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From Chalkboards to Algorithms: Exploring Teachers' Attitudes Towards AI-Based Test Construction for Measuring Learning Outcomes

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Abstract: This study explores primary school teachers' attitudes towards AI-based test construction in Saudi Arabia. Through qualitative analysis of interviews with 16 teachers, the research reveals a complex landscape of perceptions, opportunities, and challenges. Teachers generally express openness to AI innovation, recognizing its potential to enhance assessment accuracy, objectivity, and personalization. However, this enthusiasm is tempered by technological apprehension and concerns about complexity. The study identifies significant barriers to adoption, including resource limitations, privacy and ethical concerns, and resistance to change. Key facilitators for successful implementation include strong administrative support, collaborative learning opportunities, and positive experiences from pilot programs. The findings highlight the need for targeted investments in infrastructure, clear ethical guidelines, user-friendly AI tools, and comprehensive professional development. The research underscores the importance of creating supportive ecosystems that encourage innovation while addressing teachers' concerns. As AI continues to evolve, this study provides valuable insights for policymakers, educators, and researchers working towards effective integration of AI in educational assessment. The findings suggest that while challenges exist, AI offers.

Keywords: Artificial Intelligence; Educational Assessment; Teacher Attitudes; Primary Education; Technology Integration

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1. Introduction

The digital age has resulted in significant transformations in a variety of areas, including education [1,2]. The inclusion of digital technologies into educational systems has fundamentally altered traditional teaching and learning methodologies, leading to significant improvements in accessibility, engagement, and efficiency [3]. Digital transformation in education comprises using digital tools and technologies to enhance the educational experience, streamline administrative procedures, and improve learning outcomes [4,5]. The trend has been driven by a variety of factors, including the widespread availability of digital devices, advancements in internet connectivity, and the growing need for personalized learning experiences [6]. Educational institutions are increasingly using digital platforms to provide content, enable communication, and evaluate students, resulting in a more dynamic and engaging learning environment [7].

The change from conventional, paper-based tests to digital assessments is among the most significant elements of digital revolution in education [8]. The creation of several educational technologies like Learning Management Systems (LMS), e-assessment tools, and instructional software enabling the manufacturing, distribution, and analysis of tests in digital format has aided in this transformation [9,10]. These

technologies not only enhanced the evaluation process but also gave teachers important information and understanding of student performance [11].

Among the several digital technologies revolutionizing education, artificial intelligence (AI) is one that most changes the field of educational evaluation especially [12]. Artificial intelligence, or the replication of human intellect in computers designed to understand and learn like humans, is AI has the power to completely transform how tests are developed, given, and evaluated in the context of education, therefore offering a more accurate and complete gauge of student learning [13,14]. Among the several digital technologies revolutionizing education, artificial intelligence (AI) is one that most changes the field of educational evaluation especially [12,15]. Artificial intelligence, or the replication of human intellect in computers designed to understand and learn like humans, is AI has the power to completely transform how tests are developed, given, and evaluated in the context of education, therefore offering a more accurate and complete gauge of student learning [16].

Artificial intelligence may improve the dependability and correctness of tests. Human mistakes and prejudices inherent in traditional tests could compromise the validity of the findings [17,18]. Conversely, artificial intelligence systems can precisely and consistently examine enormous volumes of data, therefore lowering the possibility of mistakes and guaranteeing a more objective assessment of student achievement [19]. Furthermore, artificial intelligence can spot trends and patterns in student answers, thereby giving teachers more understanding of areas where kids might want more help or intervention [20,21].

Moreover, evaluations grounded in artificial intelligence can give teachers and students instant comments [22,23]. AI can process and evaluate replies in real-time, unlike conventional tests that could take days or weeks to grade, therefore providing instantaneous feedback that can be applied to direct education and raise learning results [24–26]. Formative assessments benefit especially from this instantaneous feedback loop as quick comments are essential for spotting areas of improvement and adjusting training plans [27].

Support of adaptive testing is another major benefit of artificial intelligence in educational evaluation [28]. Dynamic change of the difficulty level of questions depending on the student's performance in real-time is the essence of adaptive testing. This method guarantees that every student receives questions suitable for their level of challenge, therefore offering a more realistic assessment of their actual aptitudes [29]. By means of analysis of student responses and adaptation of the exam, artificial intelligence algorithms may generate a customized assessment experience catered to the particular requirements of every student [30].AI may also help with assessment data interpretation and analysis. Often needing hand input and analysis, traditional approaches of data analysis can be labor-intensive and time-consuming [31]. On the other hand, artificial intelligence can rapidly analyze vast amounts of data and provide comprehensive analyses stressing important insights and patterns. This capacity lets teachers create focused interventions to help student learning and make data-driven decisions [32].

