

Research Article

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Addressing and Managing Artificial Intelligence (AI) Challenges and Opportunities in Elementary Education in Saudi Arabia: An In-Depth Consideration

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Abstract

Background/purpose. This study investigates the integration of artificial intelligence (AI) into primary education, with a focus on identifying the needs, benefits, and challenges that schools and educators encounter in the adoption process.

Materials/methods. A descriptive-analytical approach was employed, utilizing data collected through a comprehensive, structured questionnaire. The instrument was validated and demonstrated high reliability. The study sample consisted of 515 male and female primary school teachers, selected through a simple random sampling method. The survey aimed to assess AI-related needs, perceived benefits, and encountered challenges within the educational context.

Results. The findings underscore the significant potential of AI to enhance educational outcomes, particularly through personalized learning, interactive teaching tools, and efficient data management systems. Nonetheless, several key barriers were identified, including limited access to AI technologies, insufficient teacher training, and infrastructural limitations.

Conclusion. The study emphasizes the critical need for strategic planning, professional development, and adequate resource allocation to ensure the effective integration of AI in primary education. The insights derived offer valuable recommendations for policymakers, educators, and researchers committed to harnessing AI to improve educational quality.

1. Introduction

In the past few years, the world has witnessed momentous developments across various fields of science and knowledge. The contemporary era is distinguished by its unique knowledge explosion, information age, and scientific revolution (Shapin, 2018; Strevens, 2020). The progress of nations is no longer measured solely by the volume of their information, but also by their ability to organize and employ this information for the benefit of the population and society. Among these advancements, artificial intelligence (AI) has emerged as a critical topic in academic, educational, and administrative domains (Bearman et al., 2023; Bozkurt et al., 2021). AI is a widely discussed concept and has been applied across diverse scientific, technical, and even humanities fields. Given today's global developments and innovations, the use of intelligent gadgets and technologies that can autonomously adapt and make decisions predicated on their environment and experiences over time has become customary (Carlos, 2018; Dianova et al., 2023).

AI has gained distinct prominence in the field of education, especially in designing effective instructional approaches (Khosravi et al., 2022). Drawing from theories, such as area proximate development and AI education research, qualitative analyses accentuate the educational benefits of AI, including elucidating complicated or subtle concepts through engaging and relatable learning experiences, improving students' understanding and proficiency, and nurturing critical thinking (Dai et al., 2024). For AI to be effectively utilized in education, teaching strategies must prioritize student comprehension while recognizing AI as an interdisciplinary tool with many applications.

Education centers internationally have experienced hasty updates because of technological advances, compelling them to revise their programs, teaching strategies, and educational practices. These shifts aim to satisfy quality standards that balance contemporary political, cultural, technological, and social realities while achieving overarching learning targets (Collins & Halverson, 2018; Mohamed Hashim et al., 2022). Higher education, like other sectors, has undergone technological and electronic evolution, leveraging AI as a defining technology of the era. AI has extensive application ranging from essential data processing devices and advanced intelligent systems and applications to highly complicated mechanisms.

This study explores the role of AI in improving educational quality (Tomi, 2025). AI applications in education have elicited much attention. With the rapid growth of AI technologies, optimizing the use of these tools in education has become essential for potential progress, particularly in association with Saudi Arabia's Vision 2030 (Mutambik, 2024; Alotaibi & Alshehri, 2023). AI applications in education address the challenges faced by the sector, including the need for individualized instruction, personalized teaching methods, and solutions to current educational challenges. Research has revealed numerous learning gains that can be achieved through AI technologies, particularly in elementary education (Al-Hujaili & Al-Frani, 2019; Bhutoria, 2022).

AI applications include speech-to-text programs, visual content analyzers, and platforms (e.g., Thinkster Math, Brainly, and Netex Learning). These examples show AI's groundbreaking potential and innovative capacity in Saudi education; its capabilities help and benefit educators and students (Jil Center, 2022; Darwish, 2025).

1.1. Research Problem

AI is a driving force for transforming conventional concepts in the field of education; it offers chances and allows for predictions to innovate teaching and learning methods and enhance the overall educational quality. However, integrating AI into elementary schools poses challenges that require particular attention. (George & Wooden, 2023; Albahiri et al., 2025). Elementary school teachers exhibit different degrees of acceptance and resistance toward adopting modern technologies in their teaching practices. This situation creates a considerable gap in the proper

implementation of AI in education, whether through its actual application or integration into curricula or syllabi (Salah, 2023; Lawrence & Tar, 2018).

The authors' observations, literature review, related inquiries, and parallel research reveal that multiple challenges arise from the use of AI in elementary schools. These challenges encompass concerns about losing human interaction, reduced communication between teachers and students, and lack of teacher acquaintance with and credence in understanding and employing AI technologies (Kim et al., 2022). Advanced intelligent systems that can understand student needs and provide adaptive assistance and customized guidance need to be developed to address these issues.

Resolving these problems and challenges requires AI tools, such as virtual reality (VR) and augmented reality (AR), to create fascinating and synergistic learning experiences, analyze school performance data to identify strengths and weaknesses, and make competent and beneficial decisions to improve educational quality (AlGerafi et al., 2023). These issues emphasize the necessity of providing teachers with the knowledge and skills needed to effectively integrate AI into their daily instructional practices and learning experience while maintaining a balance between technology and the human facets of education (Yadav, 2025).

1.2. Research Objectives

This research seeks to attain the following objectives:

1. To determine the needs of elementary schools in the field of AI to achieve effectiveness and efficiency in developing educational quality;
2. To understand the effects of AI technologies and programs on enhancing educational quality in elementary schools;
3. To explore the challenges that impede the adoption of AI in elementary schools;
4. To address and manage AI challenges and opportunities in elementary education.

1.3. Research Questions

In conformity with the objectives above, the following research questions are established:

1. What are the AI needs of elementary schools to achieve effectiveness and efficiency in developing educational quality?
2. What are the effects of AI technologies and programs on enhancing educational quality in elementary schools?
3. What are the challenges that hinder the adoption of AI in elementary schools?
4. How can AI challenges and opportunities in elementary education be addressed and managed from theoretical and practical perspectives?

1.4. Significance of the Research

The importance of this study lies in its theoretical and practical contributions to the field of AI in education, particularly at the elementary school level. The study is anticipated to provide valuable contributions and implicit implications, as described below.

Theoretical importance emphasizes the academic and knowledge expansion aspects of the study, with focus on the following:

- Addressing the pressing need to understand and analyze the importance of AI in elementary education;

- Underscoring the crucial role of AI in improving teaching processes at the elementary school level;
- Exploring the mechanisms of AI application in education, determining the obstacles to its implementation, and examining its most important dimensions;
- Encouraging and inspiring educational stakeholders to integrate and utilize AI technologies in elementary education to improve teaching and learning outcomes.

1.5. Practical Significance

Practical importance fixates on the study's applicability and potential to inform curriculum design and didactic approaches. It includes the following:

- Providing comprehensive information on how AI can help enhance the quality of education in elementary schools;
- Identifying the needs of students at this educational stage and utilizing previous studies to improve teachers' skills;
- Helping teachers employ AI applications effectively, improve their technological skills, and integrate AI into teaching processes;
- Offering actionable information and contributions to actionable information, educational quality, and ensuring the complete integration of technology into teaching and learning activities.

