

AI Tools in Personalized Learning for Secondary Classes

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Abstract

This research explores the significance of Artificial Intelligence (AI) in personalized learning and its potential to revolutionize educational practices. In the age of digital transformation, AI offers the ability to tailor learning experiences to the unique needs and preferences of individual learners, thereby optimizing engagement and knowledge retention. By examining the utilization of diverse AI algorithms within various platforms and tools, such as Adaptive Learning Platforms and Intelligent Tutoring Systems, this study demonstrates the efficacy of AI-driven personalized learning systems in improving educational outcomes, increasing student motivation, and fostering self-directed learning. This is achieved through a comprehensive analysis of existing literature and seeking answers for the following questions: Can secondary teachers depend on AI tools as educational resources for personalized learning? To what extent can AI tools replace secondary teachers' roles? The aim is to determine the importance of AI tools in personalized learning for secondary classes and facilitate educators' missions in secondary schools. The study employs a qualitative analysis for a focus group discussion that reflects the growing importance of AI in education. The research results underscore the imperative for educational institutions to adapt to this evolving landscape, ensuring that learners of all backgrounds benefit from the potential of personalized AI-driven education. It also reveals how considerably the educational experience can be improved by AI-driven personalized learning systems. Furthermore, the acceptance of AI by educators and students alike, as well as the readiness of educational institutions, are critical to its successful incorporation in personalized learning settings.

Keywords

AI tools; personalized learning; educational resources; AI-Enhanced Educational Apps; EdTech

Résumé

Cette recherche explore l'importance de l'intelligence artificielle (IA) dans l'apprentissage personnalisé et son potentiel à révolutionner les pratiques éducatives. À l'ère de la transformation numérique, l'IA offre la possibilité d'adapter les expériences d'apprentissage aux besoins et aux préférences uniques des apprenants, optimisant ainsi l'engagement et la rétention des connaissances. En examinant l'utilisation de divers algorithmes d'IA au sein de diverses plateformes et outils, comme les plateformes d'apprentissage adaptatif et les systèmes de tutorat intelligents, cette étude démontre l'efficacité des systèmes d'apprentissage personnalisés axés sur l'IA pour améliorer les résultats scolaires, accroître la motivation des étudiants et favoriser l'apprentissage autonome. Pour ce faire, une analyse exhaustive de la littérature existante est effectuée et des réponses sont recherchées aux questions suivantes : les enseignants du secondaire peuvent-ils s'appuyer sur les outils de l'IA en tant que ressources éducatives pour un apprentissage personnalisé ? Dans quelle mesure les outils de l'IA peuvent-ils remplacer les rôles des enseignants du secondaire ? L'objectif est de déterminer l'importance des outils de l'IA dans l'apprentissage personnalisé pour les classes du secondaire et de faciliter les missions des éducateurs dans les écoles secondaires. L'étude utilise une analyse qualitative pour une discussion de groupe qui reflète l'importance croissante de l'IA dans l'éducation. Les résultats de la recherche soulignent l'impératif pour les établissements d'enseignement de s'adapter à ce paysage en évolution, en veillant à ce que les apprenants de tous les milieux bénéficient du potentiel d'une éducation personnalisée axée sur l'IA. Il révèle également à quel point l'expérience éducative peut être considérablement améliorée par des systèmes d'apprentissage personnalisés pilotés par l'IA. En outre, l'acceptation de l'IA par les éducateurs et les étudiants, ainsi que la préparation des établissements d'enseignement, sont essentielles à son intégration réussie dans des environnements d'apprentissage personnalisés.

Mots-clés

Outils d'IA; apprentissage personnalisé; ressources éducatives; applications éducatives améliorées par l'IA, EdTech