Although artificial intelligence offers several advantages for educational evaluation, its acceptance presents certain difficulties. Data security and privacy is one of the main worries [33]. Using artificial intelligence calls for gathering and evaluating vast volumes of student data, which begs questions regarding storage, management, and protection of this information [34]. Maintaining confidence and protecting private information depends on keeping student data free from intrusion. Potential algorithmic bias presents even another difficulty. AI algorithms are only as good as the data they are trained on; so, if the training data is skewed, the judgments produced might likewise be biassed [35]. This can result in unjust assessments and help to maintain current disparities in the educational system. Development and use of fair, transparent, inclusive AI algorithms considering the various backgrounds and demands of every student is crucial [36].

Furthermore, the effective integration of artificial intelligence into educational evaluation calls for enough teacher preparation and assistance. Many educators might not know about artificial intelligence technology and would need professional development and training to properly apply AI-based evaluation instruments [37]. Ensuring the effective adoption and application of artificial intelligence in education depends on giving teachers the tools they need [38].

Aim of the Study

This study aims to explore the attitudes and perceptions of primary school teachers towards the use of AI in preparing and writing tests. Understanding teachers' attitudes is crucial for the successful implementation of AI-based assessment tools, as teachers play a pivotal role in the adoption and integration of new technologies in educational settings. By investigating teachers' perspectives, this research seeks to identify the opportunities and challenges associated with AI-based test construction and its impact on measuring learning outcomes.

Research Questions

1. What are the general attitudes of primary school teachers towards AI-based test construction?

2. How do teachers perceive the impact of AI on the accuracy and effectiveness of measuring learning outcomes?

3. What are the potential barriers and facilitators to the adoption of AI in educational assessment?

2. Materials and Methods

Study Design:

This study employed a qualitative descriptive design, rooted in naturalism and constructivism, to explore primary school teachers' attitudes towards AI-based test construction. By assuming that reality is constructed through individual experiences, this approach facilitated a deep and nuanced understanding of teachers' perspectives on integrating AI in educational assessments. Adherence to the Standards for Reporting Qualitative Research (SRQR) guidelines ensured a rigorous and transparent research process, allowing for a detailed examination of the benefits, challenges, and implications of AI integration in educational settings. This methodological framework was chosen for its ability to capture the complexity and variability of real-world educational practices, providing valuable insights into the adoption and impact of AI in education.

Study Setting:

The study was conducted in various primary schools located in the Asir region of Saudi Arabia. These schools were selected for their diverse student populations and their varying levels of technological integration, providing a broad spectrum of environments in which teachers interact with AI-based educational tools. The school settings offered a unique context for examining how teachers perceive and implement AI in their assessment practices, encompassing both technologically advanced and traditional educational environments.

Participants:

A purposive sampling technique was utilized to recruit 16 primary school teachers for this study, as data saturation was reached with this number. The participants were drawn from a diverse range of schools in the Asir region to ensure a comprehensive understanding of teachers' attitudes towards AI-based test construction. Participants included both male and female teachers, reflecting the gender distribution commonly observed in the teaching profession. The ages of the participants ranged from 25 to 60 years, providing a broad perspective across different stages of teaching careers. The selection criteria ensured that each teacher had a minimum of 2 years of teaching experience, with at least 1 year specifically dedicated to primary education. This criterion was set to capture insights from teachers who have had substantial interaction with primary school students and could provide detailed accounts of their experiences with AI-based assessments. Participants represented various subjects critical to primary education, including language arts, mathematics, science, and social studies. This variety allowed for a richer exploration of AI integration across different curricular areas.

Data Collection

Data collection was conducted through face-to-face in-depth interviews and focus group discussions, guided by a semi-structured interview guide specifically designed for this study. Each interview session was audio-recorded, with comprehensive notes taken concurrently to capture the entirety of the information shared.

The semi-structured interview guide, central to the data collection process, was meticulously developed by the primary author and subsequently subjected to a thorough review by an expert in language and communication, alongside the second and third authors, to ensure its comprehensiveness and relevance to the study's objectives (the interview guide is available in the supplementary file for reference). Interviews were conducted in designated, private rooms within the school premises or via secure online platforms, with each session lasting approximately 45-60 minutes. This setup ensured a conducive environment for participants to share their experiences freely and without interruptions.

To accommodate the linguistic preferences of the participants, interviews were conducted in both Arabic and English, depending on the participant's comfort level and language proficiency. This approach ensured that all participants could express themselves fully and accurately. Translation of the interviews conducted in Arabic was carried out by a bilingual expert, proficient in both English and Arabic, to ensure the accuracy and integrity of the translated material. This translation process was further validated by a second review conducted by an expert in language and communication, ensuring that the translated content accurately reflected the participants' original statements.

