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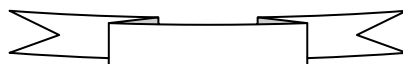
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A NEW PARADIGM IN EDUCATION: ARTIFICIAL INTELLIGENCE-ENHANCED PERSONALIZED LEARNING

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The importance of Artificial Intelligence (AI) in modern times cannot be underestimated, as it has become a transformative force across nearly every aspect of society. AI is playing an increasingly important role in education, transforming traditional methods of teaching and learning toward more personalized, adaptive approaches. This study aims to reveal advantages and challenges of AI-enhanced personalized learning and offers an in-depth examination of AI in the educational sector, highlighting the importance of personalized learning. In the study, literature review was applied to examine the research topic in details and the findings were presented under two main headings as the advantages and difficulties of AI-enhanced personalized learning. The principal advantage of AI-enhanced personalized learning is utilizing advanced technologies to customize educational content for each student. By adjusting the pacing of lessons, AI ensures that students learn at a speed that suits their individual progress. It provides real-time feedback tailored to the unique needs, preferences, and cognitive abilities of each learner, enhancing their overall educational experience. This transformation holds great promise in significantly enhancing student engagement. By providing personalized content and immediate feedback, it encourages deeper involvement, motivating students to take an active role in their education. Additionally, this shift has the potential to improve academic performance by addressing individual learning needs. Ultimately, AI-powered personalized learning systems foster a more engaging, adaptive, and efficient educational environment. However, the widespread application of AI in education presents challenges, including ethical concerns like personal data privacy or security issues. The synthesis of the literature review reveals that there is a need for guidelines for responsible AI implementation in education. With careful planning and ethical consideration, AI can significantly enhance educational outcomes, offering a more inclusive and smart learning environment for diverse student populations.
Keywords: artificial intelligence; personalized learning; educational technology; learning analytics; adaptive systems.

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1 INTRODUCTION

Artificial Intelligence (AI) has slowly integrated into our everyday lives, transforming from a distant idea into a fundamental component of contemporary society. It has now permeated various sectors, including healthcare, finance, entertainment, and education and AI systems have become embedded in everyday activities, making tasks more convenient and efficient. As AI continues to improve and expand, its presence in our lives is becoming increasingly ubiquitous, shaping the way we interact with technology.

AI is playing a crucial role in advancing technologies in the field of education. Conventional

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education methods typically follow a standardized, one-size-fits-all model, where the same curriculum and teaching strategy are applied uniformly to all students. Together with the developments, learners need more flexibility, immediate feedback and more individualized teaching methods. AI-enhanced educational technology is transforming the foundation of the teaching and learning experience by reshaping conventional pedagogical paradigms. From online platforms and interactive tools to virtual reality applications, AI is redefining possibilities and driving the creation of innovative resources that go beyond the traditional classroom settings.

To understand the impact of AI on personalized learning, it is necessary to first address these two concepts. AI, a field of computer science dedicated to creating intelligent machines. This field involves the replication of human cognitive abilities in machines designed to perform tasks that usually require human intelligence, such as learning, reasoning, problem-solving, and decision-making (Frank, 2024). Personalized learning is an approach where educational materials are tailored to students' individual learning styles, interests, and pace (Siemens, 2013). AI is a critical tool in automating this process, the role of AI in this process spans a wide range from customizing learning materials to monitoring student performance.

AI-based systems analyze learning perceptions, optimize content, collect student data, monitor each student's progress, and make content recommendations accordingly (Ayeni, et al., 2024). AI is being implemented across various educational domains, with a strong emphasis on personalized learning, automated assessments, and student monitoring systems. AI-powered learning platforms are capable of delivering customized learning resources, offering solutions that address the specific needs of each student.

AI leverages technologies such as data mining, machine learning, and natural language processing to assess student requirements (Baker, 2019). The success of these systems is directly tied to enhancing the pace of learning and improving student satisfaction. A study by Siemens and Long (2011), underscores the pivotal role of learning analytics in enhancing student performance. Given the rapid advancements in AI technology and its growing role in various educational settings, understanding its impact on personalized learning is crucial for educators, policymakers, and institutions alike. This research seeks to explore the potential of AI in reshaping educational practices by conducting a comprehensive literature review.