المستخلص

يستكشف هذا البحث أهمية الذكاء الاصطناعي (AI) في التعلم الشخصي وإمكاناته لإحداث ثورة في الممارسات التعليمية. وفي عصر التحول الرقمي، يوفر الذكاء الاصطناعي القدرة على تكييف تجارب التعلم مع الاحتياجات والتفضيلات الفريدة للمتعلمين الأفراد، وبالتالي تحسين المشاركة والحفاظ على المعرفة. من خلال فحص استخدام خوارزميات الذكاء الاصطناعي المتنوعة ضمن منصات وأدوات مختلفة، مثل منصات التعلم التكيفي وأنظمة التعليم الذكي، توضح هذه الدراسة فعالية أنظمة التعلم الشخصية التي يقودها الذكاء الاصطناعي في تحسين النتائج التعليمية، وزيادة دافع الطلاب، وتعزيز التعلم الذاتي التوجيه. ويتحقق ذلك من خلال تحليل شامل للأدبيات الموجودة والبحث عن إجابات للأسئلة التالية: هل يمكن للمعلمين الثانويين الاعتماد على أدوات الذكاء الاصطناعي كموارد تعليمية للتعلم الشخصي؟ إلى أي مدى يمكن لأدوات الذكاء الاصطناعي أن تحل محل أدوار المعلمين الثانويين؟ والهدف من ذلك هو تحديد أهمية أدوات الذكاء الاصطناعي في التعلم الشخصي للصفوف الثانوية وتسهيل مهام المعلمين في المدارس الثانوية. تستخدم الدراسة تحليلاً نوعياً لمناقشة مجموعة تركيز تعكس الأهمية المتزايدة للذكاء الاصطناعي في التعليم. وتؤكد نتائج البحث على حتمية تكيف المؤسسات التعليمية مع هذا المشهد المتطور، وضمان إستفادة المتعلمين من جميع الخلفيات من إمكانات التعليم الشخصي الموجه بالذكاء الاصطناعي. كما يكشف عن مدى إمكانية تحسين التجربة التعليمية من خلال أنظمة التعليم الشخصية التي يحركها الذكاء الاصطناعي. وعلاوة على ذلك، فإن قبول المعلمين والطلاب على حد سواء الذكاء الاصطناعي، فضلاً عن استعداد المؤسسات التعليمية، أمر بالغ الأهمية لنجاح إدماجه في بيئة التعلم الشخصية.

كلمات مفتاحية

أدوات الذكاء الاصطناعي، التعلم الشخصي، الموارد التعليمية، التطبيقات التعليمية المحسنة للذكاء الاصطناعي، تكنولوجيا التربية

1. Introduction

As humans stand at the crossroads of technological evolution and educational advancement, the integration of Artificial Intelligence (AI) tools into the field of education represents a compelling avenue for exploration. This study seeks to unravel the intricate tapestry of AI's role in education, revealing its multifaceted impact on students and educators.

“AI has the potential to revolutionize the education” (Bojorquez & Martínez Vega, 2023). In recent years, the fusion of AI with education has emerged as a compelling force of change. The promise of AI lies in its capacity to adapt, personalize, and optimize the learning experience. It possesses the ability to cater to the unique needs, preferences, and aptitudes of individual learners, transcending the limitations of one-size-fits-all education.

UNESCO Director-General Audrey Azoulay (2023) states that AI is going to fundamentally alter education. From intelligent tutoring systems that provide real-time, personalized feedback to students, to natural language processing algorithms that enhance language learning, and from data-driven insights that inform instructional design to virtual classrooms that transcend geographical boundaries, we will scrutinize the manifold facets of AI's impact on education.

1-1 Definition of Terms

Artificial Intelligence (AI) Tools: LeCun (2022) states that AI is a wide spectrum of computer programs that can carry out activities that call for human intelligence.

AI-Enhanced Educational Tools: According to York (2023) the term "AI tools for students" refers to a variety of programs and technologies that make use of AI to facilitate, improve, or accelerate the academic process.

Personalized learning: “instruction in which the pace of learning and the instructional approach are optimized for the needs of each learner” (Zhou et al., 2022).

Open Educational Resources: “are teaching, learning, and research materials--digital or print that is in the public domain redistribution by others with limited or no restrictions” (Barrientos, 2023).

EdTech: “EdTech refers to hardware and software designed to enhance teacher-led learning in classrooms and improve students' education outcomes” (Frankenfield, 2022).

1-2 Problem statement

Despite the growing interest and adoption of AI-driven personalized learning systems in educational settings, there remains a significant gap in our understanding of their true effectiveness and impact on student learning outcomes. “Researchers unlock the potential of AI in education in an ethical, equitable, and safe manner” (Chen, 2023) reflecting the importance and the need of studying AI in the educational field. This research investigates the extent to which AI can tailor learning experiences to individual student needs, and the readiness of educators to embrace and integrate AI into their teaching practices.

1-3 Purpose

The purpose of conducting research in AI in personalized learning is to harness the potential of AI to revolutionize education. This study explores how AI can be effectively utilized in educational experiences to the unique needs and preferences of individual learners to enhance student engagement, boost learning outcomes, and promote self-directed learning.

1-4 Study Importance

“AI is revolutionizing the way today's businesses compete and operate.” (Harvard Business School, 2023). In an era marked by increasing diversity in learners' needs and technological advancements, AI in personalized learning offers a promising solution to address these challenges

effectively. This research provides valuable insights that can guide educators and technologists in harnessing AI's power to create a more adaptive education system, preparing learners for the demands of the future.

