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The Impact of Artificial Intelligence Applications on Enhancing the Quality of Secondary-Level Education: Perspectives of Teachers and Students aking Skills

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http://www.aun.edu.eg/faculty_education/arabic

نبذة عن البحث

يبحث هذا البحث في وجهات نظر المعلمين والطلاب حول دمج الذكاء الاصطناعي في التعليم الثانوي في المملكة العربية السعودية. تكشف الدراسة عن نظرة واعدة وإجماع قوي بين المجموعتين فيما يتعلق بفوائد الذكاء الاصطناعي في التعليم، مع التركيز على إمكانات الذكاء الاصطناعي لتعزيز التعلم الشخصي، وتحسين الأداء الأكاديمي، وزيادة إمكانية الوصول إلى الموارد التعليمية. ومع الاعتراف بهذه الجوانب الإيجابية، تسلط الدراسة الضوء أيضًا على المخاوف المتعلقة بخصوصية البيانات، وتدريب المعلمين، وموثوقية أنظمة الذكاء الاصطناعي. وتؤكد النتائج الحاجة إلى برامج تدريبية شاملة للاستفادة من الذكاء الاصطناعي بشكل فعال في التعليم. وتساهم الدراسة في الخطاب الناشئ حول الذكاء الاصطناعي في التعليم، مع التركيز على التآزر بين تكنولوجيا الذكاء الاصطناعي والاستراتيجيات الموجهة لتشكيل مستقبل التعليم. كما يقدم رؤى ذات صلة بالممارسات التعليمية ويسلط الضوء على ضرورة إجراء مزيد من البحوث لاستكشاف الإمكانات الكاملة للذكاء الاصطناعي في التعليم.

الكلمات المفتاحية: الذكاء الاصطناعي، التعليم، المرحلة الثانوية، المملكة العربية السعودية، التعلم الشخصي، الأداء الأكاديمي، الموارد التعليمية، تدريب المعلمين، موثوقية أنظمة الذكاء الاصطناعي.

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Abstract

This research investigates the perspectives of teachers and students on the integration of artificial intelligence (AI) in secondary-level education in Saudi Arabia. The study reveals a promising outlook and a strong consensus among both groups regarding the benefits of AI in education, emphasizing AI's potential to enhance personalized learning, improve academic performance, and increase accessibility to educational resources. While acknowledging these positive aspects, the study also highlights concerns related to data privacy, teacher training, and the reliability of AI systems. The findings underscore the need for comprehensive policies and training programs to leverage AI effectively in education. The study contributes to the emerging discourse on AI in education, emphasizing the synergy between AI technology and market-oriented strategies to shape the future of education. It also offers insights relevant to educational policy and practice and highlights the necessity for further research to explore the full potential of AI in education.

Keywords: Artificial Intelligence, Education, Secondary School, Saudi Arabia, Personalized Learning, Academic Performance, Educational Resources, Teacher Training, Reliability of AI Systems.

INTRODUCTION

In an era marked by technological advancement, artificial intelligence (AI) has emerged as a powerful force driving change in the education sector. The intersection of AI and education prevails as a compelling arena of innovation, offering multifaceted opportunities and challenges in the pursuit of enhancing the quality of education. Over the last decade, the increasing ubiquity of AI-based applications in educational settings has become more evident, ranging from AI-driven personalized learning systems and intelligent tutoring tools to automated assessments and administrative optimization (Hwang et al., 2020; Roll et al., 2018), necessitating a reevaluation of the fundamental principles underpinning education.

The AI-powered classroom is no longer a theoretical concept; it has become a tangible reality, with the potential to elevate student achievements by helping address some of the most pressing challenges in education today. Once confined to the realm of science fiction, AI applications and technologies have now permeated our classrooms, and are making a profound impact on how education is delivered and experienced, as well as influencing restructuring of institutions and systems (Içen, 2022). Moreover, with an increasingly tech-savvy generation of students and an ever-evolving landscape of educational methodologies, the integration of AI applications has grown exponentially. As our classrooms become increasingly digital, understanding the dynamics of AI's role in enhancing the quality of education becomes a crucial pursuit.

According to the UNESCO (2019), AI poses as a catalyst for innovative teaching and learning practices, founded on principles of inclusivity and equity, while simultaneously propelling progress towards Sustainable Development Goal 4. However, AI's transformative influence in education can be viewed through a dual prism: the benefits it offers to students and the advantages it provides to educators and educational institutions (Martínez-Comesaña et al., 2023). This scholarly endeavor embarked on a journey to examine the profound impact of AI on secondary-level education, as perceived by the key stakeholders: teachers and students. This endeavor necessitated exploring the evolving landscape of AI applications in education, investigating the multifaceted aspects of its integration, and uncovering the transformative potential of AI to reshape educational practices.

Artificial Intelligence in Education

Student focused benefits

The applications of AI in education are extensive, encompassing a range of educational elements and tools. For students, AI offers personalized learning, adaptive assessments, intelligent tutoring systems, automated grading, and the incorporation of virtual and augmented reality into the learning process (Beaulac and Rosenthal, 2019; Xu et al., 2019).

With respect to personalized learning, AI has the capability to personalize learning experiences for students. It allows students to learn at their own pace, receive insightful feedback, and correct errors based on their unique needs (Zafari et al., 2022). Intelligent Tutoring Systems (ITS), such as Domoscio's Spark (Domoscio , 2023), powered by AI have been instrumental in providing students with individualized content and step-by-step tutorials, making the learning process in subjects like

mathematics more enjoyable, and improving performance (Zafari et al., 2022). ITS are computer programs designed to provide personalized learning experiences to students, aiming to replicate the guidance and support of human teachers. In recent years, ITS has become more domain-specific, addressing particular subjects or topics, including mathematics, physics, and language learning (Holmes & Tuomi, 2022). Despite their limited domain, these systems have demonstrated effectiveness in delivering relevant content, engaging with students, and improving academic performance (Fang et al., 2019).

