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Challenges in implementing artificial intelligence applications in secondary-level education: A teacher-centric perspective

**By
Dr/ Ashwag A. Almethen**

Assistant professor of curricula and instruction
Department of Curriculum and Instruction, College of Education,
King Faisal University, Al-ahsa, Saudi Arabia
asmethen@kfu.edu.sa

﴿ المجلد الأربعون – العدد الخامس - جزء ثانى - مايو ٢٠٢٤ م ﴾
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Abstract

Artificial Intelligence (AI) has emerged as a transformative force in education, with the potential to revolutionize teaching and learning. The researcher focus on this research study to investigate the specific challenges faced by secondary school teachers in Saudi Arabia when implementing AI applications in their classrooms, providing a comprehensive understanding of the multifaceted hurdles they encounter. Through a rigorous survey, the study revealed the complex interplay of factors contributing to these challenges, including perceptions, resource limitations, technical support, and the broader educational context. The findings highlight the unrelenting need for comprehensive public policies, infrastructure investment, and tailored professional development to support educators in embracing AI effectively. By recognizing variations in challenges based on teaching experience, subject specialization, and AI tool usage, the study also highlights the contextual nature of AI implementation. These insights not only inform educational policies and practices in Saudi Arabia but also have broader implications for fostering inclusive, efficient, and innovative learning environments globally.

Keywords: Artificial Intelligence, AI integration, secondary education, challenges, teaching experience

Introduction

The field of Artificial Intelligence (AI) has over the past decade emerged as a transformative technological frontier with the potential to reshape various facets of our social engagements (Pedró et al., 2019). In the education sector, AI initiated the development of innovative pedagogical and learning solutions that are currently undergoing rigorous evaluation in diverse educational settings Pedró et al. (2019). This profound technological shift has the potential to significantly revolutionize teaching and learning processes. These possibilities create a need to reflect on the profound implications of this technological advancement and its dynamic role in shaping the future of education, urging scholars and practitioners to explore the possibilities and challenges it presents.

AI's incorporation into education is evident globally, with China serving as a prominent example. China, given its vast population and rapid technological development, has committed to becoming a global AI leader by 2030. This vision extends to the field of education, where private entities like Huijiang, Liulishuo, and Master Learner are pioneering AI applications (Jing, 2018). For instance, Huijiang is developing software capable of understanding students' facial expressions for AI-based feedback (Chen, 2018). China's Ministry of Education mandates that local governments allocate a substantial portion of their budgets to digitize education, resulting in extensive digital experiments, including AI-based essay correction with remarkable precision often matching human accuracy in approximately 925 of the cases (Chen, 2018).

In Latin America, initiatives like Plan Ceibal in Uruguay leverage AI for education. Plan Ceibal's "*Mathematics Adaptive Platform*" (PAM) personalizes learning experiences according to students' skill levels, aligning with national curriculum standards. Studies have shown PAM's positive impacts on learning, offering students a wide array of activities to enhance their educational experiences (Perera & Aboal, 2018). In Brazil, the government's Mec Flix platform, though not strictly AI-based, incorporates elements of AI by providing personalized video content for higher education exam preparation, highlighting the increasing use of AI in educational content delivery (Rigby, 2016)

Beyond government and private initiatives, philanthropic endeavors in the developing world are also harnessing AI's potential in education. For instance, IBM's "*Simpler Voice: Overcoming Illiteracy*" project utilizes AI to help illiterate adults navigate texts with the aid of visuals or simple spoken words, aiming to eliminate literacy-related challenges (Chen, 2018). Learning Equality's open-source platform, Kolibri, serves low-resource communities with personalized educational content, demonstrating AI's role in enhancing access to education (Chen, 2018). These philanthropic efforts underline the global commitment to using AI for social good.

Other AI initiatives in education, include those in Brazil, South Africa, Kenya, Uganda, Nigeria, and India. For instance, *Geekie*, an EdTech company in Brazil, uses machine learning to offer customized learning experiences, including identifying learning difficulties encountered by students (Emmanuel & Pierre, 2022; Rigby, 2016). South Africa's *Daptio* provides personalized learning to students and teachers, while *M-Shule* in Kenya adapts lessons based on the national curriculum to students' skills and abilities using AI technology (Pedró et al., 2019).