1-5 Research Questions and Hypothesis

AI-powered personalized learning systems have the potential to revolutionize how students engage with educational content, adapt to their unique learning styles, and, in turn, foster enhanced learning outcomes. This research aims to address two questions:

- i. Can secondary teachers depend on AI tools as educational resources for personalized learning?
- ii. To what extent can AI tools replace secondary teachers' roles?

And seeks to test the following hypothesis in AI-driven personalized learning:

AI tools are useful for providing personalized learning for secondary students.

2. Literature Review

In the digital age, education is going through a significant revolution. "Artificial Intelligence in Education has been around for over 60 years." (Hardman, 2023). The history of artificial intelligence in education is an intriguing one that has seen its use in a range of educational contexts, from conventional classrooms to online platforms. Here are some significant turning points in the history of AI in education:

Early Experiments (1960s - 1970s): The initial exploration of AI in education began in the 1960s and 1970s, with early programs like Dendral and SAM that aimed to tutor students and teach them complex subjects. "DENDRAL was an influential project in artificial intelligence (AI) of the

1960s, and the computer software expert system that it produced” (University et al., n.d.). Its main objective was to research how scientists create hypotheses and make discoveries.

Intelligent Tutoring Systems (ITS) (1980s - 1990s): The 1980s and 1990s saw the emergence of Intelligent Tutoring Systems, such as the Expert Mathematics System and ALGEBRA, which provided individualized instruction based on a student's performance. “The history of ITSs can be traced back to the early 1980s” (Nikolaj et al., 2016). “Intelligent Tutoring Systems, commonly known as ITSs, are computer programs designed to deliver individualized instruction and feedback to learners” (Intelligent Tutoring Systems: Enhancing Learning through AI | the Princeton Review, 2023).

Learning Management Systems (LMS) (1990s - 2000s): In the 1990s and 2000s, LMS like Blackboard and Moodle gained prominence, “Moodle launched in 2002 as a free, open-source alternative to Blackboard’s expensive but dominant proprietary software” (Lieberman, 2018), offering a digital platform for organizing and distributing educational content.

Adaptive Learning (2000s - Present): Adaptive learning platforms, such as Knewton and Dream Box, began to gain traction. These systems use AI to tailor instruction to individual learners, adapting to their strengths and weaknesses.

Massive Open Online Courses (MOOCs) (2010s - Present): MOOCs, such as Coursera and edX, have integrated AI for features like automated grading and personalized recommendations, making education accessible to a global audience.

Chatbots and Virtual Assistants (2010s - Present): Chatbots and virtual assistants like IBM's Watson and Duolingo's AI-driven language tutors have become increasingly prevalent, offering personalized support and feedback.

Data Analytics (2010s - Present): AI and data analytics are being used to analyze and interpret student performance data, providing insights that can inform instructional design and enhance learning outcomes.

Gamification and EdTech Startups (2010s - Present): The emergence of educational technology (EdTech) startups has brought AI into the realm of gamified learning, interactive lessons, and mobile apps that support personalized learning experiences.

Online Proctoring and Assessment (2010s - Present): AI is also being employed for remote proctoring of exams and assessments, ensuring the integrity of online testing.

Future Prospects (2020s and beyond): AI continues to evolve in education, with a growing focus on natural language processing, virtual reality, and augmented reality technologies to create immersive and engaging learning experiences.

The history of artificial intelligence in education demonstrates a persistent dedication to better teaching and learning through technology.

3. AI and Learning

With the development of AI technology, there has been an increased interest and application of personalized learning which adjusts educational experiences to each student's unique requirements, preferences, and learning styles. The application of AI in personalized learning is as follows:

3-1 Adaptive Learning Platforms

Adaptive learning platforms driven by AI are tools that examine student performance data, including test results, learning preferences, and interactions with instructional materials, to modify the learning process in real time. With the help of these systems, each student can receive a personalized learning route that includes recommendations for specific exercises, materials, and interventions.

3-2 Intelligent Tutoring Systems

Intelligent Tutoring Systems uses AI systems to simulate human tutors by giving students individualized education and feedback. These systems evaluate students' knowledge and abilities, spot misconceptions or comprehension gaps, and provide practice problems and explanations that are specifically designed to meet each student's needs.

3-3 Recommendation Systems

AI-driven recommendation systems make recommendations for appropriate learning materials, including books, videos, articles, and online courses, based on the interests, learning objectives, and previous interactions of the students. These systems link students with relevant learning materials using strategies like content-based filtering and collaborative filtering (To be illustrated in the next section).

3-4 Natural Language Processing

Chatbots and virtual assistants, two examples of language-based interactions made possible by NLP technologies, allow for individualized learning experiences. These AI-powered tools may hold discussions with students, respond to inquiries, offer clarifications, and provide advice based on each student's preferences and unique learning environment.