2 METHODS

This study was conducted using a qualitative literature review method that aims to systematically analyze the information in the literature on AI-enhanced personalized learning. A literature review provides a comprehensive review of existing studies in a specific academic field and reveals trends in the field. Up-to-date and scientific resources were accessed in line with key concepts and citations compatible with the scope of the study were included.

A comprehensive framework was created regarding the current status of AI-enhanced personalized learning, its application areas, technologies used, and pedagogical approaches. Through synthesizing existing studies and findings, the research aims to critically examine the various applications of AI in personalized learning, assess its effectiveness, and identify challenges and opportunities for future implementation. This method allows for a broad and nuanced understanding of the current state of AI-enhanced education while providing a foundation for further empirical investigations in the field.

There are also some limitations to the study. The study does not include findings obtained from applied studies based on direct experience. Therefore, it limits more in-depth analyses of real user experiences of AI-enhanced personalized learning systems.

3 RESULTS AND DISCUSSION

3.1 AI-Powered Personalized Learning Systems

3.1.1 Adaptive Learning Systems

The idea that led to the emergence of the concept of adaptive learning is that each individual comes from different backgrounds so learning preferences and cognitive abilities of learners are varied. In traditional learning environment, identical content and activities are delivered to all learners without considering their unique characteristics and needs. The same learning processes are applied to all learners with an understanding of "one-size-fits-all" (Gligorea, et al., 2023).

Adaptive learning systems represent a significant breakthrough in AI-driven personalized education, fundamentally transforming the way students engage with learning material. These advanced systems are meticulously designed to adjust not only the content but also the pace of learning to accommodate the unique needs and abilities of each individual student, thereby offering a much more tailored and individualized educational experience. By continuously analyzing vast amounts of student data, including performance metrics, behavior patterns, and progress, these systems dynamically modify learning content, ensuring that students receive the most relevant and effective instructional material at the optimal time. Through this real-time adaptation, adaptive learning systems help create a more efficient and personalized learning environment, enhancing both comprehension and retention by catering to each student's specific learning journey (Papamitsiou & Economides, 2014).

The defining characteristic of adaptive learning is its ability to continuously adjust based on real-time analysis of student performance. AI algorithms track and analyze how students interact with educational content, identifying patterns and behaviors that help shape personalized learning pathways. By monitoring these interactions, the system gains insights into each student's strengths and weaknesses, enabling it to tailor content to better meet their needs. One of the most impactful aspects of adaptive learning is its capacity to offer immediate feedback to learners (Mahmoud & Sørensen, 2024).

As students progress through lessons, the system can quickly detect areas of difficulty and provide on-the-spot guidance, ensuring that no student falls behind. For instance, if a student is struggling with a particular concept, the system can modify the difficulty level of subsequent tasks or offer additional resources, such as videos, tutorials, or alternative explanations, to help reinforce the material. This dynamic and responsive approach not only supports students in overcoming challenges but also keeps them engaged and motivated by ensuring that the learning process remains both achievable and stimulating (Mahmoud & Sørensen, 2024).

3.1.2 Intelligent Tutoring Systems

Intelligent Tutoring Systems (ITS) mimic the personalized guidance of a human tutor by offering tailored support and feedback as students engage with educational content. Unlike traditional computer-assisted instruction, ITS are more interactive and adaptive, simulating one-on-one tutoring experiences. The system monitors how students solve problems, identifies their mistakes, and tracks areas of struggle. It then provides real-time feedback, modifies task difficulty, and offers hints or explanations to help students overcome challenges (Mahmoud & Sørensen, 2024).

AI Teacher Assistants and Chatbots are AI powered applications that interact with students, answer questions, and provide guidance (D'Mello & Graesser, 2015). These systems can help students fill in gaps by instantly intervening in their learning process. For example, a study by Woolf (2010) showed that AI teacher assistants can increase student achievement by 15%.