1.6. Challenges: Teacher Attitudes and Systemic Infrastructure

A key challenge in integrating AI into elementary education lies in the complex relationship between teacher attitudes and the systemic infrastructure available in schools. Teachers' acceptance of AI technologies is significantly influenced by their confidence in using these tools and their belief in the benefits AI can bring to their instructional practice (Lawrence & Tar, 2018). Many teachers exhibit resistance due to concerns about diminished human interaction, uncertainty about AI's role, and limited familiarity with AI applications (Kim et al., 2022). However, these attitudes are not formed in isolation but are deeply connected to the systemic context—specifically the availability of adequate technological infrastructure, institutional support, and professional development opportunities (Albahiri et al., 2025). Without reliable hardware, software, and ongoing training, teachers are less likely to feel competent or motivated to integrate AI into their classrooms. This gap creates a feedback loop, where insufficient infrastructure reinforces teacher skepticism, which in turn slows institutional commitment to AI adoption. To overcome these intertwined challenges, it is essential that educational leaders provide a supportive environment combining robust infrastructure with sustained capacity-building efforts. Professional development programs tailored to enhance teachers' AI literacy and confidence can transform initial resistance into proactive engagement (George & Wooden, 2023). Ultimately, fostering a positive synergy between teacher attitudes and systemic infrastructure is crucial for realizing AI's full potential to enhance educational quality in elementary schools.

2. Literature Review

2.1. Theoretical Background and Concept of AI

AI is a field of computer science preoccupied with enabling machines to mimic human behavior. In the last few years, AI has developed quickly, and it has altered people's way of life. AI has provided development strategies for improving global competitiveness and technological advancement, safeguarding security, and ensuring safety (Zhang & Lu, 2021). It comprises designing machines and computer programs capable of thinking, learning, decision-making, and acting as humans do. AI

mimics human cognitive capabilities through computer systems (Ocaña-Fernandez et al., 2019, pp. 556–557). According to Tredinnick (2017), AI is a collection of computing techniques that enable computers to make flexible and intelligent decisions in response to unpredictable environmental factors.

2.2. Evolution and Development of AI

AI's development can be divided into several critical milestones, as presented by Baker and Taha (2019, p. 389).

1. Birth of AI (1953–1956):

The term “artificial intelligence” was introduced during the Dartmouth Conference, a notable event that is often called AI's birthday. This conference set the stage for AI as a scientific discipline.

2. Golden Years of AI (1956–1974):

During this phase, implementation of AI began to appear, concentrating on linguistic engineering, programming languages, and algorithms. Tremendous improvements were achieved in areas, such as natural language processing and heuristic problem solving.

3. First AI Winter (1974–1980):

AI faced its first plateau phase during these years because of rising criticism and challenges in developed countries, particularly budget issues. Critics questioned the practicability and adaptivity of AI projects.

4. Era of Prosperity (1980–1987):

AI experienced a revival marked by the rise of expert systems, the scientific–technological revolution, and the fifth-generation computing initiative. These developments produced substantial economic returns and demonstrated AI's potential in several sectors.

5. Virtual AI Education and Training Conference (2019):

UNESCO–UNEVOC hosted a virtual conference on AI in education and training from November 11–15, 2019. The conference gathered insights from over 6,500 participants internationally, focusing on opportunities and challenges in integrating AI into technical and vocational education and training. The major findings comprised the following:

- a. Despite increasing interest in AI, pervasive enterprise-wide applications in education and training remain limited.
- b. Multistakeholder engagement is crucial to create flexible educational opportunities.
- c. Education establishments must prepare students not only for current employment markets but also for future disruptions and impending gaps.
- d. Developing countries, particularly Africa, encounter substantial macrolevel challenges in adopting AI (Virtual Conference on Artificial Intelligence, 2019).

2.3. Insights from Recent AI Trends in Education

AI has become a transformative educational tool and learning strategy that creates opportunities to address multiple challenges and enhance learning outcomes and educational attainments. According to Popenici and Kerr (2017), AI enables customized learning experiences, improves critical thinking, and promotes collaborative problem-solving among students. Moreover, Tondeur et al. (2020) indicated that countries integrating AI into their education systems often witness a shift toward competency-based learning, preparing students for the demands of future labor markets.

However, challenges in adopting AI at scale persist. As highlighted during the UNESCO virtual conference, developing nations have limited infrastructure, unsatisfactory teacher training, and inadequate policy frameworks and regulative arrangements to support AI integration (UNESCO, 2019).

2.4. Key Takeaways from the Evolution of AI

- The golden era of AI showed its potential in language processing and automated design.
- The periods of stagnancy often corresponded to funding and feasibility constraints.
- AI's reappearance in the 1980s highlighted the economic practicality of AI applications.
- Contemporary efforts, such as UNESCO initiatives, highlight comprehensive and reasonable AI adoption in developed and developing nations (Aderibigbe et al., 2023).

2.5. Importance of AI in Education

AI considerably improves education at all levels. As one of the fundamental sectors that benefit from AI, education requires considerable reforms that can be achieved with AI technologies. AI has the potential to address existing educational issues and pedagogical obstacles, analyze their implications, and create safe academic environments and teaching spaces supported by efficient planning, computer-aided design, and technological advancement (Luan et al., 2020).

AI is a nonconventional tool in the quickly evolving field of educational technology. Schools and students generate massive amounts of data that AI-driven systems can manage, analyze, and store in vast databases (Maphosa & Maphosa, 2023). Such systems can reduce operational expenses and increase efficiency. For example, AI can analyze historical databases on textbook use, student enrollment trends, and school resource allocation. On the basis of this analysis, it can anticipate future needs, such as the necessary number of textbooks for schools all over the country, thus ensuring efficacious functional planning and resource forecasting (Guan et al., 2020).

The integration of AI-powered tools and robotics tailored to individual requirements is also expected to transform the traditional classroom setting and classroom-based learning. Many students will benefit from the flexibility and adaptability of AI-driven robots that can provide consistent support. Moreover, educators will be free of bureaucratic duties and administration tasks, allowing them to concentrate on instruction and student engagement (Mousa & Bilal, 2019).

2.6. Benefits of AI Integration in Education

- a. Individualized Instruction: AI enables individualized instruction tailored to each learner's pace, interest, and learning style, thus improving engagement and outcomes (Popenici & Kerr, 2017).
- b. Data-driven Decision-making: AI systems can analyze large datasets to enhance resource allocation and anticipate future trends, such as enrollment or textbook needs; it can also reduce costs and improve planning precision (Zawacki-Richter et al., 2019).
- c. Administrative Efficiency: AI allows teachers to concentrate on teaching and mentoring students by automating administrative tasks, such as attendance recording and performance evaluations.
- d. Enhanced Flexibility: AI-based tools, such as virtual tutors and chatbots, provide learners with 24/7 support and nurture self-directed and flexible academic environments and educational atmospheres (Faggella, 2019).
- e. Improved Accessibility: AI can assist students with disabilities by providing individualized support, including speech-to-text tools, tailored learning platforms, and language translation services.

The transformative potential of AI in education highlights the need for its strategic adoption and integration. Its role extends beyond operational efficiency to creating dynamic, interactive, and inclusive learning experiences that prepare students for prospective problems.

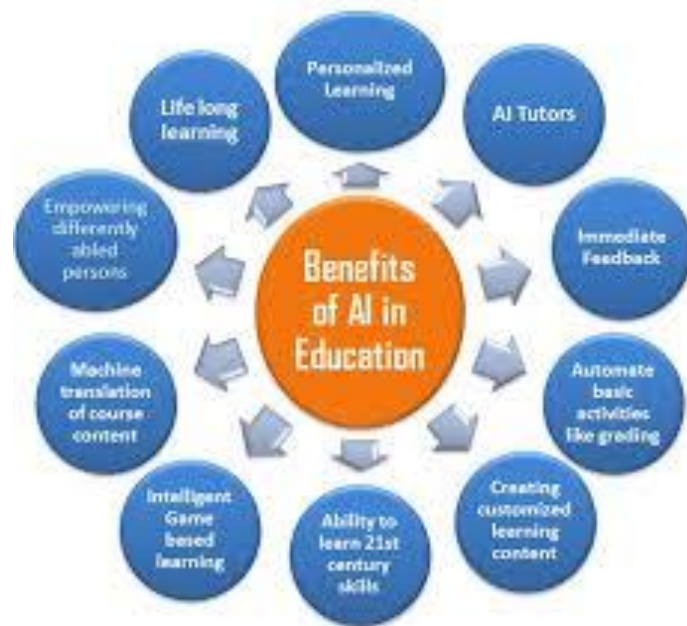


Figure 1. Using Artificial Intelligence Technologies for Personalized Learning and Responsive

Source: (Wadhwa, 2017, p. 212).