3-5 Data Analytics and Predictive Modeling

Large volumes of educational data, including student performance, behavior, and demographics, are analyzed using AI techniques like machine learning and data mining to find patterns, trends, and predictive insights. Educators can make data-driven decisions to enhance students' learning progress by using these insights to predict students' needs and understand their learning trajectories.

3-6 Personalized Content Creation

AI tools let tutors create tests and learning materials that are specific to the needs and interests of each student. These resources can provide worksheets, interactive multimedia content, and quizzes that are specifically tailored to the needs, interests, and skill levels of the users. The main AI algorithm used in these tools is Content-Based Filtering that will be defined in the next section.

3-7 Feedback and Assessment Automation

The processes of assigning grades, giving comments, and evaluating students' progress are all automated by AI algorithms. In order to promote learning and development, these systems can evaluate students' answers to open-ended questions, essays, or projects, point out their advantages and disadvantages, and provide tailored feedback.

3-8 AI Algorithm in Personalized learning

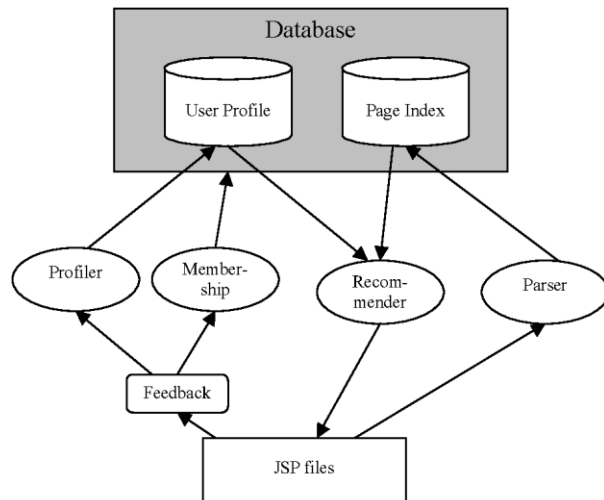
The previous mentioned AI platforms and tools uses multiple types of AI algorithms in the process of personalized learning to customize learning experiences for each student. Several well-known algorithms are as follows:

3-8-1 Collaborative Filtering

CF is the technique of evaluating or filtering objects based on the opinions of other individuals. The opinions of vast, networked groups are gathered by CF technology, which enables the filtering of significant amounts of data. To provide recommendations, this algorithm examines the behaviors and actions of individuals and offer suggestions. CF in personalized learning can recommend instructional materials based on the choices and outcomes of students with comparable learning profiles.

3-8-2 Content-Based Filtering

Figure 1. Database

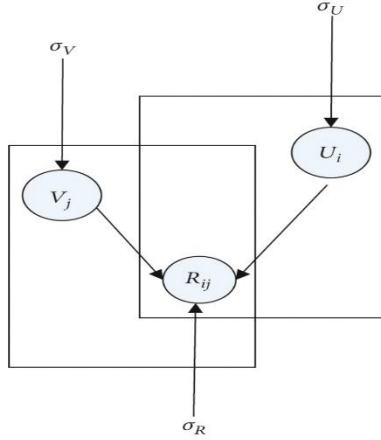


Meteren, R.V. (2000). Using Content-Based Filtering for Recommendation

In content-based recommendation systems, the user's interests are assessed based on the item's description and the user's rating of a small number of objects. After that, recommendations are made based on the assessment of the items that most closely match the user's preferences. This algorithm recommends educational materials for personalized learning based on the features of previously accessible or favorited resources for the learner.

3-8-3 Matrix Factorization

Figure 2. Matrix Factorization



The classic matrix factorization algorithm's flowchart

S. Bin, G. Sun, N. Cao et al., "Collaborative filtering recommendation algorithm based on multi-relationship social network," *Computers, Materials & Continua*, vol. 60, no. 2, pp. 659–674, 2019.

According to (Koren et al., 2009), matrix factorization can be used in personalized learning to predict students' responses to new educational resources and model their learning preferences.

3-8-4 Decision Trees

A decision tree is a tree-structured classification model that may be effectively induced from data and is simple to understand, even for non-expert users. This method was independently developed in the machine learning (Hunt, Marin, & Stone, 1966; Quinlan, 1983, 1986) and statistical (Breiman, Friedman, Olshen, & Stone, 1984; Kass, 1980) communities. A thorough overview of decision tree learning is available in Murthy (1998).

Decision trees can be used in personalized learning to identify suitable learning pathways or interventions by analyzing learning profiles and performance data for students.