3.1.3 Learning Analytics

Learning analytics involves gathering and analyzing large sets of data on student performance, behavior, and interactions with educational materials. It aims to provide instant feedback to teachers and students by analyzing students' behavior and performance. To increase

efficiency in education, AI systems need to constantly collect and analyze data, as a result, this technology makes the education process more dynamic (Baker & Siemens, 2014).

This data-driven approach enables educators and administrators to gain a more comprehensive understanding of the learning process. By analyzing student data, it helps identify trends, patterns, and potential issues that might not be apparent through traditional assessments. The insights gained from learning analytics can be invaluable in guiding instructional decisions. For example, they can help pinpoint students who are at risk of falling behind, allowing educators to intervene proactively. Additionally, learning analytics can suggest targeted interventions and adjustments to the curriculum to better meet the needs of individual students, ensuring more effective learning experiences (Mahmoud & Sørensen, 2024).

3.1.4 Natural Language Processing

Natural Language Processing (NLP) is a critical field within AI that focuses on enabling computers to interact with human language. NLP technologies allow machines to comprehend, interpret, and generate language in ways that are both meaningful and contextually appropriate. In education, NLP is applied in tools like automated essay grading, language translation services, and virtual assistants. These technologies offer immediate feedback on written work, aid language learning through real-time translations, and help students with questions, thus improving communication and learning effectiveness (Frank, 2024).

3.2 Advantages Of AI-Based Learning Systems

AI-based learning systems offer numerous advantages that are reshaping the landscape of education. Primarily, these systems provide personalized learning experiences that adapt to the individual needs, preferences, and learning paces of students. Unlike traditional methods, AI-driven platforms can offer real-time feedback, track student progress, and adjust instructional content. These features make AI-based learning systems an invaluable tool in diverse educational settings.

3.2.1. Student-Centered Learning and Flexibility

Compared to traditional learning experiences, AI-supported systems offer students more flexibility and freedom. Students can progress their learning process at their own pace and in the way they want, spend more time on some topics, repeat as much as they want, or do not spend much time on topics they know. AI-supported systems do not only provide students with theoretical information, but also provide practical and interactive learning experiences.

There is a student-centered learning experience in AI systems, the student has control over their own learning process. Prensky (2001) states that student-centered learning allows students to participate more in the learning process and understand more deeply. Students can access teaching materials whenever they need and customize their own learning processes.

Besides, AI systems can make accessing information easier for students. Students can access information resources from wherever they are. In particular, these systems can make the learning process more accessible for disadvantaged groups. For example, AI-supported systems developed for disabled individuals make the learning process more comfortable.

3.2.2 Enhanced Student Engagement and Improved Academic Success

Personalized learning makes the learning process more effective by allowing students to learn at different speeds and with different learning styles. AI can make the learning process more efficient by developing materials that suit each student's learning style (Kaswan et al., 2024). Personalized learning can play a critical role in increasing students' motivation to learn. As Anderson and Krathwohl (2001) demonstrated, students become more engaged when they encounter materials that address their individual needs, which strengthens their motivation to learn.

This personalized approach helps target specific learning gaps while strengthening areas of proficiency, ultimately contributing to improved academic performance. By providing students with challenges and support suited to their abilities, they are more likely to reach their full potential and show enhanced learning results (Frank, 2024). In other words, providing content customized to students' learning pace, level, and learning style can increase their academic success (VanLehn, 2011). Several studies have shown that personalized learning environments increase

student motivation and enable more active participation in the learning process (Baker, 2019; Cesiah, 2024).

3.2.3 Data-driven and Immediate Feedback

AI systems are able to give prompt feedback on students' performance. Conversely, in traditional education, students have to wait for the teacher to evaluate them to get feedback on what they did wrong. However, AI-based learning systems instantly detect the mistakes students make and offer them the right solutions, which enables learners to see their strengths and weaknesses and promote a more efficient learning environment.