To ensure the accuracy and integrity of data collected in Arabic, a rigorous two-step translation process was employed. Initially, Arabic audio recordings were transcribed verbatim by a bilingual educational researcher, accurately capturing linguistic nuances and educational terminologies. These transcriptions were then translated into English by a professional translator specialized in educational contexts. To guarantee the fidelity of translation and the preservation of nuanced meanings, an independent bilingual expert reviewed the English translations against the original Arabic transcriptions. Any discrepancies were resolved through consensus, sometimes involving consultation with the original interviewees for clarification. This comprehensive approach, augmented by culturally sensitive translation techniques, was designed to ensure that the translated data faithfully represented the participants' perspectives, accurately conveying the essence of their experiences and the specific context of primary education across linguistic and cultural divides.

In addition to semi-structured interviews, this study employed a comprehensive approach to data collection that included notes taken during interviews, document reviews, and observational data. Notes taken during the interviews captured immediate reflections, non-verbal cues, and contextual details, enriching the primary data collected through verbal responses. These notes were reviewed immediately after each interview and included in the analysis to ensure that nuances and insights not captured in the audio recordings were considered.

Document reviews encompassed an examination of educational policies, AI tool documentation, and other relevant documents obtained with permission from the participating schools. This review provided a contextual framework for understanding the institutional guidelines and expectations surrounding AI-based assessment practices, allowing for a deeper analysis of how teachers' experiences and actions align with or diverge from these formalized standards.

Observations were conducted in the school settings to directly witness the interactions between teachers and the AI-based assessment tools. These observations offered valuable insights into the application of AI in practice, including the non-verbal communication and the environmental aspects influencing the assessment process. The observational data were systematically recorded and then integrated with interview and document data to triangulate the findings, enhancing the validity and depth of the analysis.

Data Analysis

The data collected from the in-depth, semi-structured interviews and focus group discussions were analyzed manually, following the structured approach of thematic analysis as outlined by Braun and Clarke.

This method was chosen for its robustness in analyzing qualitative data, allowing for both the identification of explicit content and the interpretation of latent meanings within the text. The analysis process was meticulously planned and executed in several distinct steps, ensuring a comprehensive and systematic examination of the interview transcripts.

Organizing Derived Codes:

As the primary author familiarized themselves with the data, initial codes were derived directly from the text. This process involved highlighting phrases, sentences, or paragraphs that seemed particularly relevant to the study's objectives. These segments were annotated with brief labels that captured their essence, serving as the foundational codes for further analysis.

Making Notes and Labeling for Codes:

While organizing the derived codes, the primary author made extensive notes, reflecting on the context, possible interpretations, and the relationships between codes. This reflective process was critical for moving beyond surface-level descriptions to deeper analyses. Codes were then systematically labeled, categorized, and organized to facilitate the identification of patterns and themes.

Emergent Categories and Cluster Formation:

The labeled codes were grouped into emergent categories based on their similarities and relationships. This step involved a dynamic process of comparing and contrasting the codes, refining the categories as needed. Categories were then clustered together to form broader themes that encapsulated the underlying patterns in the data.

Relevancy of Data and Thematic Analysis:

In our analysis, determining the relevancy of data was guided by its direct connection to the overarching themes. For instance, 'Perceptions of AI in Education' was an overarching theme that emerged from various participant reflections on the use of AI for test construction.

Initial codes were generated from such data points, capturing specific actions, reflections, or challenges teachers faced in adopting AI. Examples of initial codes included 'technological apprehension,' indicating instances where teachers expressed concerns about using AI tools, and 'perceived benefits,' highlighting the positive impacts teachers associated with AI-based assessments.

The clustering of these initial codes into broader themes was a dynamic and reflective process. 'Technological apprehension' and 'perceived benefits' were grouped under the larger theme of "Attitudes Towards AI Integration." This theme encapsulated the various ways teachers felt about AI, recognizing both their enthusiasm and their reservations. Such clustering allowed us to draw out broader insights about the implementation of AI in education, illustrating how teachers navigate the complexity of integrating new technologies while adhering to educational standards and protocols.

Examples of Initial Codes Identified:

- "Technological apprehension": Identified when teachers expressed concerns about the complexity or reliability of AI tools.
- "Perceived benefits": Noted when teachers described positive outcomes from using AI, such as enhanced student engagement or more accurate assessments.
- "Professional development needs": Coded for discussions about the training and support teachers felt they needed to effectively use AI tools.

Example of How Codes Were Clustered into Subthemes:

- "Defining AI Integration": Initial codes such as "Understanding AI capabilities" and "AI tool familiarity" were clustered into this subtheme, where teachers' descriptions formed a collective understanding of what AI integration entails in the classroom.

- "Attitudes Towards AI Integration": "Technological apprehension" and "Perceived benefits" codes were grouped under this subtheme, illustrating the mixed feelings teachers have towards AI tools. This clustering highlighted the balance between excitement for innovation and concerns about practical implementation.

- "Barriers to AI Adoption": Codes like "Professional development needs" and "Resource limitations" were combined to form this subtheme, focusing on the external factors that challenge the adoption of AI in educational settings. This clustering brought attention to systemic issues impacting the feasibility of integrating AI practices.