3-8-5 Bayesian Networks

Bayesian network is introduced as a compact model that enables us to visualize structured systems (Pearl, 1988; Koller and Friedman, 2009). Variables are represented as the network's nodes and stand for the uncertain knowledge of a certain topic. In order to deliver personalized suggestions for students' academic success, Bayesian networks are able to capture the dependencies between students' attributes, learning habits, and academic outcomes in personalized learning.

3-8-6 Deep Learning

Deep learning is an artificial intelligence approach that utilizes many processing layers to progressively extract higher-level data properties. It is based on artificial neural networks (Modi et al., 2011; Zhang et al., 2018).

Deep learning algorithms can be used in personalized learning to forecast students' learning paths, examine how they interact with course materials, and provide tailored recommendations.

3-8-7 Reinforcement Learning

(RL) has the ability to fundamentally change how teachers assess students' progress and how students' approach and engage with learning in the educational setting. With the use of reinforcement learning (RL), learning may be personalized and made adaptive.

These algorithms serve as the cornerstone of AI-powered personalized learning systems, allowing teachers to create lessons that are specifically tailored to the needs and preferences of each student.

4. Methodology

4-1 Research Design and Data Collection Tool

Qualitative research method is adopted in this study. A data collection strategy centered solely around the use of a focus group. In this approach, a carefully selected group of participants, ten secondary science teachers, with relevant knowledge and experiences is brought together to engage in structured discussions. By utilizing open-ended questions and encouraging participants to share their thoughts, ideas, and experiences, the focus group of this study provided rich, in-depth insights into the current research.

4-2 Procedure

The current study conducted a focus group which is a systematic process aimed at gathering in-depth qualitative data through group interaction and discussion. First, the researcher defined the research objectives and addressed participants who possess relevant experiences and perspectives related to the study's concern. Then, the researcher designed a structured set of open-ended questions that will guide the discussion, encouraging participants to share their thoughts and experiences. Later, during the actual session, a facilitator guided the discussion, ensuring that all participants had an opportunity to express their views. At the same time, an observer took notes for later analysis.

4-3 Data Analysis

The transcribed data is carefully reviewed to identify recurring themes, patterns, and key concepts that emerged during the discussions involving the identification of themes, patterns, and unique insights that emerge from the discussion. The application of thematic analysis is utilized to recognize and examine recurrent topics throughout the focus group meetings. The focus group's results provided insightful qualitative information that deepened the comprehension of the research question and enhanced the overall study flow.

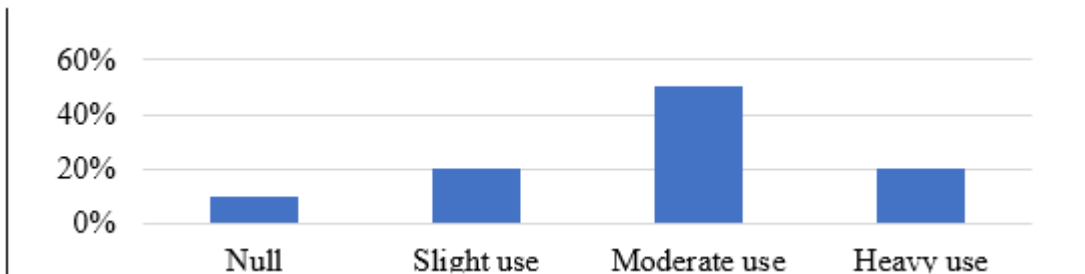
5. Findings

The focus group-guided questions are distributed among different divisions. Each of them focused on a specific theme. The first part was an introductory part, that introduced the participants.

Table 1. Participants Personal Information

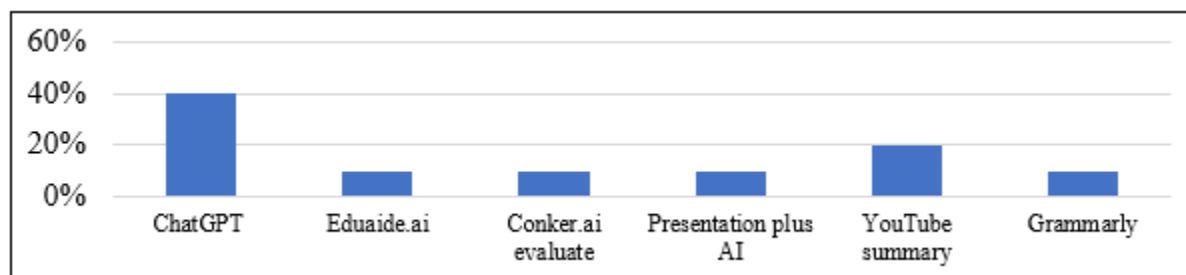
Participants	Years of experience in teaching (in years)				Gender		Subject		
	1 to 5	6 to 10	11 to 15	≥ 16	Female	Male	B	P	C
10	2	6	1	1	6	4	6	3	1