Additionally, AI is transforming education management information systems (EMIS) into learning management systems (LMS) and opening avenues for data-driven decision-making. These systems collect and analyze data to make data-driven decisions, improving the efficiency of educational planning and management. For instance, the United Arab Emirates (UAE) employs AI to analyze education-related data, including curricula, teacher development, learning resources, and student feedback, enabling real-time decision-making at a large scale (Pedró et al., 2019). Moreover, middle and lower-income countries including Kenya are exploring AI-enhanced EMIS, with programs like *iMlango* utilizing advanced analytics for student attendance tracking and personalized learning (Chen, 2018). The adoption of AI-enhanced learning analytics also remains an aspiration in countries like Bhutan and Kyrgyzstan, showcasing the potential for future integration in education (Chen, 2018).

As the world witnesses the ever-expanding presence of Artificial Intelligence (AI) in education, it becomes increasingly evident that AI is not merely a technological advancement but a dynamic force that is reshaping the very landscape of education. The UNESCO acknowledges that AI-driven innovations in education are rapidly emerging, fostering educational environments that are not only transformative but also intrinsically inclusive and equitable (UNESCO, 2023).

The role of AI in secondary education

The integration of Artificial Intelligence (AI) in education is ushering in a new era of teaching and learning. This transformative wave is sweeping across the globe, presenting unique opportunities and challenges for the education sector. Recent studies, have investigated the

myriad ways in which AI can enrich learning experiences and educational management systems (Laanpere et al., 2014). AI has emerged as a powerful tool for ensuring equitable and inclusive learning outcomes aligned with the United Nations Sustainable Development Goal 4, which advocates for inclusive and equitable quality education for all (UNESCO, 2023). In this scope, AI technologies play a pivotal role in providing marginalized individuals, including people with disabilities, refugees, those out of school, and those in remote communities, with access to tailored learning opportunities (Virkus et al., 2023).

For instance, AI-driven telepresence robotics (TPRs), facilitate remote learning for students with special needs or those in emergency situations at home or hospital, bridging geographical divides and promoting inclusivity (Virkus et al., 2023). Additionally, TPR systems empower educators to conduct remote teaching sessions, thereby extending access to education (Botev & Rodríguez Lera, 2021; Leoste et al., 2022). These technologies bridge physical gaps and enhance the sense of togetherness among students, providing a more immersive classroom experience (Leoste et al., 2022; Schouten et al. 2022; Wernbacher et al., 2022). AI-driven telepresence systems stand out in their ability to replicate physical classroom experiences, providing remote learners with a more authentic educational setting (Khadri, 2021). In contrast, traditional videoconferencing often leaves remote students feeling isolated (Bell, 2017; Khadri, 2021).

AI-based technology in education also promotes collaborative learning, especially when learners are geographically dispersed. It provides students the flexibility to choose when and where they study, with AI-powered systems monitoring asynchronous discussion groups to guide and support learner engagement (Pedró et al., 2019). AI systems

employ techniques like shallow text processing and machine learning to monitor asynchronous discussion groups, offering educators valuable insights into student interactions and engagement. This feature, in turn, aids in guiding and enhancing collaborative learning experiences (Pedro et al., 2019).

One of the most striking advancements enabled by AI in education is the creation of personalized learning paths. AI-powered systems, driven by sophisticated data analysis, have the capacity to distinguish complex behavioral patterns and various factors influencing the learning experience (Hwang et al., 2020). AI can predict future actions of learners, classify them based on their unique characteristics, and recommend tailored learning paths (Wang et al., 2019; Li and Zhang, 2019), leveraging individual learning patterns, preferences, and characteristics (Hwang et al., 2020). For instance, AI tutoring systems, operational across the United States, China, and India, are capable of recording and tracking diverse student learning attributes (Liang and Hainan, 2019). These systems recommend tailored teaching and learning strategies, fostering a transition from passive learning to active engagement (Liang and Hainan, 2019).