A systematic review of the literature by García-Martínez et al. (2023) underscores the profound impact of Educational AI (EAI) in promoting student-centered learning. EAI empowers students to take an active role in constructing their knowledge, resulting in meaningful and personalized learning experiences. Moreover, AI's capacity to understand and adapt to the unique needs of each student, empowers teachers to provide precise assistance when required, preventing any student from falling behind. This tailored support creates a dynamic and adaptive learning environment that is responsive to individual progress, ultimately benefitting both students and educators (García-Martínez et al. 2023; Lai et al., 2023). Many AI applications have also been repurposed to support students with learning disabilities, including dyslexia, ADHD, and dysgraphia (Mohd Ariffin et al., 2018) such as Huawei's StorySign (Huawei, 2021). Another company, "Lexplore," uses eye movement tracking to swiftly identify students at risk of dyslexia (Lexplore, 2023). Additionally, robots and AI tools have recently been increasingly used to assist children on the autism spectrum in educational settings (Alghamdi et al., 2023).

Additionally, EAI introduces pedagogical possibilities that encompass diverse modalities, including simulations, interactive flat-panel teaching, Virtual Reality (VR), Augmented Reality (AR), online learning platforms, and educational games (García-Martínez et al. 2023; Holmes et al., 2022; Lai et al., 2023). These multimodal approaches enhance the visual component of learning, offering students a dynamic and immersive educational experience, transcending the constraints of physical classrooms (Holmes et al., 2022; Lai et al., 2023). Through these channels, EAI allows education to transcend traditional, face-to-face methods, providing students with a flexible and accessible learning environment including in distance education (Holmes et al., 2022). Virtual reality, in particular, has revolutionized learning, creating global classrooms and connecting students from different parts of the world (Bonam et al., 2020; Chen, Xie et al., 2020). This modality is indispensable for individuals who must balance work and study, and it offers educators innovative avenues for teaching and guidance.

Moreover, AI-driven assessment and evaluation are revolutionizing how students are evaluated with increased potential for more accurate, rapid, and data-driven assessment, improving the efficiency of teachers (Lai et al., 2023; Zafari et al., 2022). It enables teachers to offer timely support to students, ensuring that no one falls behind, and streamlines routine assignments.

These applications have also transformed online education from a passive platform to an interactive and adaptive learning environment (Knox, 2020; Kuleto et al., 2021). The use of machine learning, learning analytics, and data mining technologies further augments the educational experience (Tlili et al., 2021). These technologies can provide recommendations for students' subject or university selection, help teachers assess students more efficiently, and enhance the administration

and generation of intelligent content (Chen et al., 2020; Chen et al., 2022). AI-driven chatbots are increasingly used in education to provide support and information to students. These chatbots offer guidance and answers to queries, making them valuable tools for enhancing student experiences. Recent literature has highlighted the advantages of educational chatbots, including in promoting critical thinking skills, reduced anxiety levels, memory retention, and improved language proficiency (Lin & Chang, 2020; Zahour et al., 2020).

An integral aspect of EAI's educational impact is its alignment with STEM (Science, Technology, Engineering, and Mathematics) teaching methodologies (Zafari et al., 2022). These methodologies leverage advanced tools and resources to enhance the teaching of diverse subjects. EAI becomes a catalyst for the creation of dynamic computational models that immerse students in high-visual and multimedia content (Vlachopoulos & Makri, 2017). The interactive nature of these tools facilitates a more profound understanding of subject matter.

The advent of AI in education has also resulted in what can be termed as the 'shadow education market,' where private supplementary tutoring is facilitated through automated smartphone apps and personal robot assistants (Williamson & Eynon, 2020). For instance, Pearson's AI tool, AIDA, guides students through complex subjects like calculus, providing step-by-step solutions (Chaudhry & Kazim, 2021; Williamson & Eynon, 2020). A growing number of AI-assisted apps are available, including language translation tools like DeepL Translate (DeepL, 2023) and mathematics apps such as Photomath (Photomath, 2023). However, concerns have arisen regarding whether these tools might replace the need for students to learn essential skills and concepts (Holmes & Tuomi, 2022).

Khanmigo, a product of Khan Academy, has set out to revolutionize education by offering students AI-powered support in their learning journey, gaining prominence since its launch in March 2023 (Xiaorong et al., 2023). Notably, Khanmigo is designed to provide assistance across diverse subjects, from mathematics to computer programming, thereby catering to a broad spectrum of educational needs (Khan Academy, 2023). A remarkable benefit of Khanmigo is its potential to enhance student learning and boost self-esteem (Xiaorong et al., 2023). Khanmigo can support students in understanding complex concepts, practicing vocabulary, preparing for exams, and even engaging in debates by offering personalized assistance equivalent to a thoughtful tutor (Khan Academy, 2023). Another commendable aspect of Khanmigo's approach is its encouragement of critical thinking. Rather than immediately marking students' responses as incorrect, Khanmigo seeks to understand students' reasoning (Xiaorong et al., 2023). This fosters a more collaborative learning environment, where students are prompted to explain their thought processes. Additionally, Khanmigo assists educators with administrative tasks and alleviating the burdens of educators, giving them more time to focus on instruction (Khan Academy, 2023).

Automatic formative assessment (AFA) and Automated Writing Evaluation (AWE) applications leverage AI to provide feedback on students' written assignments and outputs (Dizon & Gayed, 2021; Holmes & Tuomi, 2022). However, while these tools offer actionable feedback, they often lack the depth of interpretation and accuracy that human instructors provide. For instance, Grammarly, a widely used AWE tool, focuses on surface-level features of writing to offer suggestions for improvement effective in supporting EFL writing (Dizon & Gayed, 2021).