Figure 3. Experience with AI in Education



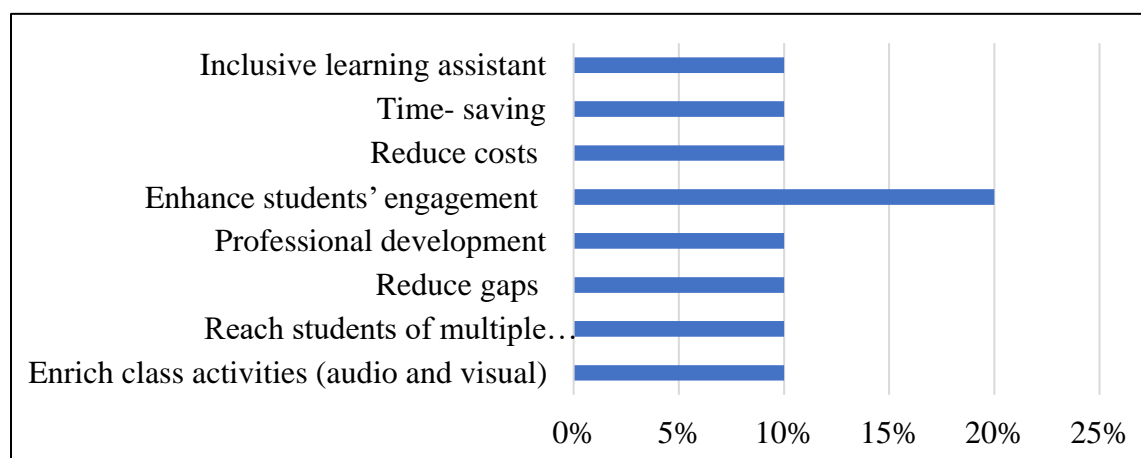
10% of teachers never dealt with AI in their career. 20% use AI slightly in their work. 50% use it as a support aid. However, 20% depend on it for completing their preparations.

Figure 4. AI Tools Currently Used in Education



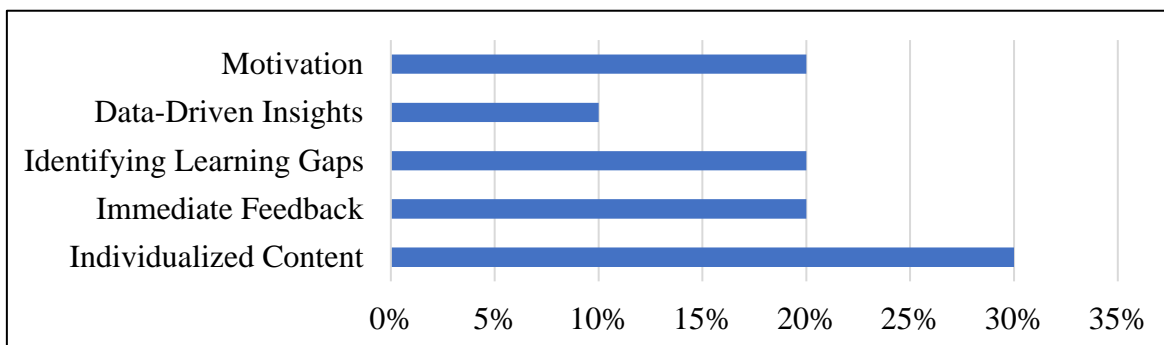
Teachers think that they can use different and multiple AI tools in their work for preparation, presentation, practice, and evaluation. 40% of them mention that ChatGPT is the most applicable tool for their work requirements.