These tailored learning paths are not confined to traditional academic assessments but also encompass an array of factors, including student's level of concentration in class, participation in learning activities, and non-cognitive skills like communication and in-class behavior. Unlike the conventional approach of solely focusing on overall scores, AI-infused systems can conduct deeper investigations into individual-specific elements, recognizing and incorporating the previously overlooked heterogeneity among learners (Liang and Hainan, 2019; Tong et al., 2019). Consequently, AI paves the way for an educational paradigm that champions personalization, through its ability

to recognize and integrate previously overlooked aspects among learners, resulting in a more personalized and efficient educational system. The Computer Assisted Learning (CAL) field further advances personalization through the utilization of AI technology (Schitteck Janda et al., 2001). AI systems accurately map individualized learning plans, catering to students' strengths, weaknesses, learning preferences, and activities. Algorithms guide students along customized learning paths, offering a deeply personalized educational experience (Nye, 2015).

The integration of AI has also introduced diagnostic and predictive solutions that surpass traditional remediation options and processes. AI, through data analysis, can preemptively diagnose learning difficulties, thereby offering solutions that can prevent severe consequences such as academic failure or dropout (Li and Wang, 2020; Luo, S. 2019). AI is capable of identifying the root causes of learning problems, contributing to more effective educational management Luo, S. 2019). AI systems can swiftly identify and address areas of concern by tapping into the extensive data available (Li and Wang, 2020). This results in a proactive approach to education, where challenges are resolved at their source rather than merely dealing with their consequences.

Additionally, AI augments educational content, actively participating in the learning process and redefining educational content. AI tools, such as ChatGPT and DALL·E, have the potential to revolutionize course development by generating descriptive content and visuals for storyboarding (Chen et al., 2019). These tools can also create study guides, develop intelligent examination systems, and optimize teaching environments for various subjects (Mondal, 2019; Li & Wang, 2020). AI's involvement also spans language studies, vocational training, transforming educational content substantially (Hui, 2020; Chen et al., 2019).

The use of AI in educations has also expanded beyond curriculum development and textbooks to include gamified learning. Using Big Data analysis, AI offers immersive learning experiences through simulation, enhancing strategic thinking and problem-solving skills (Tang et al., 2020). Virtual Reality and Augmented Reality are making these experiences even more interactive and effective bringing educational content to life in unprecedented ways (Tang et al., 2020; Fan & Zhi, 2020).

The era of AI is also revolutionizing teachers' roles, especially in assessment, grading, and feedback mechanisms, releasing educators from administrative burdens (Bhutoria, 2022). AI-driven assessment systems streamline tasks like grading, attendance tracking, and quiz generation, freeing up valuable time for educators. A key illustration of this shift is the capabilities provide by *Third Space Learning*, an AI-enabled platform in China (Bhutoria, 2022; Tong et al., 2019). *Third Space Learning* allows the automation of tasks, including identifying target students, arranging lecture materials, and preparing lecture notes, substantially reducing teachers' workload and time (Bhutoria, 2022). The time saved can be redirected toward building stronger teacher-student relationships, focusing on long-term student development, and enhancing the overall educational experience (Feng et al., 2019; Liu, 2019).

AI technology has also introduced AI-driven learning companionship through chatbots. These intelligent chatbots simulate human interaction, adapting to the specific needs and learning pace of individual students (Ram & Verma, 2023). They provide guidance, answer questions, offer feedback, and even manage administrative tasks, thereby enhancing the overall educational experience (Ram & Verma, 2023). The advent of AI-driven learning companions is a significant step

toward individualized and responsive education. Recent chatbots and tools including ChatGPT, DALL·E, and Google's Bard are capable of providing timely support to students, ensuring that their learning experiences are not marred by obstacles or unanswered queries (Ram & Verma, 2023). This revolutionizes the concept of access to education, making it more interactive and personalized. These tools generate descriptive content and visuals, which, when combined with rapid course authoring tools, result in the efficient creation of engaging eLearning courses (Jia, 2021; Chen et al., 2019). These developments illustrate the significant impact of AI on education, offering a transformative approach to learning and teaching.

Challenges in implementing AI technology education

The integration of AI and AI-based technology into educational settings presents several challenges. The attitudes of educators play a pivotal role in the effective implementation of AI in higher education. Undesirable attitudes including, resistance, overreliance, and unrealistic expectations are common among educators, often due to inadequate, irrelevant, or outdated professional development (Kuleto et al., 2022). These undesirable attitudes may hinder the effective implementation of AI-based technology in teaching contexts (Kuleto et al., 2022).

