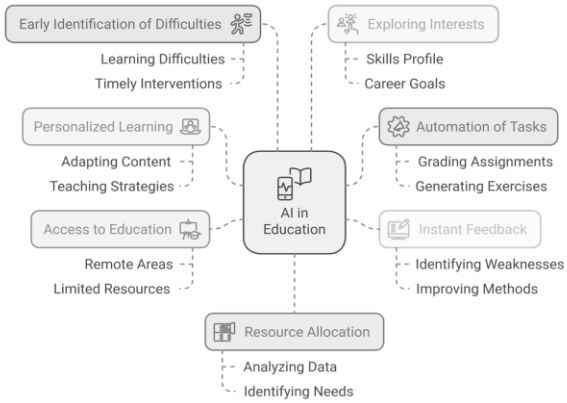

Fig. 1. Benefits of Integrating AI in Education-author own work with AI tools

3. Challenges and Limitations

Despite the obvious benefits, the widespread implementation of AI in education is not without its challenges. Among the most significant are:
Costs: Implementing and maintaining the infrastructure required for AI can be costly, especially for educational institutions with limited budgets. **Data Quality:** The effectiveness of AI systems depends largely on the quality of the data they are fed. Incomplete, erroneous, or biased data can lead to inaccurate recommendations and hinder the educational process [11]. **Bias in Algorithms:** Even with high-quality data, AI algorithms can introduce biases into the decision-making process. For example, if the training data is biased, the AI model may perpetuate existing inequalities in the educational system. **Data Privacy:** The use of personal data for educational purposes raises concerns about privacy and security. **Lack of Teacher Training:** Many teachers lack the necessary skills to effectively use AI-powered tools. **Cultural Resistance:** Some members of the educational community may be resistant to adopting new technologies [11]. The effective implementation of AI in education requires careful consideration of ethical implications, data privacy concerns, and potential biases in algorithms [3].

Technology has become the fabric of our modern lives, fundamentally transforming how we interact, learn, and work. From smartphones that connect us instantly with people around the globe to artificial intelligence systems driving autonomous vehicles, technological innovations have become ubiquitous. In the realm of education, these advancements have opened up new horizons, enabling personalized learning and providing unprecedented access to educational resources. Moreover, technology has streamlined complex tasks, automating processes and optimizing efficiency in numerous sectors [8].

The impact of technology extends beyond convenience and efficiency, reshaping the very structure of our society. Social media networks have facilitated the creation of global communities, while online learning platforms have democratized access to education. Technology has played a pivotal role in addressing some of the world's most pressing challenges, from climate change to pandemics. As technology continues to evolve, we can expect to see even more innovative solutions that will transform our world [10].

4. The Future of Education with AI

The future of education is shaping up to be one where technology and humans collaborate to create personalized and efficient learning experiences. Artificial Intelligence offers a unique opportunity to transform education and create a more equitable, efficient, and adaptable system. However, it is essential to approach this transformation with caution, addressing the challenges associated with AI implementation [9]. Over the past decade, Artificial Intelligence (AI) has revolutionized various sectors, from healthcare to finance. While the initial focus was on refining algorithms and models, a new paradigm has emerged: data-centric AI. This approach emphasizes the importance of data quality in developing machine learning systems. Instead of solely focusing on algorithm complexity, data-centric AI recognizes that clean and relevant data is fundamental to model performance. This paradigm shift reflects a deeper understanding that, regardless of a model's sophistication, it is limited by the quality of the data it is trained on [11]. By investing in the development of ethical and transparent AI systems, training teachers to effectively use these tools, and promoting open dialogue about the impact of AI on education, we can

ensure that this technology is used to benefit all students. As we stand on the cusp of a new era in education, it is imperative to embrace the potential of artificial intelligence while remaining mindful of its limitations.

By investing in research, developing robust ethical guidelines, and providing adequate training for educators, we can ensure that AI is used to augment, not replace, human interaction [2]. ‘’While AI offers immense potential to revolutionize education, it is crucial to address the challenges associated with cost, data quality, and teacher training to ensure equitable access and benefits for all learners.’’ (UNESCO 2019). Artificial Intelligence in Education: A Global Perspective. UNESCO). It is crucial to foster a collaborative approach between educators, technologists, and policymakers to navigate the complexities of AI integration and to shape a future where technology serves the best interests of students [5].