2.7. Objectives of AI in Education

AI has become a essential component of transforming education by achieving particular goals to enhance learning outcomes and address the challenges in traditional educational systems. The primary objectives of AI in education are provided below (Shehata, 2022).

a. Enhancing Education Quality

AI seeks to boost the overall quality of education by providing personalized, efficient, and effective learning experiences for students, including integrating advanced technologies that cater to diverse learning needs.

b. Personalized Learning

It enables the tailoring of educational experiences to each student predicated on their needs and level of understanding. Intelligent systems can analyze student performance, providing exclusive content that associates with individual learning speeds and preferences (Popenici & Kerr, 2017).

c. Increased Accessibility to Education

Through online lessons, automated translations, and remote learning platforms, AI makes education accessible to students in remote or marginalized regions and under-served areas, bridging geographical and language barriers (Zawacki-Richter et al., 2019).

d. Data Analysis for Improved Performance

AI systems can process massive amounts of data about student performance and can help teachers and administrators determine merits and demerits. This data-driven approach supports informed decision-making and specific interventions to improve learning outcomes.

e. Automation of Routine Tasks

By automating tasks, such as grading assignments and exams, AI allows teachers to focus on actual teaching and supporting student needs, boosting their role as facilitators of learning (Faggella, 2019).

f. Support for Students with Special Needs

AI provides customized educational tools that assist students with learning difficulties or disabilities. For example, speech-to-text and tailored learning platforms enable students with special needs to engage in education competently (Cromton & Song, 2021).

g. Fostering Engagement and Interaction

Tools, such as AI-driven chatbots, offer instant assistance to students and encourage effective participation and engagement in traditional and online learning environments. These tools support and foster a dynamic, interactive educational experience.

h. Encouraging Lifelong Learning

AI platforms are designed to motivate students to continue learning outside the classroom through interactive and innovative platforms. These tools promote a culture of continuing development and curiosity.

i. Problem-solving and Real-world Application

AI supports learning through experience, enabling students to acquire life skills, solve challenges and vocational obstacles, and address personal problems. It prepares students for the demands of the workforce and society.

j. Making Education Increasingly Inclusive and Effective

I-driven tools aim to create a comprehensive educational experience, accommodating diverse student needs while improving each individual's learning journey and studying experience.

2.8. Implications for the Future

AI's integration into education has the potential to revolutionize learning by creating adaptive systems and pervasive computing that meet the needs of different learners and educators. The focus on personalization, accessibility, and efficiency highlights its transformational power in modern educational systems. As AI technologies evolve, their ability to improve educational equity and promote innovation increases quickly.

2.9. Previous Studies

Many studies have focused on AI problems and opportunities in elementary education. For example, Yusuf (2025) found that AI in primary education can improve learning quality through AR, VR, LMS, and tailored learning, but it still encounters difficulties related to technological discrepancies, costs, infrastructure, and training of teachers. This study provided observations and suggestions for policymakers and teachers to increase competence, improve infrastructure, and ensure equitable AI access in elementary schools. Castro et al. (2025) highlighted the need for technological and educational resources associated with the distinctive qualities of their contexts, such as offline information and malleable AI curricula, to address the pervasive challenges of limited or absent Internet connection in many country schools. Kim and Kwon (2023) revealed that teachers are the least confident in domain knowledge, followed by technological lore and didactic knowledge relevant to AI, and underscored the importance of instructional design in AI education. On the basis of these results, some AI competencies for elementary school teachers were obtained and classified using the technological pedagogical content knowledge framework. Rathore et al. (2023) indicated that curriculum adaptation and curriculum tailoring are needed constantly in the contemporary era. AI can control the benefit of curricula and identify certain fields. AI has provided important

contributions to the enhancement of contents and teaching methods and adoption of multimodal teaching–learning methodology to increase creativity, innovation, and problem-solving skills. AI education in elementary school curricula can train students for the 21st century and increase employment opportunities for students through AI integration into elementary education. Lampou (2023) discovered that AI systems can provide feedback on student academic performance, highlighting fields of advancement and ensuring inclusiveness for students with special needs or language barriers. Moreover, AI can computerize administrative duties or tasks, allowing teachers to sufficiently prepare for teaching and pedagogical development. Anam et al. (2024) pointed out that integrating AI into motor skills learning considerably improves the academic performance of students pursuing professional growth and self-directed development (PGSD). These findings emphasize the importance of incorporating AI technology into teacher education, particularly to enhance the motor skills development of PGSD students. Lin et al. (2021) found that deep motivation and motivational strategies of attention, relevance, and confidence profoundly influence career motivation. Compared with female students, male students score higher in the context of motivational factors and strategies. Yim (2023) showed that literacy education has mostly been implemented at secondary and university levels, whereas the issue of what to learn and how to teach and assess AI education at the primary school level remains under-investigated. Although researchers are beginning to teach primary students AI literacy, evidence-based research that informs teachers about the pertinence of the learning content of AI curriculum, educational approaches, and quality assessment procedures that cater to primary students’ needs remains lacking. Little is known about the importance of educational strategies in connection with the educational attainments of primary students.

The current study aligns with existing research in recognizing both the potential and challenges of integrating AI in elementary education. It agrees with Yusuf (2025) on AI’s capacity to enhance learning through immersive technologies and personalized instruction. Consistent with Kim and Kwon (2023), the study acknowledges the low confidence levels and preparedness of teachers in AI-related domains, reinforcing the need for targeted teacher training and professional development.

Moreover, in agreement with Castro et al. (2025) and Lampou (2023), this study emphasizes the importance of addressing infrastructural limitations, digital inequality, and contextual needs—especially in rural and under-resourced areas. It also supports Rathore et al. (2023) in highlighting the importance of curriculum flexibility and multimodal teaching to develop 21st-century skills such as creativity and problem-solving.

Like Anam et al. (2024), the study affirms the positive impact of AI on motor skill development and self-directed learning, particularly for students in teacher training programs. Furthermore, it echoes Yim (2023) in underscoring the need for more research-based AI literacy programs and effective pedagogical strategies at the primary school level.

2.10. The contribution of This Study to the Field

This study contributes to the field by offering a comprehensive synthesis of current research on the integration of artificial intelligence (AI) in elementary education, while also addressing notable gaps in the literature. Unlike previous studies that often examine isolated factors—such as technological access, teacher preparedness, or curriculum design—this research presents a multidimensional perspective that integrates pedagogical, infrastructural, and contextual considerations. It supports prior findings that AI enhances personalized learning and instructional quality (Yusuf, 2025), while also reaffirming the challenges teachers face regarding limited technological, pedagogical, and domain-specific knowledge (Kim & Kwon, 2023). In addition, the study aligns with research stressing the importance of equitable AI access and localized solutions for under-resourced schools (Castro et al., 2025), as well as the need for curriculum adaptability and multimodal teaching approaches to foster creativity and critical thinking (Rathore et al., 2023).

Beyond reinforcing existing literature, this study expands the field by incorporating underexplored dimensions, such as the application of AI in motor skills development and self-directed learning among students in teacher training programs (Anam et al., 2024). Furthermore, it responds to the identified lack of research-based frameworks for AI literacy at the primary school level (Yim, 2023), calling for the development of age-appropriate, evidence-based curricula and assessment tools. By synthesizing diverse findings and offering context-specific recommendations for educators, policymakers, and curriculum developers, this study provides a holistic foundation for future research and practical AI implementation in elementary education.

3. Methodology

3.1. Research Design

This study adopted the descriptive analytical method to achieve its purposes and examine its topic of addressing AI challenges and opportunities in elementary education in Saudi Arabia. This method explores present events, phenomena, and practices obtainable for research and measurement as they are, without researchers' intervention. It allows researchers to directly interact with the studied phenomena (Al-Agha, 2000, p. 43).