AI technology has also revolutionized the educational landscape by offering adaptive learning through natural language conversations. Dialogue-based tutoring systems (DBTS) foster in-depth understanding by simulating a tutorial dialogue between human tutors and students (Holmes & Tuomi, 2022). These systems use a Socratic tutoring principle, guiding students toward discovering solutions. AutoTutor, a popular DBTS, engages students in adaptive conversations in natural language, adjusting to their actions, verbal contributions, and emotions (Nye et al., 2014). This adaptability mirrors the responsiveness of human tutors, promoting a personalized learning experience (Graesser, 2016). Notably, AutoTutor achieves learning outcomes that match novice and expert human tutors. Through its intelligent dialogue patterns and tailored feedback, it effectively supports students in mastering complex subject, offering a unique opportunity for students to benefit from pedagogical strategies that may not be readily available through human tutoring (Graesser, 2016; Nye et al., 2014).

On the other hand, AI-powered social networking sites promote active learning, collaboration, and meaningful connections that help overcome the constraints of the traditional classroom (Akgun & Greenhow, 2021). These platforms facilitate meaningful interactions between students and educators, enhancing the learning experience (Kim et al., 2019). These platforms often incorporate features that enable students to participate in discussions, share resources, and collaborate on projects (Akgun & Greenhow, 2021). Exploiting these platforms, students become active participants in their education, which has been shown to enhance their understanding and retention of the material.

AI technology extends its benefits to academic libraries, improving accessibility for students, including those with disabilities. Real-time transcriptions, translations, and audio descriptions make library resources more accessible, while text-to-speech tools create audio versions of written materials (Wang et al., 2023). For teachers, this implies that a broader spectrum of resources can be made available to students, accommodating different learning styles and needs (Wang et al., 2023).

Teacher focused benefits

The implementation of AI in education has unlocked numerous possibilities for both instructors and students. For instructors, AI has the potential to streamline tasks, making teaching more efficient (Alam, 2021). With up to 40% of teaching time still dedicated to activities that could be automated, there is significant untapped potential for AI in education (Alam, 2021; Martínez-Comesaña et al., 2023).

One of the primary advantages of AI technology in education is its ability to reduce teachers' workloads. AI, particularly generative AI, has evolved to not only provide educational content but also engage with students (Xiaorong et al., 2023). This collaborative approach can be a game-changer for educators, provided that AI development remains controlled and supervised (Xiaorong et al., 2023). AI tutors, while capable of offering content, aim to serve as educational allies, helping students discover answers independently rather than providing all solutions. Teachers, therefore, face a shift in their roles, moving from traditional knowledge dissemination to becoming intellectual guides (Chaudhry & Kazim, 2021). As AI systems become more adept at understanding students' individual needs and interactions, teachers can focus on personalized support and mentorship. However, this shift in roles does not equate to replacing teachers (Chaudhry & Kazim, 2021;

Xiaorong et al., 2023). Rather, it redefines their roles, emphasizing a more individualized and collaborative approach. AI can aid teachers in understanding how each student interacts with the system, ensuring they receive personalized guidance. Additionally, students still require adult mentors to navigate social environments, fostering cooperation and emotional intelligence.

On the other hand, integrating AI technology in educational assessments enables the collection of vast datasets. As AI becomes more sophisticated, it presents the ability to provide real-time, data-driven insights. These insights are not limited to merely identifying correct or incorrect answers but extend to understanding the rationale behind a student's response. This granular view into the learning process enables teachers to gain a profound understanding of individual student's learning journeys (Chassignol et al., 2018). Moreover, AI-driven assessments are anchored in meaningful learning activities, including educational games and collaborative work, wherein every facet of learning is accurately analyzed (Chassignol et al., 2018). As a result, assessments evolve from the conventional rigid, time-bound tests to dynamic and contextual evaluations, better suited to the diverse learning paths of students.

Predictive analytics have also revolutionized educators' ability to support students effectively (Wang et al., 2023). Predictive analytics enable educators to intervene early when students are struggling by identifying patterns and trends in student behavior and performance (Wang et al., 2023). For instance, early warning systems can identify students at risk of falling behind or dropping out by analyzing data on attendance, grades, and course completion rates (Lee & Chung, 2019). This timely intervention can significantly improve students' chances of success (Wang et al., 2023).

The integration of AI in education is not confined to skills development but extends to the restructuring of the entire educational landscape. As Hans and Crasta (2019) highlight, education is evolving to adapt to the fourth revolution of the human experience, characterized by the pervasive presence of AI. This evolution entails shifts such as the adoption of digital learning and teaching materials, online enrollment and payment, virtual classrooms connecting students globally, and online examinations (Martínez-Comesaña et al., 2023). These adaptations promise to revolutionize the accessibility, reach, and efficiency of education, breaking down geographical barriers and offering an unprecedented level of inclusivity and flexibility.

Additionally, the use AI-based applications in education have delivered numerous possibilities for educators. AI tools, including Turnitin (Turnitin, 2023) and Grammarly's plagiarism checker (Grammarly, 2023), have become indispensable in addressing academic dishonesty. These tools employ machine learning to detect instances of plagiarism, thus supporting educators in maintaining academic integrity (Holmes & Tuomi, 2022). AI-driven automatic assessment tools, such as autograders and e-Rater, aim to streamline the grading process for teachers. These systems are employed in evaluating technical subjects, high-stakes exams, and written tasks, providing efficiency and accuracy in scoring (Schneider et al., 2022; Ramesh & Sanampudi, 2021).

In the context of online exams, teachers are increasingly adopting digital proctoring systems that employ various hardware for student monitoring, including webcams and microphones during examinations (Kurni et al., 2023). For this approach, the choice between human-based proctoring and fully digital Automated Invigilation Proctoring Systems (AIPS) depends on factors like the availability of resources, ethical considerations, and technical feasibility (Kurni et al., 2023; Nigam et al., 2021).

AI technology can also be leveraged to manage classroom activities effectively. Educational Recommender Systems (ERS) play a crucial role in enhancing the educational experience by assist educators in planning and resource filtering (Abdi et al., 2020; da Silva et al., 2022). Additionally, ERS systems provide personalized recommendations for both instructors and learners, improving pedagogical practices and academic performance (da Silva et al., 2022). However, challenges arise from matching user expectations with recommendations and accommodating the diversity of individual learning needs (Abdi et al., 2020). The variety of factors influencing the learning process complicates the task of creating a tailored learning experience (Marras et al., 2021).