Analytical Reliability:

In our study, the reliability of the thematic analysis was enhanced through the involvement of a second experienced qualitative researcher. This reviewer independently examined a random subset of the data, applying the initial coding framework to ensure consistency and objectivity in code application and thematic interpretation. Discrepancies identified during this independent review were meticulously discussed in collaborative meetings aimed at achieving consensus on the coding and themes. This process involved iterative reviews of data and adjustments to the coding framework as needed, based on detailed discussions and additional data examination to resolve any disagreements. The collaborative effort between the primary analyst and the second reviewer not only ensured consistency in the analysis but also enhanced the credibility and rigor of the thematic structure, culminating in a set of themes that both analysts agreed accurately represented the data.

The final step involved reporting the findings in a manner that was both informative and engaging. This included detailed descriptions of each theme, supported by direct quotes from the participants to illustrate the themes and sub-themes. The reporting focused on conveying the depth and richness of the data, highlighting the nuances of teachers' attitudes towards AI-based test construction.

Credibility of the Study

Ensuring the credibility of our study involved a multi-faceted approach to data collection and analysis, employing several strategies to deepen our understanding and validation of the findings. The credibility of this study exploring primary school teachers' attitudes towards AI-based test construction was established through the following measures:

1. **Prolonged Engagement and Triangulation:**

- Prolonged Engagement: The researcher engaged extensively with the participants through semi-structured interviews and focus group discussions. This prolonged interaction deepened the understanding of teachers' intricate views and experiences regarding AI in educational assessments, enriching the data with diverse perspectives and detailed accounts.

- Triangulation: Insights were integrated from interviews, focus groups, document reviews, and observational data. This method ensured a robust and comprehensive analysis, validating the findings through multiple data sources and perspectives.

2. **Peer Debriefing and Member Checking:**

- Peer Debriefing: The researcher sought feedback from colleagues who were not directly involved in the study. These colleagues provided critical insights and validation of the interpretations, ensuring that the findings accurately reflected the data.

- Member Checking: Participants were invited to review the summarized findings and themes to confirm their accuracy and resonance with their experiences. This collaborative validation process helped to ground the findings in the participants' realities, enhancing the study's overall credibility.

3. **Thorough Documentation and Reflexivity:**

- Thorough Documentation: Detailed documentation of the research process, including the development of the interview guide, data collection procedures, and data analysis steps, was maintained. This transparency ensured that the study could be replicated and that the findings were grounded in a systematic and rigorous approach.

- Reflexivity: The researcher maintained a reflexive journal throughout the study, documenting thoughts, assumptions, and potential biases. This reflexive practice helped in critically examining the researcher's influence on the data collection and analysis, ensuring a more objective and unbiased interpretation of the findings.

4. **Iterative Data Analysis:**

- The data analysis was conducted iteratively, allowing for continuous refinement of codes and themes. This process involved re-examining the data multiple times to ensure that all relevant aspects were captured and accurately represented in the final themes.

5. **Use of a Second Reviewer:**

- To enhance the reliability of the thematic analysis, the researcher sought a second review from an experienced qualitative researcher. This reviewer independently examined a subset of the data. Discrepancies identified during this independent review were meticulously discussed and resolved through consensus, ensuring consistency and accuracy in the coding and thematic interpretation.

By employing these comprehensive strategies, the study aimed to ensure that the findings were robust, well-grounded, and reflective of the complex dynamics at play in teachers' attitudes towards AI-based test construction. This multi-dimensional approach to data collection and analysis underscores the study's commitment to capturing the depth and breadth of experiences that inform and shape teachers' perspectives on the integration of AI in educational assessments.

Ethical Considerations

This study received approval from the Institutional Review Board (IRB) of King Khaled University, Saudi Arabia, with the reference number: ECM#2024-1405, on 5.6.2024 Permissions were also secured from the participating primary schools in the Asir region. Informed consent was a priority, with participants receiving detailed explanations about the study's objectives, methods, and their rights, including the right to withdraw at any time without repercussions. Participants were informed that their interactions with AI-based assessment tools might be observed for research purposes, with assurances that no personally identifiable information would be recorded. To ensure confidentiality and anonymity, each participant was assigned a unique identifier, and all data were securely stored and accessible only to the research team. Rigorous measures, including encrypted digital storage and secure physical storage, were implemented to safeguard data. Additionally, efforts were made to mitigate any potential psychological discomfort by providing a comfortable and private environment, with access to support services if needed.

.3. Results

3.1. Demographic data

The characteristics of the participants (Table 1) illustrate the diversity within the sample, with ages ranging from 25 to 60 years and a variety of educational backgrounds, including Diplomas, Bachelor's, and Master's Degrees. The majority of participants were female, reflecting the typical gender distribution in primary education, though the inclusion of male teachers provided a broader perspective on attitudes towards AI-based test construction. Experience levels among the teachers varied from 2 to 30 years, offering a mix of seasoned insights and newer viewpoints.