3.2. Study Population and Sample

The study population encompassed 515 male and female elementary school teachers in Bahrah schools. Given the comparatively small size of the study population, the researchers used the inclusive survey method and disseminated the questionnaire to all population members. A total of 78 responses were collected, representing a 15.1% response rate, which is acceptable and representative of the population. The subsequent section provides a detailed description of the study sample distribution and the participants' demographics.

3.3. Sample Description

After collecting the questionnaires, the researchers inputted the data for analysis by using the Statistical Package for the Social Sciences (SPSS). Table (1) shows the distribution of the study sample on the basis of qualitative variables.

Table 1. Distribution of the Sample on the Basis of Classification Variables

Classification Variable	Category	Frequency	Percentage (%)
Years of Experience in Education	Less than 5 years	14	17.9%
	5–10 years	14	17.9%
	More than 10 years	50	64.2%
Total		78	100%

3.4. Analysis and Observations

From Table 1, the following points were derived:

- 17.9% of the sample have teaching experience of less than 5 years;
- 17.9% of the sample have 5–10 years of teaching experience;
- The majority or 64.2% of the sample have more than 10 years of teaching experience.

These points show that the sample comprises a substantial proportion of professional teachers, which improves the reliability of insights related to AI integration in education because these participants have extensive exposure to teaching challenges and innovations.

3.5. Study Instrument

A questionnaire was designed and administered to the study sample to achieve the objectives of this study. The questionnaire was developed after a comprehensive review of previous studies and academic theses, concentrating on how elementary schools in Bahrah address AI-related needs from the perspective of elementary school teachers.

3.5.1. Validity of the Questionnaire

Validity refers to the ability of an instrument to measure what it is intended to measure and achieve its objectives (Al-Laqrani & Al-Jamal, 1999, p. 15). To ensure the validity and reliability of the questionnaire, the researchers conducted a pilot study involving a randomly selected group of 30 elementary school teachers in Bahrah.

3.5.2. Expert Validation

The researchers presented the first version of the questionnaire to a committee of experts and specialists to assess its association with the study's objectives. The experts assessed the following:

- Whether the questionnaire appropriately achieves the study's objectives;
- The pertinence of the questionnaire items to their particular sections;
- The linguistic clarity and accuracy of the items.

3.5.3. Modifications Based on Expert Feedback

The researchers carefully reviewed the experts' feedback and suggestions. Items in the questionnaire that were judged inappropriate or confusing were modified accordingly. Items that did not receive unanimous approval from the experts were also amended. The questionnaire was then finalized in its current, enhanced form.

3.5.4. Internal Consistency Validity

The researchers calculated Pearson correlation coefficients between the scores of each item and the total score for its corresponding axis, as shown in Table 2.

Table 2. Pearson Correlation Coefficients for Items under Axis 1: Needs of Elementary Schools for AI to Enhance Education Quality

No.	Item	Correlation Coefficient (r)	Sig Value
1	Providing comprehensive scientific content	0.728**	0.000
2	Presenting precise and simple learning procedures	0.774**	0.000
3	Processing feedback accurately and transparently	0.754**	0.000
4	Providing alternative virtual learning experiences	0.613**	0.000

5	Offering learning opportunities through experimentation	0.908**	0.000
6	Storing information for easy access	0.727**	0.000
7	Enhancing thinking and problem-solving skills through diverse activities	0.668**	0.000
8	Assisting teachers in decision-making and directing the learning process	0.692**	0.000
9	Considering students' preferences and interests	0.723**	0.000
10	Diversifying assessment methods	0.813**	0.000
11	Guiding students through learning activities	0.776**	0.000
12	Encouraging collaborative group projects among students	0.816**	0.000

Notes:

- Correlation is significant at the 0.01 level (**).
- Tabular *r* value (*df* = 30-2): at 0.05 = 0.361 and at 0.01 = 0.463.

Table 3. Pearson Correlation Coefficients for Items under Axis 2: Effect of AI Technologies and Programs on Education Quality in Elementary Schools

No	Item	Correlation Coefficient (r)	Sig Value
1	Designing instruction per global quality standards	0.769**	0.000
2	Responding to students' questions and inquiries	0.700**	0.000
3	Developing activities to foster higher-order thinking skills	0.840**	0.000
4	Supporting precise implementation of educational goals	0.818**	0.000
5	Enhancing and diversifying curricula and learning content	0.838**	0.000
6	Utilizing educational technology in teaching	0.740**	0.000
7	Simulating teachers' use of diverse teaching methods	0.666**	0.000

8	Simulating key skills during educational games with students	0.777**	0.000
9	Freeing teachers to focus on other tasks	0.757**	0.000
10	Providing instant feedback	0.871**	0.000
11	Contributing to the evaluation of student performance	0.886**	0.000
12	Helping teachers identify students' strengths and weaknesses	0.695**	0.000

Note:

- Correlation is significant at the 0.01 level (**).
- Tabular *r* value (*df* = 30-2): at 0.05 = 0.361 and at 0.01 = 0.463.

3.6. Interpretation of Results

The preceding tables show that all correlation coefficients for the items under both axes are statistically significant at $p \leq 0.01$, implying the strong internal consistency and alignment of each item with its respective axis. These results reveal the reliability and accuracy of the instrument in measuring the intended variables.

Table 4. Pearson Correlation Coefficients for Items under Axis 3: Obstacles Facing AI Use in Elementary Schools

No.	Item	Correlation Coefficient (r)	Sig Value
1	Insufficient availability of devices	0.653**	0.000
2	Lack of teachers' expertise in technology	0.686**	0.000
3	Weak school infrastructure	0.563**	0.001
4	High financial costs of AI implementation	0.591**	0.001
5	Lack of knowledge about AI applications	0.501**	0.005
6	Low encouragement by school administration to use AI	0.538**	0.002
7	Fear of replacing teachers' roles with AI applications	0.501**	0.005
8	Limited training programs for AI use	0.619**	0.000
9	Weak belief in the importance of AI applications	0.657**	0.000

10	Limited availability of Arabic AI applications	0.693**	0.000
11	Concerns that these applications may distract students' focus	0.507**	0.004
12	Lack of technical support in schools	0.725**	0.000
13	Inadequate time allocated for lessons to use AI applications	0.480**	0.007

Note:

- Correlation is significant at the 0.01 level (**).
- Tabular r value ($df = 30-2$): at 0.05 = 0.361 and at 0.01 = 0.463.

3.6.1. Analysis and Interpretation

As shown in the table above, all Pearson correlation coefficients for the items under this axis are statistically significant at $p \leq 0.01$. This result shows a high level of internal consistency and confirms that the items efficiently measure the challenges and opportunities aligned with AI integration in elementary schools.

Key observations:

1. Lack of technical support in schools had the highest correlation ($r = 0.725$) with the total axis score, underscoring the pressing need for IT infrastructure and support.
2. The limited accessibility of Arabic AI applications and the lack of the teachers' expertise in technology have strong correlations ($r = 0.693$ and $r = 0.686$, respectively), highlighting gaps in localized resources and professional education and training.
3. Items, such as concerns about teachers' roles being replaced by AI and inadequate time for AI integration in lessons, have low correlations but are still significant, implying that these items pose small but notable barriers.

This strong internal consistency demonstrates that the instrument accurately captures the multifaceted obstacles of AI application in elementary education.

3.7. Reliability of the Questionnaire

Reliability refers to the consistency of an instrument in measuring what it is intended to measure. In reliability measurement, an instrument is applied to a group of individuals, and their scores are recorded. Then, the same instrument is reapplied to the same group, and the relative order of the individuals' scores should remain similar in both instances (Abu Nahia, 2000, p.179). The researchers calculated the reliability of the instrument by using two methods.