Another promising advancement is AI's ability to curate learning materials based on individual students' preferences and progress (Owan et al., 2023). AI enhances educators' ability to access and manage educational resources. Yoon et al. (2022) note that AI serves as a reliable substitute for some human services in academic libraries. Educators can benefit from AI's ability to locate and provide pertinent resources rapidly, reducing time spent on resource discovery (Yoon et al., 2021). For instance, Smart Sparrow utilizes AI to generate customized learning materials tailored to students' specific needs and progress in subjects like biology (Smart Sparrow, 2023). Another prominent tool is X5GON (X5GON, 2023) automatically searches the web for learning and teaching resources based on a teacher’s queries. These materials can range from tailored lab scenarios to specialized content dependent on the learners’ interests and learning pace (Owan et al., 2023). Such tools not only save teachers time but also support diverse learning needs. The ability to adapt content to students' progress and interests enhances the teacher's capacity to address diverse learning styles (Owan et al., 2023).

AI technologies, including search and recommendation systems have also revolutionized how educators access resources in academic libraries (Wang et al., 2023; Yoon et al. 2021). Digitization of library collections through AI ensures accuracy and speed in retrieval, while minimizing the need for physical storage space and manual organization (Yoon et al. 2021). This efficiency leads to resource and time savings, enhancing the overall academic environment.

Administrative benefits

Educational institutions can also harness AI for multiple administrative tasks, including classroom scheduling, resource allocation, and student support services (Lai et al., 2023). AI supports the development of Intelligent Educational Management and Services (IEMS) that help streamline the management of educational institutions, ensuring a more efficient and responsive ecosystem (Lai et al., 2023). AI based technology also assists in tasks, including student clustering, content development, instructional design, grading, and curriculum sequencing and management, ultimately reducing the administrative burden on educators (Crompton & Burke, 2023).

A systematic review by Crompton and Burke (2023) reported that the highest percentage of AI use for administrative purposes is primarily in making predictions followed by admissions related activities. AI, in the form of Chatbots, plays a pivotal role in simplifying an automating admission procedures (Cui et al., 2017). These technology-driven virtual assistants engage with prospective students, providing information and answering queries round the clock (Ahmad et al., 2022; Cui et al., 2017). Chatbots efficiently guide applicants and reduce the workload on admission staff by leveraging keyword and string similarity algorithms (Ahmad et al., 2022).

Challenges

Amid these existing benefits and promising prospects, the integration of AI in education also raises numerous concerns. One of the leading concerns relates to privacy as students may perceive data collection and analysis, a basis of AI technology, as a breach of privacy, akin to the Facebook–Cambridge Analytica scandal (Chan, 2019). Moreover, the possibility for data and algorithmic bias looms as a significant concern, as AI systems that fail to account for these risks can be seen as discriminatory (Crawford & Calo, 2016). The incorporation of AI in educational settings also extends to areas where it may encroach upon personal boundaries, such as the measurement of unconscious behaviors like facial expressions and eye tracking such as the case of Lexplore (Lexplore, 2023) and other tracking software. While such systems promise to enhance the connection between students and instructors, students may view them as intrusive (Seo et al., 2021). The concern arises that students' unconscious behaviors may be misinterpreted or oversimplified, creating discomfort and complications in social interactions. This narrative is consonant with broader concerns surrounding AI, facial recognition, and privacy (Stark, 2019).

Additionally, the adoption of Generative AI like GPT-4, while promising, also raises concerns. These AI systems are not infallible and may sometimes generate incorrect information (Xiaorong et al., 2023). To mitigate this, leading applications like Khanmigo's basis its interactions with students primarily on Khan Academy's trusted information sources, reducing the likelihood of propagating erroneous content (Khan Academy, 2023).

Moreover, a substantial amount oof teachers lack sufficient skills to harness the full potential of AIEd, that requires specific skills for specific applications. Firstly, they need to become technologically proficient, enabling them to understand, evaluate, and adapt new educational technology tools (Chaudhry & Kazim, 2021). While they may not use every tool, it is crucial for teachers to comprehend the functionalities and potential benefits of these tools. For instance, tools like Zoom have played a pivotal role in remote teaching during the pandemic. Teachers must not only be able to schedule lessons on such platforms but should also be capable of harnessing advanced features like breakout rooms for group work and the Whiteboard for interactive writing, allowing enriched learning experiences (Chaudhry & Kazim, 2021). Secondly, teachers must develop analytical skills to interpret the data generated by these ed-tech tools (Chaudhry & Kazim, 2021). Equipped with such skills, teachers can collaborate more effectively with ed-tech tools, ultimately reducing their workload by gaining insights into learner data and recognizing their specific needs.

On the other hand, instructors have their reservations relating to AIEd. They worry that excessive reliance on AI systems might diminish students' ability to think independently, solve problems creatively, and engage in critical thinking (Wogu et al., 2018). Moreover, some AI systems, while improving instructional communication, pose challenges when students are held responsible for AI-generated answers that are often inexplicable or unreliable (Castelvecchi, 2016). The black-box nature of AI responses leaves students in a precarious position, with AI's unreliability potentially leading to grading disputes. To address these issues, the concept of "explainability" has been proposed, offering human-understandable justifications for AI outputs (Gunning, 2017). Explainability emerges as a critical boundary determining students' trust and acceptance of AI systems, accentuating the importance of the human-AI partnership.

There are also concerns that, in its pursuit of personalized support, AI may over-standardize the learning process, potentially undermining students' agency and the exploration of new skills. This over-standardization may diminish opportunities for students to learn from their mistakes, raising concerns among instructors (Seo et al., 2021). Additionally, the increasing commercialization of AI in education can pose challenges. Corporations primarily focused on profit generation may prioritize business interests over educational goals (Lauterbach, 2019). The lack of transparency in proprietary systems and the potential monopolization of AI-driven education could influence governance and national policies (Lauterbach, 2019).