Another challenge relates to ensuring inclusion and equity in AI-based education. While AI has the potential to support inclusion in education, it can also exacerbate existing inequalities, creating a digital divide. Factors, including ICT hardware availability, electrical supply, internet reliability and data costs (Häfner et al., 2023), students' ICT skills, language, and culturally appropriate content are obstacles to AI adoption (Babu & Vasumathi, 2023; Vincent-Lancrin & Vlies,

2020), especially in developing countries. Governments and organizations need to invest in improving technological infrastructure and leverage international collaborations to improve infrastructure in disadvantaged areas (Babu & Vasumathi, 2023).

Moreover, teachers often lack the required knowledge and skills to effectively integrate AI into their teaching practices (Chiu & Chai, 2020). A systemic adoption of AI-based applications for teaching and learning has been lacking, acknowledging that technology often promotes new teaching methods that may not align with traditional practices (Babu & Vasumathi, 2023; Richards & Dignum, 2019). Teacher training becomes crucial to equip educators with the skills to use AI-enabled technologies effectively, understand AI's impact, and manage both human and AI resources, while recognizing that AI should assist, not replace, teachers (Chiu & Chai, 2020).

Another challenge relates to the importance of developing quality and inclusive data systems as a fundamental component of AI systems. The availability and accuracy of data are essential for the proper functioning of AI algorithms (Vincent-Lancrin & Vlies, 2020). However, many countries face challenges in collecting essential educational data, particularly for marginalized or vulnerable populations. Building infrastructure and ensuring open, usable data at various levels of the education system is critical (Vincent-Lancrin & Vlies, 2020). Real-time data processing and disaggregation according to demographic factors can help address educational inequalities.

There are also emerging concerns that incorporating AI techniques in the classroom also introduces a dilemma wherein the convenience of AI tools may unintentionally discourage students from engaging in critical knowledge processing activities, hindering deep learning (Zhai et al., 2021). AI-driven tools that provide instant solutions can reduce students' inclination to immerse themselves in in-depth inquiry. For instance, Zhai et al., (2021) highlights the case of AI-driven translators that often provide ready illustrations, pronunciation guidance, and predefined phrases, potentially leading to a decline in students' inclination to immerse themselves in in-depth inquiry. Additionally, while AI systems offer the potential for personalized assistance in education, there is a concern that excessive standardization in guiding student behavior might emerge (Seo et al., 2021). Students value the support AI can provide, but they also express apprehension that rigid, pre-defined assistance might diminish their autonomy in the learning process (Seo et al., 2021). Instructors share similar concerns, fearing that excessive AI support could limit students' room for exploration and self-discovery, potentially impeding their ability to acquire new skills and learn from their mistakes (Seo et al., 2021). This highlights a delicate balance that must be struck when integrating AI into educational settings, ensuring that it enhances rather than restricts the learning experience.

Moreover, the implementation of AI in education arouses concerns related to ethics, privacy, surveillance, and transparency in data collection, use, and dissemination (Akgun and Greenhow, 2021). With the growing importance of data science, the ethical implications of AI have become a central concern. While AI offers various benefits, there

are concerns about fairness, transparency, privacy, and potential job displacement (Luan et al., 2020; Ade-Ibijola & Okonkwo, 2023). Addressing these concerns requires a thoughtful approach to AI governance, regulations, and research that takes into account societal and ethical considerations.

Another prevalent challenge is the limited technical capabilities of AI in certain domains. AI may struggle with efficiently scoring graphics, figures, and text, particularly when these include images (Fitzgerald et al., 2015; Qian et al., 2020). Moreover, AI systems tend to be context-dependent, limiting their adaptability to different educational settings, especially when faced by language and cultural variations (Nikiforos et al., 2020). An AI algorithm designed for specific behaviors in a particular online learning environment may not be transferable to other languages or cultural contexts, driving challenges in adapting AI for diverse classrooms.