3.8. Split-Half Method

The split-half method was utilized to calculate the reliability of the study's axes. Pearson's correlation coefficient was computed between the total scores of odd- and even-numbered items. The Spearman-Brown formula was used to adjust the reliability for axes with an even number of items, and the Guttman formula was applied for axes with an odd number of items.

Table 5. Reliability Coefficients for the Study Axes Using the Split-half Method

Axes	No. of Items	Correlation Before Adjustment (r)	Reliability Coefficient
Needs of elementary schools for AI to achieve effectiveness in improving educational quality	12	0.780	0.876
Effect of AI technologies and programs on improving the quality of education in elementary schools	12	0.798	0.887
Obstacles to using AI in elementary schools	13	0.564	0.564

3.9. Interpretation of Findings

- The reliability coefficients for all the axes were high, implying the consistency and validity of the questionnaire in assessing the extent to which elementary school teachers in Bahrah understand and address the need for AI in education.
- The highest reliability was observed for the “effect of AI technologies and programs” axis (0.887), followed by the “needs for AI in elementary schools” axis (0.876).
- The “obstacles to AI usage” axis had a slightly low reliability (0.721), but it is still within acceptable levels for educational research.

3.10. Reliability Using Cronbach's Alpha Method

The researchers estimated the reliability of the questionnaire’s final version by calculating Cronbach’s alpha coefficients for the study axes. The results are presented in Table 6.

Table 6. Cronbach's Alpha Coefficients for the Study Axes

Axes	No. of Items	Cronbach's Alpha Value
Needs of elementary schools for AI to achieve effectiveness in improving educational quality	12	0.922
Effect of AI technologies and programs on improving the quality of education in elementary schools	12	0.938
Obstacles to using AI in elementary schools	13	0.838

3.10.1. Interpretation of Cronbach's Alpha Results

- High Reliability:

All Cronbach’s Alpha values are above 0.80, showing a high internal consistency level for the items within each axis.

- Strong Consistency:
 - The highest reliability was observed for the “effect of AI technologies and programs” axis (0.938), indicating that the items within this axis systematically measure their intended construct.

- The “needs for AI in elementary schools” axis also shows high reliability (0.922).
- The “obstacles to AI usage” axis has low reliability, but it still illustrates strong reliability (0.838).

3.11. Study Procedures

The researchers followed an organized procedure to conduct the study and ensure its accuracy and validity, as indicated below.

a. Development of the Study Instrument:

The researchers developed the study tool titled *Extent of Understanding and Meeting the Needs of Schools in the Field of Artificial Intelligence from the Perspective of Elementary School Teachers in Bahra Schools*.

b. Validation by Experts:

The questionnaire was presented to a group of specialists and experts in the field to ensure the following:

- The appropriateness of the items to their respective axes;
- The linguistic accuracy and clarity of the items;
- The relevance of the items to the study’s objectives.

c. Pilot Testing:

The researchers administered the questionnaire to a pilot sample of 30 elementary school teachers in Bahra to verify the following:

- The validity (content and construct validity) of the questionnaire;
- The tool’s reliability through various statistical methods, such as Cronbach’s alpha and split-half reliability.

d. Distribution to the Full Sample:

The questionnaire was distributed electronically to the study’s full sample of 78 elementary school teachers in Bahra.

e. Data Analysis:

The data collected were entered into a computer and analyzed using SPSS software. This step included applying statistical techniques to interpret the results and answer the study’s research questions.

3.12. Researcher Reliability in Coding

To ensure the reliability of the researchers during the coding process, procedures were implemented to achieve intercoder consistency—a key indicator of dependability in qualitative research.

3.12.1. Intercoder Reliability Procedure

Two independent researchers participated in the coding of qualitative responses. A random sample of approximately 25% of the data was selected for double coding. Each researcher independently analyzed the data using a predefined coding framework derived from the research objectives and literature.

To assess the level of agreement between the coders, Cohen's Kappa coefficient was calculated. This statistical measure accounts for the agreement occurring by chance, providing a more accurate reliability estimate than simple percentage agreement.

3.12.2. Inter-coder Reliability Results

The inter-coder reliability, as measured by Cohen's Kappa, was $\kappa = 0.82$, indicating substantial agreement according to the interpretive scale proposed by Landis and Koch (1977). Discrepancies were resolved through discussion and mutual agreement, and the coding scheme was refined accordingly to enhance clarity and consistency in the final coding process.

4. Results and Discussion

4.1. Study Results, Interpretation, and Recommendations

This section presents and analyzes the study's key statistical results, focusing on understanding and meeting the needs of schools for AI from the perspective of elementary school teachers in Bahra schools. It also comprises the results of the study's questions and hypotheses and interpretations of these results in connection with the study's phenomena and variables.

4.2. Adopted Criterion for the Study

The study prepared the research tool by employing a five-point Likert scale. To assess the responses, the study utilized the criterion outlined in Table 7 for judging the level of agreement with each item and axis. The key determinant was the mean score and its corresponding relative weighting.

The interval range for the Likert scale was calculated as follows:

1. Subtract the minimum value from the maximum value of the five-point scale:
 $\text{Range} = 5 - 1 = 4$

2. Divide the range by the number of levels in the scale to determine the interval length:
 $\text{Interval Length} = \frac{4}{5} = 0.8$

On the basis of this interval, the criterion shown in Table 7 was developed.

Table 7. Study Criterion for Mean Scores. (Source: Abu Saleh, 2001, p. 46)

Degree of Agreement	Interval Length	Corresponding Relative Weight
Very Low	Less than 1.80	Less than 36%
Low	1.80 to 2.59	36% to 51.9%
Average	2.60 to 3.39	52% to 67.9%
High	3.40 to 4.19	68% to 83.9%
Very High	4.20 and above	84% and above

4.3. Interpretation of the Criterion

- Mean scores below 1.80 indicate a very low level of agreement with an item or axis.
- Mean scores between 1.80 and 2.59 reflect a low level of agreement.
- Mean scores between 2.60 and 3.39 indicate a medium level of agreement.
- Mean scores between 3.40 and 4.19 suggest a high level of agreement.

- Mean scores of 4.20 and above denote a very high level of agreement.

4.4. Results and Interpretation Related to the First Research Question

The first research question is as follows: What are the most effective AI needs for improving the quality of education at the elementary school level? To answer this question, the researchers calculated the mean, standard deviation, and relative weight for responses from the study sample on the axis “AI needs for enhancing education quality in elementary schools” in its entirety. The findings are summarized in Table 8.

Table 8. Mean, Standard Deviation, and Relative Weight for AI Needs in Enhancing Elementary Education

Overall score for the axis “AI needs to achieve effectiveness in improving the quality of education” at the primary stage	Number of Items	Mean	Standard Deviation	Relative Weight (%)	Evaluation
	12	4.474	0.544	89.48	Very High

4.4.1. General Interpretation of Results

The results revealed that the respondents evaluated the AI needs for developing the quality of elementary education with a very high degree, achieving a relative weight of 89.48%. This result is in line with the findings of Anam et al. (2024), who emphasized the importance of integrating AI into basic education, highlighting that well-designed AI curricula considerably enhance education quality and address challenges in the education field. Furthermore, it agrees with the findings of Castro et al. (2025), who highlighted the need for technological and educational resources associated with the distinctive qualities of their contexts, such as offline information and malleable AI curricula, to address the pervasive challenges of limited or absent Internet connection in many countries’ schools.

4.4.2. Detailed Analysis of Items

The researchers further analyzed the individual items of the axis by calculating their means, standard deviations, relative weights, and rankings. The results are presented in Table 9.