This diversity among participants was crucial for a nuanced understanding of the complexities surrounding teachers' attitudes towards AI in educational assessment. The wide range of ages, educational backgrounds, and teaching experiences contributed to a comprehensive view of the factors influencing their perceptions and readiness to adopt AI technologies in their teaching practices.

Table 1. Characteristics of Teacher Participants

Participant	Age (Years)	Gender	Education Level	Years of Teaching Experience
T1	34	Female	Bachelor's Degree	10
T2	46	Female	Master's Degree	15
T3	39	Male	Bachelor's Degree	8
T4	58	Female	Advanced Diploma	25
T5	30	Female	Bachelor's Degree	5
T6	50	Female	Diploma	25
T7	44	Male	Bachelor's Degree	12
T8	49	Female	Diploma	18
T9	37	Male	Bachelor's Degree	9
T10	41	Female	Bachelor's Degree	16
T11	28	Female	Bachelor's Degree	7
T12	53	Female	Diploma	22
T13	25	Female	Bachelor's Degree	2
T14	60	Male	Master's Degree	30
T15	38	Female	Bachelor's Degree	11
T16	42	Female	Master's Degree	17

3.2.Thematic Analysis

In exploring primary school teachers' attitudes towards AI-based test construction, the qualitative analysis identified four main themes and three subthemes for each theme (Table 2). These themes and subthemes address the research questions and capture the essence of the teachers' perspectives, experiences, and challenges regarding AI integration in educational assessments.

I. General Attitudes Towards AI-Based Test Construction

1. **Openness to Innovation:** Primary school teachers in our study expressed a general openness and curiosity towards AI-based test construction. They viewed AI as a potential tool to enhance their teaching methods and improve student assessments. For instance, Participant T3 remarked, "I'm excited about what AI can bring to the table. It could revolutionize how we create tests and engage students." This enthusiasm underscores a positive attitude towards integrating new technologies. Participant T7 highlighted the readiness to experiment, stating, "I'm willing to try out AI tools in my classroom to see how they can help my students learn better." These responses collectively illustrate a forward-thinking mindset among teachers, eager to explore and implement innovative AI solutions in education.

2. **Technological Apprehension:** Despite the enthusiasm for innovation, some teachers expressed apprehensions about the complexity and reliability of AI-based assessments. Participant T5 voiced a common concern, "I'm worried about how complicated these AI tools might be. Will I need a lot of training to use them effectively?" This sentiment reflects a fear of the unknown and a potential barrier to adoption. Participant T8 added, "Can we trust the results from AI assessments? What if they make mistakes?" These

doubts highlight the need for robust support and assurance regarding the reliability and accuracy of AI tools. Such apprehensions suggest that while teachers are open to new technologies, they require confidence and reassurance in their efficacy and user-friendliness.

3. **Professional Development Needs:** The necessity for adequate training and support emerged as a significant theme. Teachers recognized that successfully integrating AI into test construction would require substantial professional development. Participant T1 emphasized, "To use AI tools effectively, we need proper training. Without it, we might not be able to leverage their full potential." This statement underscores the importance of equipping teachers with the skills and knowledge necessary to navigate AI technologies. Participant T6 highlighted the need for ongoing support, "It's not just about initial training. We need continuous support to adapt to new updates and features in AI tools." These insights reveal that professional development is critical for overcoming technological apprehension and ensuring the effective use of AI in educational assessments.

II. Perceived Impact of AI on Measuring Learning Outcomes

1. Accuracy and Objectivity Teachers in our study articulated that AI has the potential to enhance the accuracy and objectivity of educational assessments. For instance, Participant T1 described AI as "a tool that can provide precise data on student performance, eliminating much of the human error and bias inherent in traditional assessments." This perspective underscores the shift from subjective to data-driven evaluation methods. Participant T3 highlighted the consistency AI brings, stating, "AI ensures that assessments are graded uniformly, providing a fairer measure of student abilities." These definitions collectively paint AI as an objective, reliable tool that can significantly improve the accuracy of learning outcome measurements.

2. Personalization of Learning Teachers identified AI's capability to personalize learning experiences as a major advantage. AI's ability to tailor assessments to individual student needs was emphasized. Participant T5 explained, "AI can adapt questions based on a student's performance in real-time, ensuring they are always working at the right level of challenge." This adaptability is crucial for addressing the diverse learning needs within a classroom. Participant T7 highlighted the benefits of immediate feedback, stating, "Students receive instant results and tailored feedback, which helps them understand their mistakes and learn more effectively." These insights show that AI can create a more personalized and responsive educational environment, catering to the unique needs of each student.