Therefore, challenges of implementing AI in higher education are multifaceted, ranging from the need for robust public policies to address ethical concerns and the importance of educator attitudes and training to the imperative of promoting inclusion and equity. Furthermore, ensuring data quality and accessibility, encouraging deep learning, and overcoming technical limitations and context dependence are vital aspects of successfully integrating AI in education. Addressing these challenges requires a holistic approach that prioritizes both the technological potential of AI and the human elements of education. As the world moves forward with the adoption of AI in education, it is essential to navigate these challenges effectively to maximize its benefits while minimizing its pitfalls.

The existing literature offers a comprehensive view of the potential benefits and applications of AI in education. However, there is a noticeable research gap in understanding the specific challenges faced by secondary school teachers in implementing AI applications in their classrooms, the factors contributing to these challenges, and potential solutions to address them, especially within countries in the Middle East. Consequently, this study aimed to investigate and catalog the nature and extent of challenges encountered by secondary school teachers in the implementation of AI applications in their classrooms within this region. The study also sought to identify and analyze the factors that contribute to these challenges from the perspective of secondary school teachers. These efforts were aimed at exploring and proposing potential solutions and best practices to address the challenges cited by teachers in integrating AI into secondary education effectively within Saudi Arabia with implications for other nations across the region and globally.

The research was guided by the below research questions:

- i. What are the specific challenges faced by secondary school teachers in the implementation of AI applications in their classrooms?
- ii. What factors contribute to these challenges from the perspective of secondary school teachers?
- iii. How do these challenges impact teachers' experiences and effectiveness in using AI in secondary education?
- iv. What are the perceived solutions and best practices for addressing these challenges?
- v. Are there variations in the challenges faced by teachers based on their teaching experience, subject specialization, or the type of AI applications used?
- vi. How can the findings inform educational policies and practices to improve AI integration in secondary education, especially in the context of Saudi Arabia and the Middle East region?

Theoretical framework

Understanding the challenges of AI integration in secondary education within the Middle Eastern region also requires exploring the acceptance and implementation within this region. To accomplish this, we adopted a modified version of the Technology Acceptance Model (TAM). While the conventional TAM has been valuable in assessing technology acceptance, it requires adaptation to encompass the distinctive sociocultural, educational, and contextual factors at play in this specific region, particularly Saudi Arabia as depicted in Figure 1.

Drawing from Davis' (1989) Technology Acceptance Model, perceived usefulness remains a critical factor in understanding the acceptance of AI-based technology in Middle Eastern secondary education. It explores the extent to which educators in Saudi Arabia perceive AI applications as valuable tools capable of enriching the teaching and learning processes.

This construct scrutinizes how teachers in Saudi Arabia perceive the user-friendliness and compatibility of AI technology with their existing pedagogical practices. The assessment of this factor underscores the unique challenges and opportunities that arise within the socio-cultural norms and educational structures of Saudi Arabia.

Another crucial adaptation to the TAM framework is the introduction of subjective norms, particularly pertinent in the Middle Eastern context. This construct explores the influence of social and cultural factors, as well as the impact of professional networks and peer opinions on teachers' acceptance and adoption of AI in the realm of secondary education. Notably, Saudi Arabian educators may find themselves significantly swayed by the perceptions and viewpoints of their peers and colleagues.



Figure 1: Theoretical model of the research

In this adapted model, the emergence of perceived risk as a critical element addresses the notable gap in the conventional TAM. Saudi Arabian educators might harbor reservations and uncertainties concerning AI adoption in the educational sphere. These apprehensions may encompass potential drawbacks, ethical considerations, and the dependability of AI-based systems. The evaluation of perceived risk is fundamental in comprehending the obstacles that educators envisage when it comes to integrating AI into their teaching methodologies.

Lastly, the primary outcome in the adapted TAM remains the behavioral intention to use AI in Saudi Arabian secondary education. This construct encompasses Saudi Arabian teachers' willingness and commitment to integrate AI technology into their teaching practices, considering the unique sociocultural and contextual factors influencing their decisions.