Table 9. Detailed Results for AI Needs in Enhancing Elementary Education

Item No.	Statement	Mean	SD	Relative Weight	Evaluation	Rank
1	Delivering comprehensive scientific content	4.269	0.989	85.38	Very High	12
2	Providing clear and easy learning procedures	4.448	0.766	88.96	Very High	7
3	Accurate feedback processing	4.410	0.812	88.20	Very High	9
4	Offering alternative virtual educational experiences	4.320	0.845	86.40	Very High	11
5	Learning through experience	4.512	0.751	90.24	Very High	6
6	Information storage for easy access	4.666	0.617	93.32	Very High	1
7	Developing thinking and problem-solving skills	4.564	0.636	91.28	Very High	3
8	Supporting teacher decision-making and learning guidance	4.538	0.750	90.76	Very High	4
9	Considering students’ interests and preferences	4.397	0.744	87.94	Very High	10

10	Diversity in evaluation methods	4.589	0.653	91.78	Very High	2
11	Guiding students through learning activities	4.525	0.715	90.50	Very High	5
12	Encouraging collaborative group projects among students	4.448	0.800	88.96	Very High	8

4.4.3. Interpretation of Item Rankings

The overall evaluation of the AI needs axis ranged from 85.38% to 93.32%, implying a very high level of agreement on all items. The highest-ranked items were the following:

- Item 6: Information storage for easy access (mean: 4.666, relative weight: 93.32%)
 - This item highlights the importance of centralized, accessible information systems in schools, enabling convenient data retrieval and utilization for decision-making and teaching.
- Item 10: Diversity in evaluation methods (mean: 4.589, relative weight: 91.78%)
 - This underscores the necessity of adopting varied assessment tools that align with students' diverse abilities and learning styles, boosting the overall evaluation process.

The lowest-ranked items were the following:

- Item 1: Delivering extensive scientific content (mean: 4.269, relative weight: 85.38%)
 - Despite the item's importance, its low ranking may show difficulties in presenting content cohesively across different AI platforms.
- Item 4: Offering alternative virtual educational experiences (mean: 4.320, relative weight: 86.40%)
 - Although this item is statistically significant, its low weight might reflect the need for a higher level of integration and accessibility of interactive technologies, such as virtual and artificial environments.

4.5. Results and Interpretation Related to the Second Research Question

The second research question is as follows: How do AI technologies and programs contribute to improving the quality of education at the elementary level? To address this question, the researchers calculated the mean, standard deviation, and relative weight of the responses from the study sample on the axis "effect of AI technologies and programs on enhancing the quality of elementary education" in its entirety. The results are summarized in Table (10).

Table 10. Mean, Standard Deviation, and Relative Weight for the Effect of AI Technologies on Enhancing the Quality of Elementary Education

Overall score for the axis "effect of AI technologies and programs on improving the quality of education" at the primary stage	Number of Items	Mean	Standard Deviation	Relative Weight (%)	Evaluation
	12	4.434	0.560	88.68	Very High

4.5.1. General Interpretation of Results

The researchers analyzed the individual items under this axis by calculating their means, standard deviations, relative weights, and rankings. The findings are shown in Table 11.

Table 11. Detailed Results for the Effect of AI Technologies on Elementary Education

Item No.	Statement	Mean	SD	Relative Weight	Evaluation	Rank
1	Designing instruction in accordance with global quality standards	4.423	0.584	88.46	Very High	7
2	Answering students' questions and inquiries	4.397	0.663	87.94	Very High	10
3	Developing instructional activities to enhance higher-order thinking skills	4.589	0.553	91.78	Very High	2
4	Supporting the precise implementation of educational goals	4.538	0.626	90.76	Very High	5
5	Enhancing and developing curricula with diverse experiences	4.564	0.597	91.28	Very High	3
6	Employing educational technology in teaching	4.500	0.646	90.00	Very High	6
7	Simulating teachers in employing diverse teaching methods	4.384	0.630	87.68	Very High	11
8	Representing game performance skills during play with students	4.487	0.587	89.74	Very High	8
9	Allowing teachers to focus on other tasks	4.423	0.596	88.46	Very High	9
10	Providing immediate feedback	4.666	0.508	93.32	Very High	1
11	Contributing to student performance evaluation	4.589	0.529	91.78	Very High	2
12	Helping teachers identify students' strengths and weaknesses	4.448	0.613	88.96	Very High	4

4.5.2. Interpretation of Item Rankings

The evaluation score of the individual items in this axis ranged between 87.68% and 93.32%, reflecting a very high level of agreement across all items. The highest-ranked items were as follows:

1. Item 10: Providing immediate feedback (mean: 4.666, relative weight: 93.32%)

- Immediate feedback is crucial in improving learning by helping students understand their progress and areas for improvement. It also allows teachers to adjust instruction in real time.

2. Items 3 and 11: Developing higher-order thinking skills and contributing to performance evaluation (mean: 4.589, relative weight: 91.78%)

- These items highlight the role of AI in fostering advanced cognitive skills and enabling precise and objective assessment of student learning.

The lowest-ranked items were as follows:

1. Item 7: Simulating educators in utilizing different teaching methods (mean: 4.384, relative weight: 87.68%)

- Although this item is essential, its low ranking may demonstrate that this facet of AI is still underdeveloped or less prioritized in real-time applications.

2. Item 2: Answering students' questions and inquiries (mean: 4.397, relative weight: 87.94%)

- Despite its importance, this result may suggest limitations in the current capabilities of AI systems in responding thoroughly to different student queries.

4.6. Analysis of Individual Items for the Second Research Question

To probe deep into the findings related to the second research question, the researchers examined the individual items under the axis "effect of AI technologies on enhancing elementary education." The results are summarized in Table 12.

Table 12. Detailed Results for the Effect of AI Technologies on Elementary Education

Item No.	Statement	Mean	SD	Relative Weight	Evaluation	Rank
1	Designing instruction in accordance with global quality standards	4.500	0.751	90.00	Very High	5
2	Responding to students' questions and inquiries	4.500	0.679	90.00	Very High	4
3	Developing instructional activities to enhance higher-order thinking skills	4.525	0.678	90.50	Very High	3
4	Supporting the precise implementation of educational goals	4.525	0.597	90.50	Very High	2
5	Enhancing and developing curricula with diverse experiences	4.487	0.659	89.74	Very High	6
6	Employing educational technology in teaching	4.576	0.829	91.52	Very High	1
7	Simulating teachers in employing diverse teaching methods	4.346	0.909	86.92	Very High	11
8	Representing game performance skills during play with students analyzing	4.359	0.852	87.18	Very High	9
9	Allowing teachers to focus on other tasks	4.217	0.831	84.34	Very High	12
10	Providing immediate feedback	4.461	0.696	89.22	Very High	7
11	Contributing to student performance evaluation	4.371	0.854	87.42	Very High	8
12	Helping teachers identify students' strengths and weaknesses	4.346	0.735	86.92	Very High	10

4.6.1. Key Insights from the Table

- Highest-ranked Items:
 1. Item 6: Employing educational technology in teaching (mean: 4.576, relative weight: 91.52%)
 - This item ranks first, suggesting the vital role of integrating educational technology into teaching practices. The high ranking shows the increasing recognition of AI as a tool for boosting teaching efficacy and capability.
 2. Item 4: Supporting the precise implementation of intended learning outcomes (mean: 4.525, relative weight: 90.50%)
 - Ranking second, this item highlights the value of AI in ensuring that specific educational objectives are met with accuracy and precision.
- Lowest-ranked Items:
 1. Item 9: Allowing teachers to concentrate on other tasks (mean: 4.217, relative weight: 84.34%)
 - Despite its importance, this item ranks last possibly because of the limited application of AI tools that effectively offload administrative tasks from teachers in the study context.
 2. Item 7: Simulating teachers in employing diverse teaching methods (mean: 4.346, relative weight: 86.92%)
 - This second-to-the-last ranking may indicate that AI tools are not yet fully developed to replicate teachers' subtle methods in utilizing varied educational strategies.

4.6.2. Overall Analysis

- The persistent and very high level of agreement on the effect of AI technologies on boosting elementary education, with relative weights ranging between 84.34% and 91.52%, reaffirms the validity of the research.
- The results relate to existing literature findings, underscoring AI's transformative potential in education, particularly in instructional design, curriculum enhancement, and precise goal implementation.
- These findings emphasize the pressing need for the subsequent development of AI tools that can assist teachers in diverse educational strategies and administration tasks.