To address these concerns, data governance and regulations have emerged as essential factors in maintaining the ethical and responsible use of AI in education. The effective implementation of AI in education is dependent on the establishment of data governance, ensuring accessibility, security, and accuracy while respecting privacy rights (Owoc et al., 2019). Additionally, the utilization of AIEd demands ethical scrutiny, considering privacy concerns and the potential for false positives (Butler-Henderson & Crawford, 2020).

With the growing presence of AI in education, the need to comprehend its impact on the quality of education surfaces as a pivotal concern. It is crucial to ascertain to what extent AI applications and technologies influence the overall educational experience. While previous studies have examined the adoption of AI in education, including challenges, opportunities, and benefits, with some providing an overview of AI applications in education, most of these studies have concentrated on higher education or specific learning areas. However, there is a noticeable lack of research specifically targeting AI adoption in K-12 education, especially secondary school level education.

Consequently, this study seeks to determine the potential of AI in contributing to an improved quality of secondary education by shedding light on the dynamics of AI's influence on secondary-level education from the perspectives of educators and students. Insights from the research are aimed to serve as a valuable resource for educational policymakers, institutions, and researchers struggling with the integration of AI in education. The study was also aimed at providing a deeper understanding of the impact of AI applications on education quality and help validate the hypothesis that AI applications positively influence the quality of education.

The following research questions guided the study:

i. How do teachers perceive the impact of AI applications on the quality of secondary-level education?
ii. How do students perceive the influence of AI tools on their learning experiences?
iii. What are the key benefits and challenges associated with the integration and use of AI applications in secondary-level education?
iv. What are the key factors influencing the effectiveness of AI applications in enhancing educational quality?
v. To what extent do teachers and students believe that AI applications can positively contribute to personalized learning and academic performance?
vi. what are the disparities in the perspectives of teachers and students regarding the impact of AI in education quality?

Theoretical Framework

The Technology Acceptance Model (TAM) offered a robust framework for exploring the impact of AI on secondary education in Saudi Arabia. It helps create an understanding of how teachers and

students perceive and accept AI applications, particularly due to its ability in its focus on behavioral aspects of technology adoption. Proposed by Davis (1989), the TAM model explores users' acceptance of technology and their subsequent use of the technology in concern. TAM suggests that perceived ease of use (PEOU) and perceived usefulness (PU) are critical factors influencing individuals' attitudes towards adopting and utilizing technology. For the current research PU refers to the degree to which individuals believe that using AI in secondary education will improve the quality of education, enhance learning experiences, and positively impact academic performance. On the other hand, PEOU addresses the extent to which individuals believe that utilizing AI and AI technology in education is effortless and straightforward. PEOU would correspond to the comfort levels expressed by students and teachers in using AI applications as well as the teachers' perceived adequacy of training for incorporating AI-based technology in the classroom. Davis (1989) argued that PU and PEOU significantly impact users' attitudes (A) towards adopting a technology. Teachers and students who perceive AI applications to be useful in promoting education quality and easy to use are more inclined to have a positive attitude toward the adoption of such technology in secondary education.

The concept, attitude (A), represents individuals' overall positive or negative feelings and perceptions towards adopting AI technology in the educational context. For the current research, attitude reflects the overall positive outlook and enthusiasm demonstrated by teachers and students toward the integration of AI in secondary education. These attitudes, in turn, influences their behavioral intention (BI) to use the technology resulting in the actual system use (AU). Positive attitudes toward AI applications, influenced by PEOU and PU, will lead to a higher intention to use AI tools in educational settings. BI reflects the possibility that

individuals express an intention to use AI in their teaching or learning practices based on their attitudes while AU would reflect the teachers' and students' real-world application of and engagement with AI technology in secondary education as depicted in Figure 1. Moreover, the actual use of AI technology in secondary education will also be positively influenced by external factors affecting the implementation of AI besides BI.

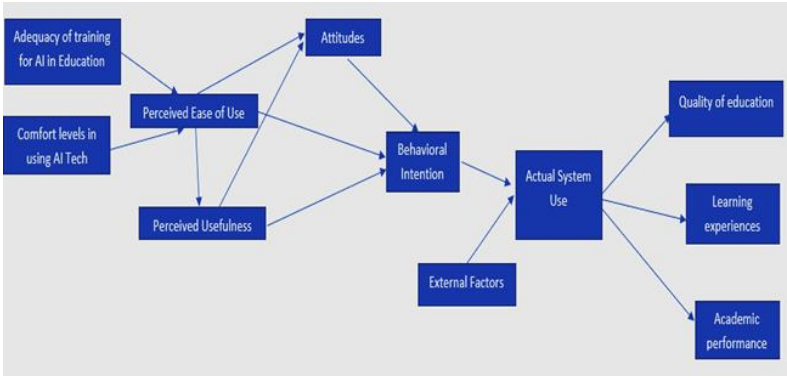

Figure 1: The Technology Acceptance Model

METHODOLOGY

A quantitative approach was employed to investigate the perceptions and experiences of both secondary school students and teachers in Saudi Arabia regarding the impact of AI in secondary school education.

Survey design and data collection

The study was conducted using online questionnaire consisting of closed-ended questions. The questionnaire was administered online, with data collection taking place between 1st July and 31st August 2023. Given the limited existing research on the specific topic of AI's impact on secondary-level education within the Saudi Arabian context, a tailored questionnaire was developed to address the research objectives and

questions. The questionnaire comprised a set of 24 close-ended questions, of which four were demographic inquiries, designed to collect essential information such as participants' roles, the type of educational institution (public or private secondary school), the age groups of student participants, and their geographical locations. The questionnaire questions were predominantly multiple-choice employing Likert scales to assess participants' responses, ensuring that the questionnaire remained concise and straightforward. Additionally, participation in the survey was entirely voluntary, and all questions were optional for the respondents.