Study Design

Data for this study were collected through an online survey administered via Google Forms, consisting of both closed-ended and scaled questions. To ensure relevance and context specificity, the survey targeted a cohort of educators teaching at the secondary school level within the Saudi Arabian educational landscape. The participants were

drawn from the attendees of the International Conference on ICT for Education and Training (ICICTET), held on November, 2023, in Jeddah, Saudi Arabia. A stratified random sampling approach was employed, adhering to an inclusion criterion that exclusively encompassed secondary school teachers. The survey link was shared with an initial pool of 120 conference participants. Furthermore, two subsequent reminders were dispatched to the workshop attendees at the conclusion of October 2023. A total of 104 participants actively engaged with and completed the survey. The survey was thoughtfully constructed to encompass a variety of question types. These included closed-ended scaled questions employing the Likert scale.

Responses obtained through Google Forms were accurately transferred and organized in MS. Excel to facilitate systematic data handling and analysis through SPSS v.26 software. This platform was also harnessed for the examination and categorization of scores indicated in the Likert scales. The quantitative data gathered through the survey, comprising close-ended, scaled questions, underwent a comprehensive descriptive analysis. This process facilitated the generation of meaningful insights and understanding. Subsequently, the descriptive statistics were interpreted and contextualized aligned with the extensive literature review conducted for this research.

Participants

The final composition of the sample group (N = 104) consisted of 61 female and 43 male. The age distribution of the participants was diverse, spanning from 21 to 50+. Within this range, 12 respondents fell within the 21–30 age bracket, 66 were aged between 31 and 40, another 20 were in the range of 41–50, and six participants were over 50 years. Predominantly, a substantial portion of the study participants (66 individuals) fell within the 31–40 age group.

The participants were exclusively comprised of educators actively teaching at the secondary school level within Saudi Arabia. Each of the participants possessed experience as a secondary school teacher within Saudi Arabia, with tenures spanning from one to more than 20 years. The educational experience distribution is as follows: six participants with over 20 years, 17 between 16 and 20 years, 33 between 11 and 15 years, 20 within six to ten years, 16 within three to five years, nine with 1 to 2 years, and one with less than a year of educational experience, resulting in a diverse and richly experienced sample. For clarity, the sample demographics are presented in Table 1.

Variable	Total (N = 104)	Women	Men
Age (years)			
- 21–30	12	9	3
- 31–40	66	37	29
- 41–50	20	13	7
- 50+	6	2	4
Teaching Experience (years)			
- >20	6	3	3
- 16–20	17	11	6
- 11–15	33	21	12
- 6–10	20	12	8
- 3–5	16	8	8
- 1–2	9	5	4
- <1	1	1	0

Table 1: demographic characteristics of the sample group, including age distribution and teaching experience, separated by gender.

Diverse educational disciplines were represented among the participants, including Arabic, Islamic Studies, English, mathematics, biology, history, chemistry, geology, physics, geography, health, and information technology, all pertinent to the secondary school level within Saudi Arabia. The majority of the sample demonstrated novice to

intermediate levels of proficiency in technology acceptance, with 23 participants rating their skills as novice. Only one individual possessed limited prior experience with technology acceptance. Additionally, educational sciences emerged as the most prominently represented discipline in the survey.

Results

We conducted a comprehensive online survey to gather insights from teachers seeking to address the challenges of implementing AI applications in Saudi Arabian secondary school-level education. The survey aimed to shed light on the various dimensions of AI acceptance, challenges, and perceptions within the Saudi Arabian educational context. This section presents the results derived from the collected data, allowing for an in-depth understanding of the challenges and factors influencing AI integration in secondary education.

i. Challenges Faced by Secondary School Teachers

The findings revealed that secondary school teachers encounter multifaceted challenges when implementing AI applications in their classrooms. The influence of peer opinions and perceptions regarding AI in education was evident, with a majority of teachers expressing agreement or strong agreement (82.69%) with this notion. Only a few respondents disagreed (5 respondents) or strongly disagreed (2 respondents) with the influence of peer opinions. Perceived risk related to potential drawbacks or ethical considerations emerged as another significant challenge with a considerable number of teachers expressing agreement or strong agreement (78.85%).

A substantial proportion of teachers expressed agreement (Strongly Agree and Agree) with statements indicating that integrating AI into their curriculum was time-consuming (70.19%). 69.23% of the respondents also indicated that AI applications often did not align with educational objectives, while 47.11% reported that there were technical difficulties when using AI applications.