3. Enhanced Student Engagement The study also revealed that AI-based assessments could significantly boost student engagement. Participants noted that the interactive and dynamic nature of AI tools makes learning more engaging for students. Participant T2 shared, "AI assessments often include gamified elements, making the learning process more fun and motivating for students." This approach can lead to increased student interest and participation. Participant T6 added, "The interactive nature of AI tools helps keep students engaged and interested in the subject matter, which is often challenging with traditional methods." These comments illustrate how AI can transform the learning experience by making it more engaging and interactive, ultimately enhancing student outcomes.

III. Barriers to the Adoption of AI in Educational Assessment

1. **Resource Limitations:** Teachers in our study highlighted significant resource limitations as a major barrier to adopting AI-based test construction. For instance, Participant T1 mentioned, "Our school doesn't have the necessary technological infrastructure to support AI tools. We're still struggling with basic computer access." This reflects the broader issue of inadequate technological resources in many schools. Participant T7 emphasized funding constraints, stating, "AI tools are expensive, and we simply don't have the budget to invest in them right now." These statements underscore the financial challenges schools face in adopting new technologies. Additionally, Participant T12 pointed out access disparities, "There's a big gap between schools in affluent areas and those in less privileged areas. Not all schools have equal access to technology, which is a huge hurdle for AI implementation."

2. **Privacy and Ethical Concerns:** The study also revealed significant concerns about data privacy and ethical implications of using AI in educational assessments. Participant T5 expressed, "I'm worried about the privacy of student data. How can we ensure that the information collected by AI tools is secure?" This highlights the critical issue of data security in the digital age. Participant T9 added, "There are ethical considerations. We need to ensure that AI is used fairly and that it doesn't disadvantage any group of students." This comment reflects broader concerns about transparency and fairness in AI applications. Participant T3 elaborated on algorithmic bias, "If the AI is trained on biased data, it will produce biased results. We need to be very careful about how these tools are developed and used."

3. **Resistance to Change:** Resistance to change emerged as another significant barrier. Participant T4 noted, "There's a cultural resistance to adopting new technologies in our school. Many teachers prefer sticking to traditional methods." This sentiment illustrates the challenge of changing long-standing educational practices. Participant T8 mentioned a lack of awareness, "Many of my colleagues don't really understand what AI is or how it can benefit our teaching. There's a lot of skepticism." This indicates the need for greater awareness and education about AI's potential benefits. Furthermore, Participant T11 highlighted the preference for traditional methods, "We've been using the same assessment methods for years. It's hard to convince everyone to switch to something new, especially when there's uncertainty about its effectiveness."

IV. Facilitators for the Adoption of AI in Educational Assessment

1. **Administrative Support** Participants in the study highlighted the critical role of administrative support in facilitating the adoption of AI in educational assessments. Administrative endorsement is viewed as essential for creating a conducive environment for technological innovation. For instance, Participant T4 stated, "Having the principal's backing made a significant difference. It gave us the confidence to experiment with AI tools without fearing backlash." This underscores the importance of leadership in fostering a culture of innovation and acceptance of AI technologies. Participant T9 added, "Clear policies and guidelines from the administration help us understand the boundaries and expectations, making the integration process smoother." These insights suggest that strong leadership and clear policy frameworks are pivotal in supporting teachers as they navigate the complexities of AI adoption.

2. **Collaborative Learning** The theme of collaborative learning emerged as another key facilitator. Teachers emphasized the value of peer collaboration and professional learning communities in sharing knowledge and best practices related to AI. Participant T2 described, "Working with colleagues who are also exploring AI has been incredibly beneficial. We share tips, troubleshoot issues, and support each other." This peer support system fosters a collaborative environment where teachers can learn from one another's experiences. Participant T11 highlighted the role of mentorship programs, stating, "Having a mentor who is experienced with AI tools has been invaluable. It has accelerated my learning curve and helped me implement AI more effectively in my classroom." These comments illustrate how collaborative learning and mentorship can build a supportive network that encourages the successful adoption of AI technologies.

3. **Positive Pilot Programs** Successful pilot programs were identified as a crucial factor in demonstrating the benefits of AI and building confidence among teachers. Participants noted that seeing positive results from pilot programs can significantly influence their willingness to adopt AI tools. Participant T6 shared, "Seeing a pilot program succeed in another school gave us the motivation to try it ourselves. The tangible benefits were hard to ignore." This highlights the impact of real-world examples in convincing educators of AI's potential. Additionally, Participant T13 mentioned, "Starting with small-scale pilots allowed us to gradually integrate AI, making the transition less overwhelming." This phased approach, combined with feedback mechanisms, enables teachers to adapt at their own pace and provides opportunities to refine the integration process based on practical experiences.