5. A View of the Future-L2.T.O.R

Artificial Intelligence (AI) is revolutionizing the field of education by automating processes and optimizing efficiency. According to McKinsey & Company estimates, by 2030, AI could automate nearly 800 million jobs globally, and the education sector is no exception. However, AI is not replacing teachers but supporting them, allowing them to focus on more complex and creative pedagogical activities [12].

One area that is particularly impacted is that of programming and robotics courses for children. AI provides new tools and resources that make learning more engaging and efficient. For example, AI-powered online learning platforms can adapt the content to the pace and learning style of each child, providing personalized feedback and interactive exercises. Educational robots, such as NAO, can be programmed to interact with children, providing a fun and engaging learning environment. An interesting case study is that of the NAO robot, launched in 2016. Initially designed to help immigrant children learn a new language, NAO demonstrates the potential of robots in education. However, it is important to emphasize that robots do not replace teachers but complement them, providing individualized support. The initial investment in a robot like NAO can be significant, but in the long term, costs may be lower than those associated with hiring a human tutor [4]. ‘’We need to let artificial intelligence express itself here, among us, we need to let it and support it to develop, but it's true that we need to constrain it. First and foremost, it needs to be ethically constrained. What does an ethical constraint mean? It means several things. It means not posing a risk to humans, and secondly, it means not creating imbalances among people’’ (Daniel David) [10].

L2TOR or Second Language Tutoring using Social Robots is a project aimed at developing a child-friendly robot tutor to assist preschoolers in learning a second language. The robot will interact with children in a socially engaging manner, similar to human tutors, utilizing both verbal and nonverbal communication. The project will evaluate the robot's effectiveness in teaching English as a second language to native Dutch, German, and Turkish speakers, as well as teaching Dutch and German to Turkish-speaking immigrant children. The robot will adapt its interactions to the child's responses, providing increasingly complex language stimuli and feedback to support language acquisition. By combining artificial intelligence and social robotics, L2TOR aims to create a unique and effective learning experience for young children [13].

The L2TOR project delves into the science and technology of social robots for second language tutoring in preschool settings. The primary goal is to develop an adaptive, embodied digital learning environment, comprising a tutor robot and supporting technologies, that can engage with children to enhance their second language learning. The system will be personalized to cater to children's specific linguistic competency levels, optimizing the effectiveness of language tutoring [14].

A key aspect of the project is defining and extending the pedagogy of robot-assisted language tutoring. This involves establishing guidelines for robot behavior and its integration into preschool teaching practices. The L2TOR robot will be evaluated to assess its effectiveness in various learning domains, such as number, space, and narrative. The project also aims to establish design principles for developing commercial social robots for language tutoring. A ‘’cookbook’’ will be created for industrial stakeholders, outlining the steps to design a commercially viable robot-assisted tutoring system. Additionally, a software stack will be developed to support language tutoring, encompassing modules for perception, planning, output generation, data logging, and communication. This project conducts rigorous evaluations of social signal processing techniques, including speech recognition, voice activity detection, face detection, and recognition. These technologies are assessed for their suitability in human-robot interaction with young children. Through observation of second language learning and tutoring sessions, insights are gained into human tutor approaches, including feedback strategies, language use, and scaffolding techniques. These observations inform the design of the robot tutor [13].

A series of experiments and pilot studies explore various factors influencing L2 learning, such as the impact of robot behavior, the use of real objects versus screen-based objects, and the effectiveness of personalized tutoring. The L2TOR consortium is a leading force in second language tutoring research, distinguished by its focus on this specific domain and

its extensive long-term studies involving hundreds of children. While there is cautious optimism within the teaching profession regarding classroom technology, there is growing interest in the potential of personalized tutoring by social robots. The L2TOR project actively engages in outreach and public events to explore this future vision of classrooms with robot-assisted learning [13].

A personalized robotic tutor can significantly enhance student performance and engagement. By adapting learning activities and difficulty levels to individual student needs, these systems can effectively simulate human tutoring. One common approach involves tracking students' knowledge on a skill-by-skill basis, often represented probabilistically, particularly in language learning scenarios. While effective, this method can be inflexible due to the need for domain-specific metrics to select the next skill [8].