Participants

The targeted sample for this research comprised 120 participants selected through stratified random sampling, including both students of secondary school level and teachers actively engaged in secondary education within Saudi Arabia. This sample size was deemed sufficient to provide valuable insights into the research questions while being manageable for data collection and analysis. However, only 114 participants sent back their completed the questionnaire. The participants were invited to take part in the study via online questionnaires distributed through educational networks and platforms. The invitation included consent forms that were to be sent back before initiating the questionnaire. Teachers were expected to provide informed consent by signing the consent form. For students, their parents or legal guardians were approached via different social media to provide consent for their children's participation.

Considering the diversified nature of this target group, the questionnaire was structured to address the perspectives and experiences of both teachers and students regarding the impact of AI in secondary school education, in line with the research objectives. With a final sample size of 114 participants, it is essential to acknowledge that the research

represents a proportion of the target population, and the findings can be generalized to a certain extent within the defined margin of error. Statistical significance was determined through rigorous data analysis, and the research achieved a 90% response rate with a 6% margin of error, based on the full responses received, primarily from students and teachers in the Saudi Arabian context.

Data Analysis

The data collected through the online questionnaires were exported to software suitable for statistical analysis, including Excel and SPSS. Since the Likert scale questions generate structured quantitative data, these responses were analyzed using descriptive statistics. The analysis was performed separately for the two groups of participants - students and teachers. The responses from students and teachers were segregated for individual analysis, allowing the researcher to determine potential variations in perceptions between the two groups. The analysis aimed to address the research questions, particularly those related to the impact of AI applications on secondary-level education quality.

Results

A. Teachers' Perspectives

Demographic Characteristics of Participants

A total of 62 teachers participated in the online questionnaire. The respondents' demographic characteristics revealed a diverse group: the majority of participants identified as classroom teachers (64.5%), most were working in public secondary schools (72.6%), and a significant proportion fell within the age range of 31-40 (45.2%). Regarding teaching experience, the responses were spread across various categories, with the highest proportion (41.9%) having 11 to 20 years of teaching experience as indicated in Table 1.

Category	Teachers (N=62)	Students (N=52)
Role	Classroom Teachers (40)	
	Subject Teachers (22)	
Educational Institution	Public (45)	Public (35)
	Private (17)	Private (17)
Age Group (years)	31-40 (28)	15-16 (28)
	41-50 (21)	17-18 (24)
	51-60 (13)	
Teaching Experience	1-10 years (24)	
	11-20 years (26)	
	21-30 years (12)	
Gender Distribution	Female (36)	Female (23)
	Male (26)	Male (29)
Grade Level (Students)		10th grade (18)
		11th grade (17)
		12th grade (17)

Table 2: Participants' Demographics

Perceptions of AI in Secondary School-level Education

The study sought to investigate teachers' perceptions of AI in secondary education using a 5-point Likert scale. A substantial number of teachers indicated a positive outlook on AI's potential in education. A significant proportion (79%) expressed agreement or strong agreement with being familiar with current AI applications used in secondary education. The majority (78.8%) either agreed or strongly agreed that AI applications could improve the quality of secondary-level education, with 40.3% strongly agreeing. When assessing the influence of AI applications on students, 63.9% of teachers agreed or strongly agreed that these applications enhance students' overall learning experiences, and 74.2% agreed that AI applications improve students' academic performance.

Regarding personalized learning, 64.5% of teachers were in favor of AI's ability to personalize learning for students. Interestingly, 66.1% of teachers believed that AI helps identify and address students' individual needs, indicating a positive impact on personalized learning. With respect to teaching efficiency, 70.9% of teachers agreed or strongly agreed that AI applications make teaching more efficient. Additionally, the majority (67.7%) agreed that integrating AI in education presented more benefits than challenges.

Moreover, majority of the teachers (71%) expressed higher comfort levels in using AI applications with 76.1% of the teacher respondents agreeing or strongly agreeing that they had adequate training for incorporating AI-based technology in the classroom. The positive influence of AI on the future of secondary-level education was also acknowledged by 81.6% of the teachers, with 34.8% strongly agreeing.

The teachers' views on challenges related to AI implementation in secondary also varied. A significant portion (69.4%) agreed or strongly agreed that a lack of resources (e.g., AI tools and technology) presented a barrier to effective AI implementation. 66.1% of the teacher respondents also expressed concerns about data privacy and security limiting AI adoption with this lot strongly agreeing or agreeing. Additionally, nearly two-thirds (63.3%) experienced teachers' resistance to AI technologies as a challenge in its implementation. The absence of clear policies and guidelines for integrating AI in secondary education was also acknowledged by 58% of the teachers who agreed or strongly agreed.

The survey also assessed factors influencing AI effectiveness in secondary education. Results revealed that 67.7% of teachers agreed or strongly agreed that adequate training and professional development are available for teachers to use AI applications effectively. On the other hand, 66.1% of teachers agreed or strongly agreed that infrastructure and technology support in their institutions are sufficient for AI integration. Similarly, 64.5% agreed or strongly agreed that the curriculum is designed to accommodate AI applications effectively, indicating institutional readiness for AI integration.

With respect to teachers' support for their students' use of AI, 67.7% of respondents were in favor of encouraging students to use AI in their learning. The readiness of the curriculum to accommodate AI applications received a positive response from 64.5% of teachers. Finally, in assessing the overall impact of AI in education, 72.6% of teachers agreed or strongly agreed that AI has a positive impact on secondary school-level education. These results collectively highlight the optimistic outlook of teachers regarding AI's role in shaping the future of secondary-level education. Moreover, the findings offer valuable insights into teachers' perspectives on AI's role in secondary education, indicating general enthusiasm for the positive potential of AI while acknowledging the challenges that need to be addressed for effective implementation.

B. Students' Perspectives

Students' Demographics

A total of 52 students participated in this survey focused on understanding the impact of AI applications on secondary-level education in Saudi Arabia. The gender distribution among the student participants was almost balanced, with 45% identifying as female and 54% as male. While most participants fell within the 15-16 age group (38%), the 17-18

age group was also well-represented at 31%. Among the participating students, 34% were in the 10th grade, 33% in the 11th grade, and 33% in the 12th grade. The majority of students came from public schools (68%) rather than private schools (32%) as illustrated in Table 1.