This immediate personalized feedback on assignments also highlight the areas that need improvement. This instant feedback enables students to make ongoing adjustments and refine their learning process, rather than having to wait for periodic evaluations from teachers (Frank, 2024). Also the feedback given by AI systems is based on data, AI systems analyze student performance, and thus, their strengths and weaknesses can be determined more clearly (Spector, 2017). They offer personalized suggestions to students to improve their performance. Studies show that personalized feedback accelerates learning processes (Heffernan & Heffernan, 2014).

Students' being able to control their own learning process also provides them with flexibility in terms of time management. They gain the freedom to decide what and how much time they will spend on the learning process. Students can also become masters in using time effectively.

3.3 Challenges and Limitations of AI-Based Learning

Although AI has a significant impact on education, it faces some challenges. While personalized learning applications in education take into account the unique needs of students, some students may not find AI systems interactive and empathetic enough. There may be resistance or prejudice against technology-based learning tools. In such a case, teacher guidance or support is needed for students to adapt to AI systems and use them effectively. Students' emotional and social development is as important as their academic development. In this respect, AI systems may not contribute enough to the desired development. For this reason, the use of AI systems with the guidance and guidance of a teacher can provide much more efficient results for the student's academic and personal development.

In order to use these technologies effectively, teachers need to have the necessary knowledge and skills. Teachers' competence in AI technologies is important. When teachers have sufficient knowledge about these systems and sufficient skills on how to integrate them into their classes, they can manage teaching and learning processes effectively. However, if teachers do not understand AI systems, the effects of these systems on education will be limited. In such a case, teachers need to be given comprehensive training on how to integrate AI tools into their classes. Teachers' mastery of technology is of great importance for the successful implementation of personalized learning. Frank (2024), points out that providing teachers with proper training and ongoing support is essential for the successful adoption and effective use of AI in educational environments.

AI-supported personalized learning applications require technological infrastructure and internet access. However, the technological infrastructures of countries around the world are not equal. In some developing geographies, students have no or limited access to technological devices and AI-supported resources. Kubilay (2021), draws attention to inequality in education at this point in her study on the digital gap, especially disadvantaged groups have limited access to digital learning opportunities. In this case, while students in developed regions can access such applications more easily, students in developing regions may be deprived of these opportunities. This situation may deepen inequality in education.

While AI holds great promise for enhancing personalized learning in education, it also brings forth challenges that must be carefully managed. Ethical issues, such as data privacy and algorithmic bias, require the implementation of strong policies and safeguards (Frank, 2024). In an era where the importance of protecting personal data is increasing, another risk that can be created by the use of AI systems is the security concerns that may be experienced during the collection, storage and analysis of student data. A weakness in privacy and security can create troublesome

situations for the student. For this reason, AI systems may need to be developed in order to keep personal data confidential and secure.

In addition, data quality and accuracy are also important issues. The effectiveness of AI-supported personalized learning systems largely depends on the accuracy and quality of the data collected. However, it may not always be possible to collect and analyze student data correctly. Incorrect or incomplete data can lead to erroneous results in personalized learning processes. The accuracy of data directly affects the decision-making processes of AI systems. Such errors can negatively affect students' learning experiences.

4 CONCLUSIONS AND FURTHER RESEARCH

AI tools can tailor learning programs to meet the specific needs, interests, and learning styles of individual students, enhancing engagement and boosting academic performance. AI-driven personalized learning offers a dynamic and customized content that best fits to the learner's profile. AI tools allow learners progress at their own pace and develop expertise in various areas. Adaptive content and assessment, instant feedback, flexibility and freedom help learners experience more meaningful and effective learning process.

AI-based learning has the potential to enhance inclusive education by providing personalized learning experiences to those with disabilities or learning difficulties. This level of personalization helps to bridge gaps for students who may struggle with traditional one-size-fits-all teaching methods. Moreover, AI can assist in breaking down physical and cognitive barriers to education by offering accessible learning platforms for students with special needs, such as those with visual, auditory, or motor impairments. In doing so, AI not only fosters a more inclusive learning environment but also promotes educational equity, ensuring that all students, regardless of their backgrounds or abilities, have the opportunity to thrive.