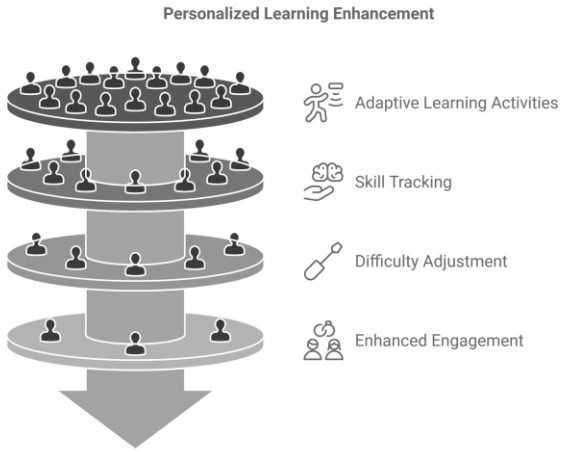

Fig. 2. Personalized Learning Enhancement-author own work with AI tools

Dynamic Bayesian Networks provide a more sophisticated approach, considering past interactions and skill interdependencies. However, this requires detailed domain knowledge and complex modeling. A simpler yet powerful approach is Bayesian Knowledge Tracing (BKT). It estimates a student's mastery of a skill based on their performance on tasks, accounting for factors like guessing and slipping. BKT has been shown to outperform traditional methods and can be extended to incorporate factors like student emotions. In their previous work, the researchers extended BKT with action nodes to model the tutor's decision-making process. They introduced a latent variable to represent different levels of skill mastery, allowing for uncertainty quantification and the impact of tutoring actions on future learning. This Adaptive Bayesian Knowledge Tracing (A-BKT) approach selects the next skill and action to maximize learning gains, balancing challenge and support. A-BKT's goal is to create a state of flow, where students are neither overwhelmed nor bored. This aligns with spaced repetition techniques like the Leitner system. While A-BKT has been used in previous research, its application with children and in conjunction with other techniques, such as gestures, remains unexplored [15].

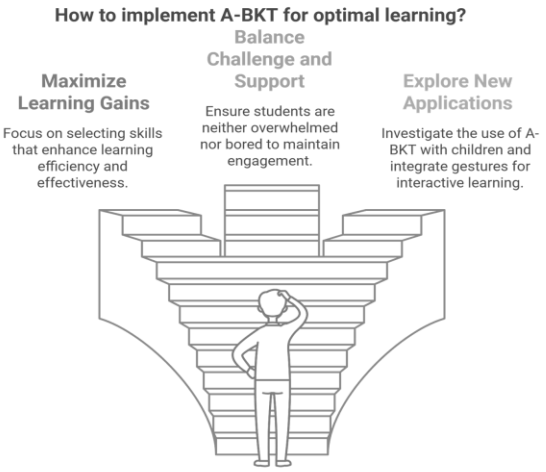

Fig. 3. Implement A-BKT for optimal learning-author own work with AI tools

The adaptive tutoring strategy helps maintain engagement by providing personalized support. Combining adaptivity and gestures creates a powerful learning experience, balancing challenge and support. While the adaptive system might not directly increase the number of words learned, it focuses on the most challenging words for each child. Future research could explore the long-term impact of robot-assisted language learning, refine adaptive strategies, and investigate the use of a wider range of gestures. Additionally, incorporating measures of student affect and motivation can further enhance the learning experience [9].

The study yielded several key findings:

1. **Effectiveness of Robot Tutoring:** Children were able to learn new English words through interaction with the robot tutor and retain this knowledge over time.
2. **Impact of Gestures:** The use of co-speech gestures by the robot significantly improved long-term word retention. Children were more engaged and performed better on tasks when gestures were incorporated.
3. **Adaptive Tutoring:** The A-BKT model effectively tailored the learning experience to individual children's needs. It helped maintain

engagement and optimize learning by balancing challenge and support.

6. Conclusion

The findings of this study demonstrate the potential of humanoid robot tutors to effectively support second language learning in young children. By combining personalized instruction and engaging gestures, robot tutors can create a more effective and enjoyable learning experience. Further research is needed to explore the long-term impact of robot-assisted language learning and to investigate the optimal combination of adaptive tutoring strategies and gesture use. The research delves into the potential of humanoid robot tutors in facilitating second language acquisition in young children. By employing an adaptive Bayesian Knowledge Tracing (A-BKT) model, the robot can tailor the learning experience to the individual needs of each child, optimizing learning outcomes. The integration of co-speech gestures further enhances engagement and comprehension, making the learning process more effective. The personalized approach, combined with the use of gestures, creates a more engaging and effective learning environment. However, further research is necessary to explore the long-term impacts of robot-assisted language learning and to refine the adaptive tutoring strategies. By advancing the field of human-robot interaction and educational technology, this research contributes to the development of innovative tools that can revolutionize language learning and other educational domains.

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