The overwhelming majority of students (90%) reported having access to computers or smartphones for learning purposes. This access to technology could have implications for their familiarity with AI. Notably, 33% of students indicated they were somewhat familiar with AI, while 24% reported a neutral level of familiarity. A substantial portion (38%) found that they were moderately familiar with AI. When asked about the subjects they mainly used AI for, mathematics emerged as the most common choice, with 38% of students selecting it. Furthermore, 27% mentioned science, 19% language arts, and 7% history.

A notable proportion of students (43%) had often or always used AI-based educational tools in school, highlighting the prevalence of AI applications in their educational experiences. When evaluating the impact of AI on their learning experiences, the majority of students (52%) believed that AI had improved their learning, with 26% reporting that AI had significantly improved their educational experiences.

Students' Perceptions of AI in Secondary School-Level Education

With respect to perceptions, the students' responses indicated a generally positive view of AI applications in education. For instance, 64% of the students either agreed or strongly agreed that AI makes learning more interesting. Additionally, 69% believed that AI helped them better understand difficult subjects and concepts, and 67% found AI tools easy to use for their learning. When assessing the impact of AI on their academic performance, 68% of students believed that AI

applications had a positive effect, either agreeing or strongly agreeing with this statement. A majority of students (72%) also agreed that AI applications helped them complete their assignments more efficiently.

Moreover, AI appears to boost students' confidence in their studies, with 73% either agreeing or strongly agreeing that they felt more confident when using AI applications. Students also considered AI-applications to be effective in making learning more engaging and enjoyable, with 66% agreeing or strongly agreeing. Many students also believed that AI could significantly improve their academic performance, with 76% choosing the "moderately" to "significantly" options.

Notably, 63% of students agreed or strongly agreed that AI could offer personalized learning recommendations based on their strengths and weaknesses. Additionally, AI was seen as a convenient way to access a wide range of educational resources by 74% of students. A large majority (73%) also believed that AI in education saved them time on tasks like homework and research, allowing them to learn at their own pace.

Challenges Encountered by Students when using AI Applications for Secondary School Education

Students were generally unconcerned about the technical skills required to use AI in education, with 62% either disagreeing or strongly disagreeing with the statement that the use of AI in education required a lot of technical skills. However, some students expressed concerns regarding the accuracy of AI applications, with 63% agreeing or strongly agreeing that AI sometimes provided incorrect or irrelevant information, which could be confusing.

Nonetheless, technical issues were the most commonly reported challenge, affecting 65% of the students. Additionally, 47% found difficulty in using AI tools, and 34% cited a lack of access to necessary technology as a challenge. Almost a third of students (29%) identified a lack of suitable AI tools, and 27% reported restrictions imposed by institutions, teachers, and parents. On the other hand, concerns about data privacy and security were relatively evenly distributed among the students, with 42% being slightly to moderately worried and 18% being significantly worried. However, 40% were either not at all worried or neutral about data privacy and security when using AI educational tools.

Teachers' use of AI Tools and their Effectiveness

An evaluation of the teachers' use of AI tools in daily lessons also revealed a range of experiences. While 45% reported that teachers sometimes or often incorporated AI tools in their lessons, 37% of the students found their use to be effective in facilitating learning. In contrast, 22% considered the teacher's use of AI tools very effective, and 22% believed it to be ineffective or very ineffective. Additionally, the students displayed confidence in AI's ability to assist teachers in delivering lessons more effectively, with 56% believing in its potential. However, a minority (7%) expressed skepticism, while 37% remained uncertain. In the overall assessment of AI's contribution to secondary school education, 67% of students agreed or strongly agreed that AI had made a positive impact, while 16% disagreed or strongly disagreed with this notion.

DISCUSSION

The study aimed to investigate teachers' and students' perspectives on AI in secondary school-level education in Saudi Arabia and provide insights into the challenges and potential benefits for students and teachers. The alignment between the literature and the study findings reinforces the notion that AI effectively facilitates personalized learning, benefiting both students and teachers. AI systems like Intelligent Tutoring Systems (ITS) are reported to provide tailored guidance, enhancing performance in subjects like mathematics (Beaulac & Rosenthal, 2019; Zafari et al., 2022). Teachers in the study acknowledged the positive impact of AI on personalized learning. A significant number of teachers agreed that AI has the capacity to personalize learning for students, and believed that AI could identify and address students' individual needs, highlighting its positive impact on personalized learning. Students in the study also reflected the importance of personalized learning. These findings were reinforced by responses from majority of the students who agreed that AI could offer personalized learning recommendations based on their strengths and weaknesses, enhancing the learning process. Effective use of EAI empowers students, allowing them to construct their knowledge actively and receive precise assistance when required for their personalized learning (García-Martínez et al., 2023). Additionally, the agreement among teachers and students on AI's ability to personalize learning highlights its potential as a valuable tool in the Saudi Arabian educational context.

Moreover, a significant majority of the students reported that AI applications had helped them access a wide range of educational resources, and believed that AI saved them time on tasks like homework

and research, allowing them to learn at their own pace. This resonates with the literature, which highlights the capacity of AI to provide personalized learning experiences for students, helping them learn at their own pace and receive insightful feedback (Zafari et al., 2022). Students can also benefit from the multimodal approaches, including simulations, virtual reality, and educational games, which make learning more dynamic and immersive (García-Martínez et al., 2023). Moreover, AI-powered chatbots and dialogue-based tutoring systems foster active learning and collaboration (Akgun & Greenhow, 2021).

The teachers also exhibited a positive perspective on the impact of AI on academic performance. Majority of teachers agreed that AI applications improve students' academic performance and believed that AI applications could improve the quality of secondary-level education. AI has the capacity to generate vast datasets and provide real-time, data-driven insights for teachers. This is supported by predictive analytics, which enable educators to intervene early when students are struggling by identifying patterns and trends in student behavior and performance (Wang et al., 2023). These results were consistent with the students' responses. A majority of students believed that AI applications had a positive effect on their academic performance, emphasizing its potential to enhance learning and teaching. Undeniably, the positive influence of AI in education has consistently been highlighted in existing literature acknowledging the power of AI in revolutionizing assessment, offering timely support to students, enhancing the administration of intelligent content (Chen et al., 2022), and improving students' academic performance (Lai et al., 2023).