Figure 5. Benefits of AI in Education



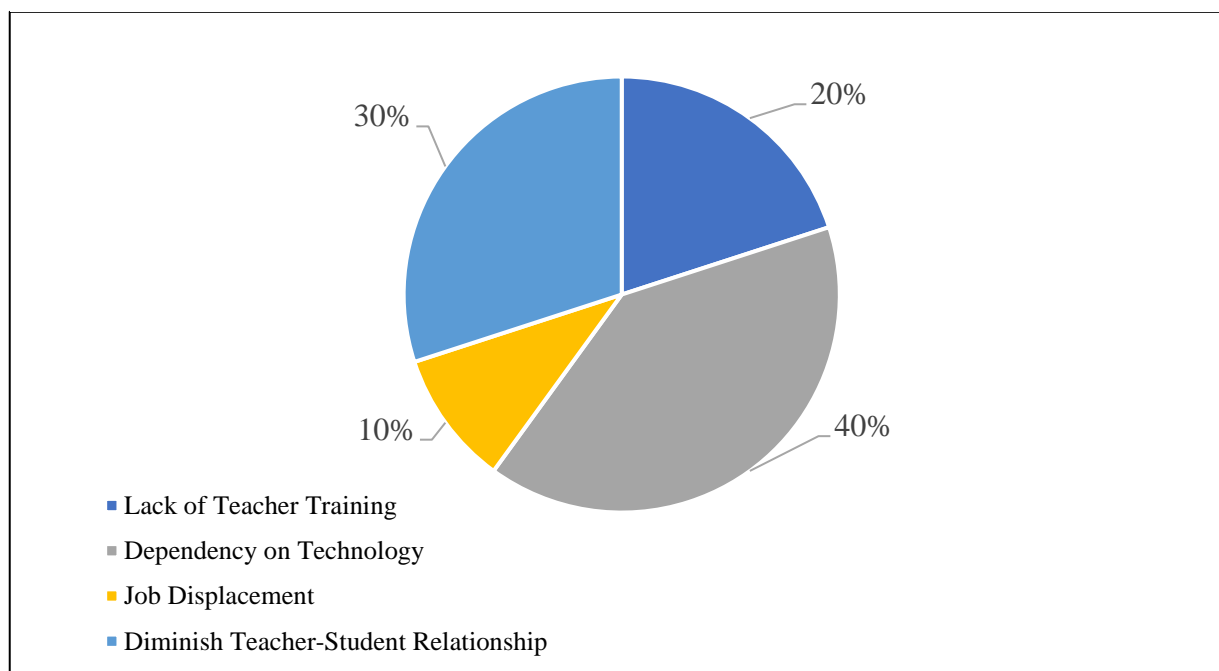
Teachers admit that AI can enrich class activities, reach students of multiple intelligences, reduce scientific gaps for learners, develop their professional development, enhance students' engagement, reduce costs, save time, and empower inclusive learning.

Figure 6. AI in Personalized Learning



Educators state that AI provides individualized content that ensures personalized learning. In addition to being a quick tool for grasping immediate feedback. Moreover, it identifies gaps quickly and provides teachers with the required insights.

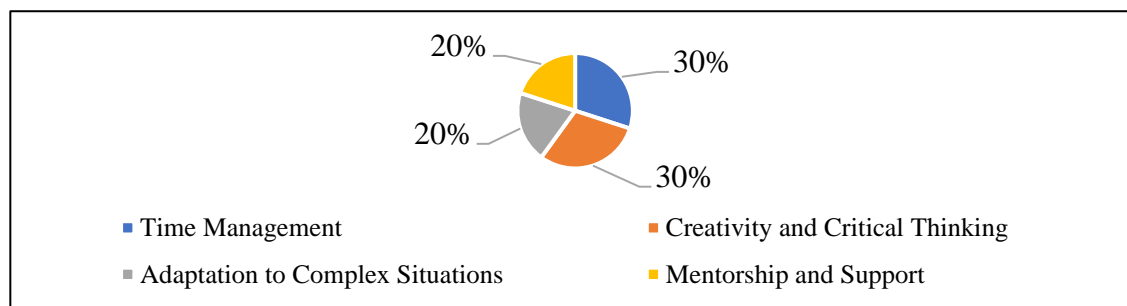
Figure 7. Challenges and Concerns



40% of the focus group educators worry about the full dependency on technology. And 30% of them are afraid of reducing the teacher-student relationship while using AI during the teaching-

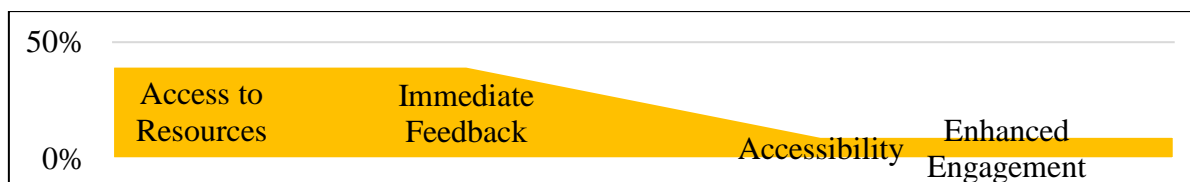
learning process. Where others have concerns related to the lack of teacher training 20% and job displacement 10%.