Table 2: Summary of Main Themes and Subthemes Identified in the Study

Theme	Subtheme	Description
I. General Attitudes Towards AI-Based Test Construction	Openness to Innovation	Teachers expressed curiosity and enthusiasm about AI, showing a willingness to experiment with new AI tools and positive expectations for AI's potential benefits.
	Technological Apprehension	Concerns about the complexity, reliability, and ability to effectively use AI tools. Some teachers were resistant to change and skeptical about AI-based assessments.
	Professional Development Needs	Emphasis on the need for comprehensive training and support systems to develop the technical skills necessary for integrating AI tools in education.
II. Perceived Impact of AI on Measuring Learning Outcomes	Accuracy and Objectivity	Appreciation for AI's ability to provide detailed, objective data, reduce human bias, and ensure consistent and fair evaluations.
	Personalization of Learning	Valued AI's capability to create personalized assessments, adjust learning paths in real-time, and provide immediate feedback.
	Enhanced Student Engagement	Recognition of AI-based assessments as more engaging and interactive, with potential to increase student motivation and interest, incorporating gamification elements.
III. Barriers to the Adoption of AI in Educational Assessment	Resource Limitations	Major barriers included lack of adequate technological infrastructure, insufficient funding, and disparities in access to technology among different schools and regions.
	Privacy and Ethical Concerns	Worries about data privacy, security, and ethical implications of AI, including transparency, fairness, and potential biases in algorithms.
	Resistance to Change	Cultural resistance to adopting new technologies, lack of awareness and understanding of AI, and a preference for traditional teaching and assessment methods.
IV. Facilitators for the Adoption of AI in Educational Assessment	Administrative Support	Importance of strong administrative endorsement, clear policies, and guidelines in fostering a culture of innovation and supporting teachers in AI adoption.
	Collaborative Learning	Value of peer collaboration, professional learning communities, and mentorship programs in sharing knowledge, troubleshooting issues, and supporting AI integration.
	Positive Pilot Programs	Successful pilot programs demonstrated AI benefits, motivating other teachers to adopt AI. Phased implementation and feedback mechanisms helped in adapting AI effectively.

4. Discussion

This study explored primary school teachers' attitudes towards AI-based test construction in Saudi Arabia, revealing a complex landscape of perceptions, opportunities, and challenges. The findings highlight four main themes: general attitudes towards AI-based test construction, perceived impact on measuring learning outcomes, barriers to adoption, and facilitators for adoption. These themes provide valuable insights

into the potential integration of AI in educational assessment and the factors that influence its acceptance and implementation.

General Attitudes Towards AI-Based Test Construction

The results indicate a mixed response among teachers, characterized by openness to innovation coupled with technological apprehension and a recognized need for professional development. This aligns with previous research suggesting that while educators often express interest in new technologies, they may also harbor concerns about their implementation [39,40] .

The openness to innovation demonstrated by many participants reflects a growing recognition of AI's potential in education. This aligns with the findings of Holmes et al. (2019), who noted increasing interest in AI applications among educators [41]. However, the technological apprehension expressed by some teachers underscores the importance of addressing concerns and building confidence in AI tools. This apprehension is not unique to this study; Blikstein similarly found that educators often worry about the complexity and reliability of new technologies in the classroom [42].

The emphasis on professional development needs highlights a crucial aspect of successful AI integration. This finding echoes the work of which stressed the importance of comprehensive training programs for educators to effectively implement new technologies [43]. The need for ongoing support and training, as expressed by participants, suggests that one-time workshops may be insufficient [44]. Instead, a sustained, iterative approach to professional development may be necessary to build and maintain teachers' competence and confidence in using AI-based assessment tools [45].

Perceived Impact of AI on Measuring Learning Outcomes

Teachers in this study recognized AI's potential to enhance the accuracy, objectivity, and personalization of assessments, as well as to increase student engagement. These perceptions align with current research on the benefits of AI in education.

The potential for increased accuracy and objectivity in assessments, as noted by participants, is supported by studies found that AI can reduce human bias and provide more consistent evaluations [46]. This capability of AI could address longstanding concerns about subjectivity in traditional assessment methods, potentially leading to fairer and more reliable measures of student performance [47].

The emphasis on personalization of learning through AI aligns with the growing trend towards adaptive learning systems. AI-powered adaptive systems can tailor content and assessments to individual student needs, potentially improving learning outcomes [48]. The teachers' recognition of this potential suggests a readiness to embrace more personalized approaches to assessment and instruction [49].

The perception that AI-based assessments could enhance student engagement is particularly noteworthy. This aligns with studies found that interactive, AI-driven educational tools can increase student motivation and participation [50]. The potential for gamification elements in AI assessments, as mentioned by participants, further supports this view, on the positive impact of gamification on student engagement [51].

Barriers to the Adoption of AI in Educational Assessment

The identified barriers – resource limitations, privacy and ethical concerns, and resistance to change – represent significant challenges that need to be addressed for successful AI integration in educational assessment.

Resource limitations, including inadequate technological infrastructure and funding constraints, are common obstacles in educational technology adoption. This finding aligns with research who identified resource disparities as a key factor in the digital divide among schools [52]. The disparity in access to technology between affluent and less privileged areas, as noted by participants, highlights the need for targeted investments to ensure equitable access to AI-based educational tools [53].