Despite all these advantages, it would not be right to ignore the risks that AI-based learning systems bring. It is crucial to acknowledge the ethical concerns such as data privacy and security, algorithmic bias and data accuracy. In addition to ethical concerns, factors such as the characteristics of the student's social environment, the economic level of the country s/he lives in, and her/his proximity or distance to technology also affect the accessibleness of AI-based educational applications. In order to increase the effectiveness of these technologies, students' emotional and social learning needs must also be taken into account. It should be noted that human interaction is an important part of the learning process. While AI-based systems can assist students with learning materials and content, teachers' guidance is needed in important areas such as emotional and social skills. The student's social support during the learning process and studying with a teacher who has a developed sense of empathy will improve the process. Therefore, it would not be right to ignore the power of interaction between individuals during the learning process.

As the field of AI continues to advance, it becomes increasingly important for researchers, educators, practitioners, and policymakers to work together in developing comprehensive best practices and exchange them. Clear guidelines can be developed cooperatively to robust ethical frameworks. These efforts are crucial in ensuring the responsible, equitable, and transparent implementation of AI-based learning technologies. Collaborative action will help address the challenges of fairness, data privacy, and accessibility, while also fostering an environment where AI can be used to enhance educational outcomes for all learners. Establishing these standards will not only safeguard the integrity of educational systems but also promote trust in AI's role in shaping the learning.

As for future studies, priority can be given to studies that include user experiences and learning outcomes. The literature mostly includes data on the theoretical framework of AI-supported learning processes such as the designs, advantages and difficulties of learning processes. Experimental studies can be conducted to compare the learning experiences of students who are included and not included in the personalized learning processes. Similarly, the impact of AI-supported individualized learning systems in the learning process of different age groups or in

the teaching of different disciplines can be investigated. In this context, studies can be conducted to examine the pedagogical effects of AI-supported systems that include multi-user interactions.

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Севда Угур. Нова парадигма в освіті: персоналізоване навчання на основі штучного інтелекту. Важливість штучного інтелекту (ШІ) у сучасному світі важко переоцінити, оскільки він став трансформаційною силою практично у кожній сфері суспільства. ШІ знаходить все більше застосувань у освітній галузі, перетворюючи традиційні методи навчання на більш персоналізовані та адаптивні. Ця стаття пропонує глибоке дослідження ролі ШІ в освітньому секторі, акцентуючи увагу на значенні персоналізованого навчання та ролі освітніх технологій. ШІ у персоналізованому навчанні використовує передові технології для створення індивідуального освітнього контенту для кожного студента. Шляхом регулювання темпу уроків, ШІ забезпечує навчання з урахуванням індивідуального прогресу кожного учня, надає зворотний зв'язок у реальному часі, адаптований до унікальних потреб, вподобань і когнітивних здібностей кожного

навчальника, покращуючи їх загальний освітній досвід. Ця трансформація збільшує залученість студентів, надаючи персоналізований контент та миттєвий зворотний зв'язок, що стимулює більшу залученість і мотивує студентів брати активну участь у своєму навчанні. Крім того, ШІ має потенціал покращити академічні результати, враховуючи індивідуальні потреби в навчанні. Системи персоналізованого навчання, з застосування ШІ, сприяють більш залученому, адаптивному та ефективному освітньому середовищу. Однак широке впровадження ШІ в освіту ставить перед собою виклики, включаючи етичні питання. Стаття досліджує потенційні переваги та виклики систем персоналізованого навчання, підсилені ШІ, підкреслюючи потребу в рекомендаціях щодо відповідальної реалізації ШІ в освіті. Дослідження показують, що за умови ретельного планування та етичного урахування ШІ може значно покращити освітні результати, пропонуючи більш інклюзивне та ефективне освітнє середовище для різноманітних студентських аудиторій.

Ключові слова: штучний інтелект; персоналізоване навчання; освітні технології; аналітика навчання.