Figure 8. AI Impacts Teachers' Role



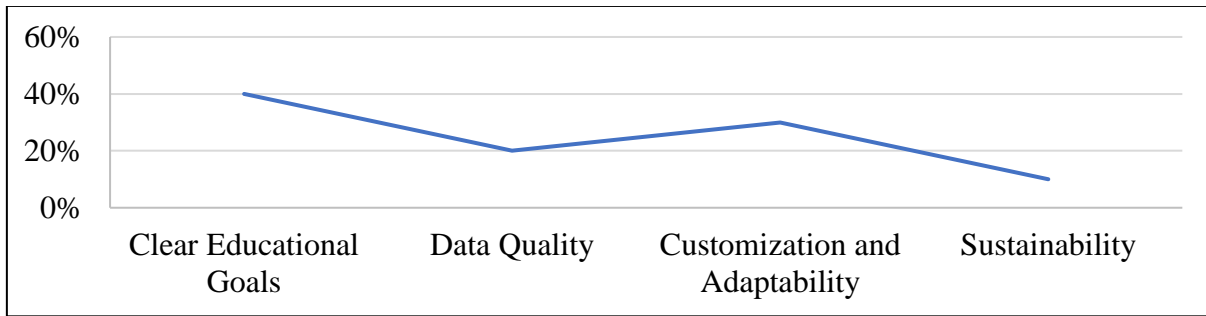
30% of teachers state that AI enhances educators' creativity and critical thinking by providing them with multiple resources to add their human touch to it. Similarly, 30% of them indicate that AI manages the time frame for the teaching-learning process. As well as 20% admit that AI has a role in support and adaptation to complex situations

Figure 9 AI Impact on Learning Experience from Students' Perspective



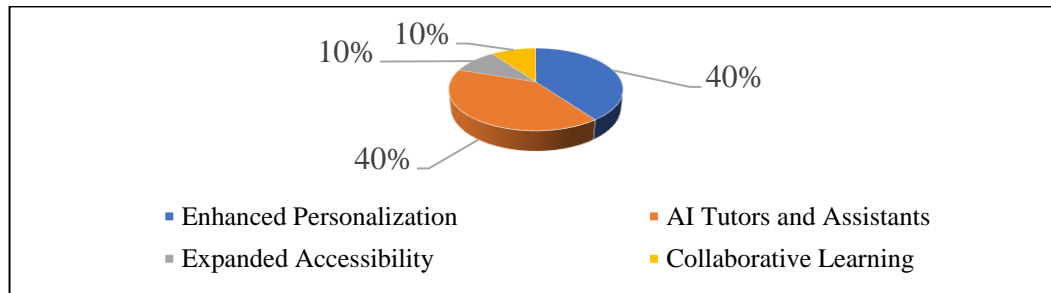
The focus group teachers find that 40% of their students have enough knowledge and skills to access AI resources and a similar percentage of 40% indicates the students benefit from the direct feedback that AI provides to them. However, 10% of them admit that students like to use AI tools while learning for its easy access. Finally, 10% focus on the engagement role that AI affords to learners.

Figure 10. Factors that influence the Successful Implementation of AI in Education



40% of teachers reveal that the educational goals should be clear before choosing any AI tool. 30% say that this implementation has to be customized. 20% indicate that it is a must to make sure of the data quality before adopting any AI tool in the educational process. And 10 % find that such tools must be sustainable to be successful.

Figure 11. The Role of AI in the Coming Years



40% of the teachers find that AI is going to enhance personalized learning. And the other 40% state that it is going to assist educators. While 10% mention that it is going to expand accessibility and same for collaborative learning.

Discussion and Conclusion

The incorporation of artificial intelligence (AI) has emerged as a transformative force in the quickly changing educational scene, promising to completely change how we teach and learn. The focus group is a flexible and useful method that academics have used to fully realize the promise of AI in education. This approach to qualitative research brings a variety of stakeholders together for controlled talks and the exchange of insightful information, including educators of different backgrounds. Focus groups enable a deeper comprehension of how AI technologies can be used to improve the educational experience.

The analysis of the findings reveals that AI tools are capable of enriching educators with multiple resources for utilizing in personalized learning for different learners of different backgrounds and needs. Also, such tools facilitate the work of educators by allowing them to track their different students' work in an organized way and in a short time. Thus, validating the importance of AI tools in personalized learning.

Conclusion

“AI in education is not about humanoid robots as a teacher to replace human teachers, but it is about using computer intelligence to help teachers and students and making the education system much better and effective” (Java T point, 2023). Our findings demonstrate that AI-driven personalized learning systems can significantly enhance the educational experience. Additionally, the successful integration of AI in personal learning environments depends on the readiness of educational institutions and the acceptance of both educators and learners. To realize the full benefits of AI for personal learning, ongoing research and development efforts must prioritize usability, accessibility, and transparency. Overall, as AI continues to evolve, it has the potential to revolutionize education by providing learners with tailored, data-driven experiences that empower them to reach their full potential.

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