Moreover, technical support emerged as a crucial factor. While 27.89% of the teachers strongly disagreed or disagreed with the idea that the lack of technical support hinders the effective use of AI in education, a notable number of respondents (45.19%) agreed or strongly agreed that technical support remains a hindrance. On the other hand, AI applications often disrupting the traditional teaching process were met with mixed perceptions. A significant number agreed or strongly agreed (45.19%), while 29.80% neither agreed or disagreed with this claim.

However, many teachers claimed that they received little student resistance in their attempts to implement AI technology, with a significant number expressing disagreement (33 respondents) or strong disagreement (63.46%). Nonetheless, challenges related to adapting AI tools to specific subject areas were prevalent, with a substantial number agreeing or strongly agreeing (59.69%). Concerns about school infrastructure not fully supporting AI integration were also expressed to varying degrees, with a considerable number agreeing or strongly agreeing (56.73%) with the inadequate support from the school's infrastructure.

The cost associated with AI technology was also identified as a significant challenge, with a notable number of teachers (75.0%) agreeing or strongly agreeing underscoring this challenge. This challenge was further compounded by the finding that 71.15% of the respondents agreed

or strongly agreed that there is a lack of appropriate AI resources and tools for secondary education. Additionally, the lack of proper training and support making AI technology integration difficult was acknowledged, with 66.35% of the respondents' expressing agreement and strong agreement to this query. Lastly, the unavailability of AI applications, with a substantial number (55.77%) agreeing or strongly agreeing.

ii. Factors Contributing to Challenges

From the perspective of secondary school teachers, several factors were identified as contributing to these challenges. Teachers reported that inadequate funding plays a major role in the challenges associated with AI integration in education. In this scope, 72.11% of the respondents agreed or strongly agreed that inadequate funding significantly drives hurdles encountered in the attempts to integrate AI-based technology in education. Similarly, a substantial number of educators acknowledged that the lack of administrative support (66.35% of the respondents) and resistance to change from colleagues (65.38% of respondents) were contributing factors.

Moreover, inadequate financial support emerged as a significant concern, with a majority of respondents agreeing and strongly agreeing (80.77%) that insufficient financial support contributes to the challenges of AI implementation. Additionally, the lack of awareness and understanding among educators about AI technology was a notable issue, as 66.35% of the respondents agreeing and strongly agreeing.

With respect to challenges related to resource allocation, 69.23% of the respondents highlighted concerns about the limited budget allocation for AI technology in schools as a major contributor to the challenges they faced in the implementation of AI-tech in education. Similarly, the

inadequate provision of teacher training programs for AI technology was perceived as a contributing factor, with 41 respondents agreeing and 32 respondents strongly agreeing, accounting for 70.19% of the participants.

The issue of compatibility between AI applications and teaching methods also drew attention, with 58.65% of the respondents agreeing that it is a contributing factor. Additionally, limited access to quality AI resources and tools was recognized as a challenge, as 45 respondents agreed, and 25 respondents strongly agreed equivalent to 67.31% of the total respondents. These findings underscore the prominent factors contributing to the challenges faced by educators in integrating AI into secondary education and highlight areas that require attention and support.

iii. Variations in Challenges

Teachers perceived variations in challenges based on their teaching experience, subject specialization, and the type of AI applications used. A majority of respondents recognized these variations. This indicates that challenges in AI implementation are influenced by contextual factors and the specific roles of teachers. Notably, a significant number of respondents (63.46%) acknowledged the existence of variations in challenges based on their subject specialization, highlighting that subject-specific differences play a substantial role in the challenges faced by teachers. Additionally, the findings revealed that a considerable proportion of respondents (60.58%) perceived variations in challenges related to teaching experience, indicating that the duration of teaching experience significantly influences the nature of challenges encountered. Moreover, a majority of educators (65.38%) recognized variations in challenges related to the type of AI applications used in teaching. This highlights the importance of considering the specific AI tools employed, as they have a discernible impact on the challenges faced in secondary education.

Discussion and Policy Implications

The findings highlight the multiple challenges that secondary school teachers in Saudi Arabia encounter when implementing AI applications in their classrooms. Notably, the influence of peer opinions and perceptions regarding AI in education emerges as a dominant challenge. This observation aligns with the Technology Acceptance Model (TAM) (Davis, 1989), as perceived social influence and subjective norms are pivotal constructs in understanding the acceptance of AI technology. The impact of colleagues and professional networks is evident in the hesitation that some teachers experience.