Privacy and ethical concerns emerged as another significant barrier, reflecting broader societal debates about AI and data privacy. These concerns align with findings emphasized the ethical implications of using

student data in AI systems [54]. The teachers' awareness of potential algorithmic bias and fairness issues demonstrates a sophisticated understanding of AI's complexities and the need for careful implementation [55].

Resistance to change, particularly the preference for traditional methods, is a well-documented phenomenon in educational innovation [56]. This resistance may stem from a lack of understanding about AI's potential benefits or concerns about job security. Addressing this barrier will likely require a combination of education, demonstration of AI's effectiveness, and reassurance about the continued importance of human teachers in the educational process [57].

Facilitators for the Adoption of AI in Educational Assessment

The identified facilitators – administrative support, collaborative learning, and positive pilot programs – provide valuable insights into strategies that can promote the successful adoption of AI in educational assessment.

The importance of administrative support aligns with research found that school leadership plays a crucial role in technology integration [58]. Clear policies and guidelines, as mentioned by participants, can provide a framework for AI implementation and help alleviate teachers' concerns about its use [59].

Collaborative learning emerged as a key facilitator, highlighting the value of peer support and professional learning communities, also the importance of collaborative professional development in technology integration [60]. The mention of mentorship programs suggests that a structured approach to peer learning could be particularly effective in building teachers' confidence and skills in using AI tools [61].

The impact of positive pilot programs in motivating AI adoption aligns with the concept of observability in diffusion of innovations theory. Seeing successful implementations can reduce uncertainty and demonstrate the tangible benefits of AI in education [62]. The preference for small-scale, gradual implementation, as noted by participants, suggests a need for a phased approach to AI integration, allowing for adaptation and refinement based on real-world experiences [63].

Implications and Future Directions

The findings of this study have several implications for the integration of AI in educational assessment, particularly in the context of primary education in Saudi Arabia.

Firstly, there is a clear need for comprehensive, ongoing professional development programs that address both the technical aspects of AI tools and their pedagogical applications. These programs should be designed to build teachers' confidence and competence over time, addressing the technological apprehension expressed by some participants.

Secondly, the development and implementation of AI-based assessment tools should prioritize user-friendliness and transparency. Tools that are intuitive to use and provide clear explanations of their decision-making processes may help alleviate concerns about complexity and reliability.

Thirdly, addressing resource limitations will require coordinated efforts from educational authorities, policymakers, and potentially private sector partners. Initiatives to improve technological infrastructure and ensure equitable access to AI tools across different schools and regions are crucial for widespread adoption.

Fourthly, the ethical and privacy concerns raised by participants highlight the need for clear guidelines and policies governing the use of AI in education. These should address data protection, algorithmic fairness, and transparency in AI-based assessments.

Finally, the success of AI integration may depend on creating a supportive ecosystem that includes strong administrative backing, opportunities for collaborative learning, and carefully designed pilot programs. This ecosystem should foster a culture of innovation while providing the necessary support structures for teachers to experiment with and adopt AI tools.

Future research could explore the long-term impact of AI-based assessments on student learning outcomes, comparing them with traditional assessment methods. Additionally, studies examining the effectiveness of different professional development approaches in preparing teachers for AI integration would be valuable. Further investigation into strategies for addressing the digital divide and ensuring equitable access to AI tools across different socioeconomic contexts is also warranted.

5. Conclusions

This study on primary school teachers' attitudes towards AI-based test construction in Saudi Arabia reveals a complex landscape of perceptions, challenges, and opportunities. The findings highlight four main themes: general attitudes, perceived impact on learning outcomes, barriers to adoption, and facilitators for adoption. Teachers generally show openness to AI innovation, recognizing its potential to enhance educational practices, particularly in improving assessment accuracy, objectivity, and personalization. However, this enthusiasm is tempered by technological apprehension and concerns about complexity. Significant barriers include resource limitations, privacy and ethical concerns, and resistance to change, while key facilitators are strong administrative support, collaborative learning opportunities, and positive experiences from pilot programs. The study underscores the need for targeted investments in infrastructure, clear ethical guidelines, user-friendly AI tools, comprehensive professional development, and supportive ecosystems for innovation. These findings have important implications for educational policy and practice, highlighting areas for future research such as the long-term impact of AI-based assessments and strategies for bridging the digital divide. While integrating AI in educational assessment presents challenges, it offers significant potential to enhance teaching and learning. By addressing concerns and leveraging opportunities identified in this study, stakeholders can work towards a more effective, equitable, and innovative approach to assessment in primary education. As AI continues to evolve, ongoing research, dialogue, and adaptation will be crucial in shaping its role in education, ensuring it complements rather than replaces the essential human elements of teaching and learning.

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