4.7. Results and Interpretation of the Third Research Question

The third research question is as follows: What are the obstacles to using AI in elementary education? The researchers calculated the mean, standard deviation, and relative weight of the study sample's responses on the axis "obstacles to using AI in elementary education" to answer this question. The results are summarized in Table 13.

Table 13. Mean, Standard Deviation, and Relative Weight for Obstacles to Using AI in Elementary Education

Total score for the axis "obstacles facing the use of AI in elementary education" at the primary stage	Number of Items	Mean	Standard Deviation	Relative Weight (%)	Evaluation
	13	4.171	0.583	83.42	High

4.7.1. Overall Findings

- The total relative weight for the obstacles axis is 83.42%, suggesting a high level of agreement on the obstacles to using AI in elementary education.
- This result emphasizes key challenges that hinder the beneficial integration of AI tools and systems into the academic environment at the elementary level.

4.7.2. Detailed Analysis of Individual Items

The researchers analyzed the individual items within this axis to gain further insights. The mean, standard deviation, relative weight, and ranking for each item are presented in Table 14.

Table 14. Detailed Results for Obstacles to Using AI in Elementary Education

Item No	Statement	Mean	SD	Relative Weight	Evaluation	Rank
1	Lack of sufficient devices	4.359	0.679	87.18	Very High	1
2	Teachers' lack of experience in technology	4.308	0.718	86.16	Very High	2
3	Weak school infrastructure	4.256	0.749	85.12	Very High	3
4	High financial costs of AI implementation	4.192	0.833	83.84	High	5
5	Lack of knowledge about AI applications	4.154	0.712	83.08	High	7
6	Low motivation from school administration to use AI	4.192	0.741	83.84	4	4
7	Fear of replacing teachers with AI applications	4.089	0.806	81.78	High	10
8	Limited training programs on using AI applications	4.231	0.690	84.62	High	6
9	Weak conviction of the importance of AI applications	4.115	0.743	82.30	High	8
10	Limited availability of Arabic applications	4.115	0.802	82.30	High	9
11	AI applications causing distraction for students	4.089	0.823	81.78	High	11
12	Lack of technical support within the school	4.256	0.712	85.12	Very High	3
13	Insufficient class time to use AI applications	4.141	0.701	82.82	High	12

4.7.3. Key Findings

- Top Three Obstacles:
 1. Lack of sufficient devices (Item 1): This ranks first, with a mean of 4.359 and a relative weight of 87.18%.
 - This result emphasizes the critical need to provide appropriate technological resources to schools.
 2. Teachers’ lack of experience in technology (Item 2): This item ranks second, with a mean of 4.308 and a relative weight of 86.16%.
 - This result shows a gap in teachers’ technical competencies, impeding their ability to employ AI efficiently.
 3. Weak school infrastructure (Item 3): This item ranks third, with a mean of 4.256 and a relative weight of 85.12%.
 - This result shows challenges related to schools’ physical and technological readiness for AI integration.
- Lowest-ranked Obstacles:
 1. AI applications causing distraction for students (Item 11): This items ranks second to the last, with a mean of 4.089 and a relative weight of 81.78%.
 - This result shows the perception that AI tools may sometimes absorb students’ attention, although it is not viewed as a crucial impediment.
 2. Fear of replacing teachers with AI applications (Item 7): This items ranks last, with a mean of 4.089 and a relative weight of 81.78%.
 - This result may suggest that concerns about AI replacing educators are acknowledged but not seen as a substantial barrier.

4.8. Detailed Results for the Obstacles to Using AI in Elementary Education

Analysis of the individual items within the axis “obstacles to using AI in elementary education” provided further insights into the challenges faced in integrating AI tools in schools. The results are presented in Table 15.

Table 15. Means, Standard Deviations, Relative Weights, and Rankings for Obstacles to Using AI in Elementary Education

Item No	Statement	Mean	SD	Relative Weight	Evaluation	Rank
1	Lack of sufficient devices	4.576	0.781	91.52	Very High	1
2	Teachers’ lack of experience in technology	4.076	1.053	81.52	High	9
3	Weak school infrastructure	4.448	0.877	88.96	Very High	2
4	High financial costs of AI implementation	4.256	0.931	85.12	Very High	7
5	Lack of knowledge about AI applications	4.307	0.916	86.14	Very High	6

6	Low motivation from school administration to use AI	4.115	0.980	82.30	High	8
7	Fear of replacing teachers with AI applications	3.935	1.036	78.70	High	11
8	Limited training programs on using AI applications	4.410	0.844	88.20	Very High	4
9	Weak conviction of the importance of AI applications	4.012	1.098	80.24	High	10
10	Limited availability of Arabic applications	4.371	0.869	87.42	Very High	5
11	AI applications causing distraction for students	3.423	1.222	68.46	High	13
12	Lack of technical support within the school	4.423	0.781	88.46	Very High	3
13	Insufficient class time to use AI applications	3.871	1.199	77.42	High	12

4.8.1. Key Findings

- Highest-ranked Obstacles:
 1. Lack of sufficient devices (Item 1): Ranks first, with a relative weight of 91.52% and a mean of 4.576.
 - This result emphasizes the pressing need for investment in technological resources to support AI implementation in schools.
 2. Weak school infrastructure (Item 3): Ranks second, with a relative weight of 88.96% and a mean of 4.448.
 - This result shows challenges related to the physical and technological preparedness of schools.
 3. Lack of technical support within the school (Item 12): Ranks third, with a relative weight of 88.46% and a mean of 4.423.
 - This result highlights the importance of ongoing technological support to facilitate the effective use of AI tools.
- Lowest-ranked Obstacles:
 1. AI applications causing distraction for students (Item 11): Ranks last, with a relative weight of 68.46% and a mean of 3.423.
 - This result suggests that while distractions are noted, they are not considered as critical as other barriers.
 2. Insufficient class time to use AI applications (Item 13): Ranks second to the last, with a relative weight of 77.42% and a mean of 3.871.
 - This result indicates concerns about the time constraints in integrating AI effectively into classroom activities.

4.8.2. Interpretation

- The availability of devices, school infrastructure, and technical support are perceived as the most pressing obstacles.
- Teacher readiness and training programs also pose challenges, reflecting the need for professional development initiatives to equip teachers with the skills and confidence to use AI tools effectively.
- The low concern about distractions and time constraints indicates that these factors, while present, are not viewed as insurmountable.

4.8.3. Sample Quotes

- a. There aren't enough devices for every student to use the AI tools during class, which makes it hard to do group work or individualized tasks."
 - *Teacher 3, Female, 10 years of experience*
- b. "We lack the infrastructure for reliable internet access—sometimes even the basic electricity setup is not consistent."
 - *Teacher 7, Male, 15 years of experience*
- c. "Even though I'm interested, I've never been trained in how to use AI apps effectively in the classroom."
 - *Teacher 2, Female, 6 years of experience*

5. Conclusion

5.1. Summarized Results of the Field Study

1. AI Needs in Elementary Education: The study found that elementary schools rated the need for AI to enhance the quality of education very highly.
2. Effect of AI Technologies: The contribution of AI technologies and programs to developing the quality of education in elementary schools was rated very high.
3. Barriers to AI Adoption: The obstacles to using AI in elementary education were rated high.

5.2. Critical Factors for Successful AI Integration

Based on the thematic analysis, the following critical factors must be addressed to ensure effective AI integration in elementary education:

- **Technological Resources:** Sufficient availability of digital devices is essential, as the lack thereof is the most urgent barrier (91.52% relative weight).
- **School Infrastructure:** Robust physical and network infrastructure is required to support AI tools and applications effectively.
- **Technical Support:** Continuous in-school IT support is crucial to maintain AI systems and assist teachers and students in their use.
- **Managing Distraction:** Although AI could be a source of distraction, this factor is less critical but should be monitored.
- **Time Allocation:** Adequate class time must be allocated for AI-based activities, balancing curriculum demands and technology use.