Moreover, the perceived risk associated with AI implementation is another critical challenge, resonating with prior literature on ethical concerns (Ade-Ibijola & Okonkwo, 2023). As AI applications become more integrated into educational practices, educators have raised apprehensions concerning potential drawbacks and ethical considerations.

Teachers' concerns about the technical difficulties when using AI applications also reflect the need for effective training programs (Babu & Vasumathi, 2023). The presence of technical support as a significant factor echoes the importance of technical assistance for successful AI integration (Chiu & Chai, 2020).

Additionally, it is worth noting that teachers report relatively little student resistance to AI integration. This finding is consistent with the potential benefits of AI to students, including providing tailored learning experiences (Li and Zhang, 2019), and it highlights that students often embrace the opportunities that AI technology offers.

The lack of appropriate AI resources and tools further reinforces the requirement for adequate support and resource allocation. Moreover, the challenges related to adapting AI tools to specific subject areas and

concerns about school infrastructure not fully supporting AI integration underline the contextual factors that impact AI implementation in Saudi Arabia. These contextual factors have been highlighted in the adapted TAM framework as crucial in understanding AI acceptance.

The perception of variations in challenges based on subject specialization, teaching experience, and the type of AI applications used also highlight the contextual and individual factors that influence the challenges faced by teachers. These findings support the premise that AI implementation is not one-size-fits-all and must be tailored to suit specific contexts (Liang and Hainan, 2019). Tailoring AI applications to the specific needs and characteristics of teachers and students is critical to successful implementation.

The study's findings also offer valuable insights into how educational policies and practices can be informed to enhance AI integration in secondary education, especially in the Saudi Arabian and Middle Eastern context. First, there is a need for policies that address the ethical concerns of AI integration and that promote the responsible use of AI in education. This involves providing adequate training and technical support and establishing mechanisms for oversight and ethical considerations.

Government support is also pivotal in addressing the financial challenges associated with AI integration. Initiatives that allocate budgets to digitize education, similar to those in China (Chen et al., 2019). Policies should also emphasize the importance of developing infrastructure and providing necessary resources for successful AI implementation. On the other hand, educational authorities should focus on raising awareness and understanding about AI among educators. Professional development programs should also be designed to ensure

that teachers possess the knowledge and skills to make the most of AI technology. Lastly, the policies should be flexible and adaptable, acknowledging the diverse needs of teachers based on their subject areas, experience, and the specific AI tools employed to help address variations in challenges. Therefore, an individualized approach to AI integration is essential.

Limitations and Recommendations for Future Research

The research findings are based on self-reported survey responses, which may be subject to bias and social desirability effects. Future research can consider a mixed-methods approach, combining surveys with interviews or observations, to gain a more comprehensive understanding of the challenges. Moreover, the study focused on secondary school teachers in Saudi Arabia, and expanding the research to include other educational levels and regions could provide a more holistic view. Additionally, as AI technology is rapidly evolving, ongoing research is required to stay up-to-date with the latest challenges and advancements in AI integration in education. Longitudinal studies can offer insights into the changing landscape of AI in education.

Conclusion

The current research provides an understanding of the challenges encountered by secondary school teachers in Saudi Arabia when implementing AI applications in their classrooms. The findings highlight the multifaceted nature of these challenges, including concerns related to peer opinions, perceived risk, time consumption, alignment with educational objectives, technical support, and cost. Factors contributing to these challenges, such as inadequate funding, resistance to change. The variations in challenges based on teaching experience, subject specialization, and the type of AI applications used emphasize the

contextual nature of AI integration. These insights offer valuable implications for educational policy, emphasizing the need for investment in resources, infrastructure, and teacher training, and encouraging a balanced approach to AI integration that supports educators rather than replacing them. While this study is based on the Saudi Arabian context, its contributions extend to the broader discourse on AI in education, providing a foundation for future research and policy initiatives aimed at enhancing AI adoption, promoting inclusive learning, and fostering equitable educational environments.

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