The results also indicate that students perceive AI applications as having a positive impact on their learning experiences. A significant majority of the students reported that AI applications had helped them access a wide range of educational resources, and believed that AI saved them time on tasks like homework and research, allowing them to learn at their own pace. These findings correspond with findings in past literature, reinforcing the idea that students generally perceive AI as enhancing their learning experiences by making education more accessible and efficient.

On the other hand, the consistency between the literature and the study's findings with respect to challenges encountered when implementing AI tools underlines the universality of these challenges. Teachers in Saudi Arabia face similar concerns and obstacles to their counterparts in other regions. A significant number of teachers expressed concerns about data privacy and security concerns as a barrier to AI adoption. Privacy concerns, algorithmic bias, and issues related to data collection and analysis are common challenges, aligning with the study's findings (Chan, 2019; Crawford & Calo, 2016). A majority also identified teachers' resistance to AI technologies as a challenge alongside the absence of clear policies and guidelines for integrating AI in secondary education was a challenge. These challenges are predominantly highlighted in recent literature (García-Martínez et al., 2023), warranting attention in the implementation of AI in education to ensure a smooth and ethical integration of technology.

Additionally, the study also highlighted some concerns among students regarding AI applications. A significant number of students believed that AI sometimes provided incorrect or irrelevant information. This aligns with some researchers' concern about the reliability of AI systems, especially when they use Generative AI like GPT-4 (Xiaorong et al., 2023). These AI systems, while promising, may sometimes

generate incorrect information (Xiaorong et al., 2023). Addressing these concerns is essential to maintain students' trust in AI systems (Gunning, 2017).

Ultimately, both teachers and students in the study had a favorable perception of AI applications in education, with a majority agreeing on its positive impact. However, there were differences in their perspectives. While majority of teachers found AI effective, only 57% of students believed that teachers effectively incorporated AI tools into their lessons. This discrepancy could be due to variations in how AI tools were implemented in classrooms. Teachers might have encountered more challenges in using AI effectively, highlighting the need for teachers to develop technological proficiency and analytical skills (Chaudhry & Kazim, 2021). Additionally, this difference in perspective may be attributed to the different roles and responsibilities of teachers and students in the educational process. Teachers may have a more nuanced view, taking into account concerns about over-standardization, the potential for AI-generated answers to be unreliable, and the need to maintain their roles as intellectual guides. On the other hand, students may primarily consider the immediate benefits of AI, such as personalized learning, individualized content, and enhanced visual learning experiences. This difference in perspective highlights the importance of considering the viewpoints of both teachers and students when implementing AI in education.

Implications for Educational Policy and Practice

The findings of this study have significant implications for educational policy and practice in Saudi Arabia. With a majority of teachers and students recognizing the potential benefits of AI applications in secondary-level education, there is a clear mandate for integrating AI

technology into the educational framework. To harness the advantages of AI, educational policymakers should consider the development of comprehensive guidelines and policies for AI adoption in schools. These policies should address concerns related to data privacy, security, and algorithmic bias. Moreover, professional development programs for teachers are imperative to enhance their technological proficiency and analytical skills. Training and support should be provided to empower educators to effectively incorporate AI tools into their teaching methods, ensuring the optimal utilization of AI for personalized learning.

This study also contributes to the existing knowledge and literature by corroborating the positive impact of AI applications on personalized learning, academic performance, and access to educational resources. The study's findings emphasize the importance of pioneering approaches that leverage AI technology to enhance the quality of education. This research underscores the significance of a synergistic approach between market-oriented strategies and AI technology in education by acknowledging both the benefits and challenges. It reinforces the notion that AI can empower teachers and students to create a dynamic and efficient learning environment, and urges educational policymakers to act upon these insights. The study also serves as a beacon for future research and as evidence to the transformative potential of AI in the Saudi Arabian education system.

Limitations and Potential Biases

The study also has several limitations and potential biases. The data collection was conducted in a specific region of Saudi Arabia and may not fully represent the diversity of educational contexts within the country. Additionally, self-report surveys can be subject to response bias. While efforts were made to ensure anonymity and honesty in responses,

there may still be some degree of response bias in participants' answers. Furthermore, this study primarily focused on teachers and students, and other stakeholders, such as parents and administrators, were not included. Future research should aim to address these limitations by conducting more extensive and diverse studies to obtain a broader perspective on the implementation of AI in Saudi Arabian education.

Recommendations for Further Research

This study provides a foundation for further research on the implementation of AI in Saudi Arabian education. Future research endeavors could explore the experiences and perceptions of parents, administrators, and policymakers concerning AI in education. Moreover, it is crucial to investigate the long-term effects of AI integration on student learning outcomes and teacher practices. Comparative studies across different regions of Saudi Arabia would offer insights into regional variations in AI adoption and identify specific needs in diverse contexts. Additionally, assessing the effectiveness of professional development programs for teachers in integrating AI tools into their teaching methods would provide essential insights for improving educational practices. More in-depth investigations into the concerns surrounding data privacy, security, and algorithmic bias should also be conducted to ensure ethical AI integration in education.

CONCLUSION

The study provides valuable insights into the perceptions of teachers and students regarding AI applications in secondary school-level education in Saudi Arabia. The alignment of the findings with existing literature emphasizes the potential benefits of AI, particularly with respect to personalized learning and improved academic performance. It also underscores common challenges, including data privacy and

reliability concerns. The study's results can inform educational policy and practice in Saudi Arabia, highlighting the need for comprehensive guidelines, professional development, and considerations for the concerns raised. This study serves as a foundation for further research and contributes to the ongoing evolution of the education system in Saudi Arabia.

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