5.3. Thematic Structure of Key Findings

Table 16. Thematic Structure of Key Findings

Theme	Subtheme	Relative Weight (%)	Mean Score	Interpretation
Technological Resources	Lack of sufficient devices (Item 1)	91.52%	4.576	Urgent need for investment in digital devices for effective AI integration.
School Infrastructure	Weak infrastructure (Item 3)	88.96%	4.448	Schools lack the physical and network infrastructure needed for AI implementation.
Technical Support	Lack of in-school technical support (Item 12)	88.46%	4.423	Continuous IT support is critical to maintain and use AI tools effectively.
Distraction Concerns	AI as a student distraction (Item 11)	68.46%	3.423	Distractions are noted but not seen as a major barrier to AI adoption.
Time Constraints	Limited class time for AI (Item 13)	77.42%	3.871	Class time limitations are concerns but are less significant than other factors.

5.4. Recommendations

On the basis of the results, the study recommends the following:

1. Adoption of AI in Elementary Education

- Implement AI technologies in elementary education to ensure improved teaching quality and effectively integrate traditional and technological teaching methods across different subjects.

2. Continuous Teacher Training

- Provide continuous training for teachers on using AI tools to effectively utilize modern applications and technologies, enhancing their educational performance.

3. Inclusion of AI in Curricula

- Integrate AI into educational curricula across all levels to foster interactive learning and promote students' critical thinking and problem-solving skills.

4. Parental Awareness

- Raise awareness among parents about the importance of AI in education to ensure their support for introducing these technologies into the learning process and encouraging children to use the technology positively.

5. Allocation of Financial Resources

- Allocate sufficient financial resources to support technological innovation in schools and to provide the necessary devices and software to use AI tools efficiently.

6. Periodic Evaluation of AI Effectiveness

- Conduct regular research and evaluations to monitor the effectiveness of AI usage in education and assess its effect on developing students' skills and improving learning outcomes.

6. Limitations

This study acknowledges several limitations that may affect data quality and the generalizability of its findings:

- **Online Data Collection:** Some interviews and surveys were conducted online due to logistical constraints, which may have limited rapport building, reduced observation of non-verbal cues, and been vulnerable to technical disruptions, potentially affecting the richness of the data.
- **Teacher Sample Bias:** Participation was limited to teachers who were accessible and willing to participate, possibly resulting in a sample skewed toward those with stronger opinions—either positive or negative—about AI integration.
- **Variation in AI Exposure:** Differences in teachers' familiarity with and access to AI tools across various schools may have influenced their perceptions and responses, limiting the applicability of results to schools with less or more advanced technological infrastructure.
- **Rapid Technological Advancements:** The fast-evolving nature of AI in education means that specific tools or platforms discussed in the study may become outdated, affecting the long-term relevance of some findings.
- **Systemic Infrastructure Disparities:** Variations in technological and institutional support across schools mean that some findings may be context-specific, limiting broader generalization.
- **Cultural Context:** As the study focuses on Saudi Arabia and its Vision 2030 educational goals, findings may not be directly transferable to different cultural or national contexts without considering local educational policies and practices.

Declarations

Author Contributions. The authors contributed equally to drafting, analyzing the data, and proofreading this paper.

Conflicts of Interest. The authors declare no conflict of interest.

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References

- Aderibigbe, A. O., Ohenhen, P. E., Nwaobia, N. K., Gidiagba, J. O., & Ani, E. C. (2023). Artificial intelligence in developing countries: Bridging the gap between potential and implementation. *Computer Science & IT Research Journal*, 4(3), 185–199.
- Albahiri, F., Alotaibi, M., & Saeed, N. (2025). Challenges of integrating artificial intelligence in elementary education. *Journal of Educational Technology*, 12(1), 45–58.
- Albahiri, M. H., Alhaj, A. A., & Al Oteibi, B. M. (2025). Proposed educational program predicated on gamification for teaching mathematics as required by TIMSS and its effect on developing strategic competence among fourth-grade male students. *Educational Process: International Journal*, 14, e2025042. <https://doi.org/10.22521/edupij.2025.14.42>
- AlGerafi, M. A., Zhou, Y., Oubibi, M., & Wijaya, T. T. (2023). Unlocking the potential: A comprehensive evaluation of augmented reality and virtual reality in education. *Electronics*, 12(18), 3953.
- Alotaibi, N. S., & Alshehri, A. H. (2023). Prospers and obstacles in using artificial intelligence in Saudi Arabia higher education institutions—The potential of AI-based learning outcomes. *Sustainability*, 15(13), 10723.
- Anam, K., Sadli, M., & Wijaya, H. (2024). Analysis of artificial intelligence (AI) utilization for improving motor skills learning outcomes among elementary school teacher education (PGSD) students. *DIAJAR: Jurnal Pendidikan dan Pembelajaran*, 3(2), 202–209.
- Baker, A. J., & Taha, M. A. (2019). Artificial intelligence: Policies, programs, and applications in higher education. *Journal of Educational Science*, 3(184), 383–432.
- Bearman, M., Ryan, J., & Ajjawi, R. (2023). Discourses of artificial intelligence in higher education: A critical literature review. *Higher Education*, 86(2), 369–385.
- Bhutoria, A. (2022). Personalized education and artificial intelligence in the United States, China, and India: A systematic review using a human-in-the-loop model. *Computers and Education: Artificial Intelligence*, 3, 100068.
- Bozkurt, A., Karadeniz, A., Baneres, D., Guerrero-Roldán, A. E., & Rodríguez, M. E. (2021). Artificial intelligence and reflections from educational landscape: A review of AI studies in half a century. *Sustainability*, 13(2), 800.
- Carlos, J. (2018). Artificial intelligence and its evolution: Challenges and opportunities. *International Journal of Technology Advances*, 35(4), 45–59.
- Carlos, R. C., Kahn, C. E., & Halabi, S. (2018). Data science: Big data, machine learning, and artificial intelligence. *Journal of the American College of Radiology*, 15(3), 497–498.
- Castro, A., Díaz, B., Aguilera, C., Prat, M., & Chávez-Herting, D. (2025). Identifying rural elementary teachers' perception challenges and opportunities in integrating artificial intelligence in teaching practices. *Sustainability*, 17(6), 2748.
- Cloneria, N. J., Ismaila, T. S., Musa, A. A., et al. (2024). Artificial intelligence in compulsory education: Perspectives from Namibian in-service teachers. *Education and Information Technologies*, 29, 76–98.
- Collins, A., & Halverson, R. (2018). Rethinking education in the age of technology: The digital revolution and schooling in America. *Teachers College Press*.
- Cromton, H., & Song, D. (2021). The potential of artificial intelligence in higher education. *Revista Virtual Universidad Católica del Norte*, (62), 1–4.

- Dai, H., Liu, Y., & Zhao, X. (2024). Educational applications of artificial intelligence: Pedagogical benefits and challenges. *Journal of Artificial Intelligence in Education*, 32(1), 21–38.
- Dai, Y., Lin, Z., Liu, A., et al. (2024). Effect of an analogy-based approach of artificial intelligence pedagogy in upper primary schools. *Journal of Educational Computing Research*, 61(8), 159–186.
- Dai, Y., Liu, A., Qin, J., Guo, Y., Jong, M. S.-Y., Chai, C.-S., & Lin, Z. (2023). Collaborative construction of artificial intelligence curriculum in primary schools. *Journal of Engineering Education*, 112(1), 23–42. <https://doi.org/10.1002/jee.20503>
- Darwish, D. (2025). Artificial intelligence implementation in education processes. *Deep Science Publishing*.
- Dianova, V. G., & Schultz, M. D. (2023). Discussing ChatGPT’s implications for industry and higher education: The case for transdisciplinarity and digital humanities. *Industry and Higher Education*, 37(5), 593–600.
- Faggella, D. (2019). Artificial intelligence in the classroom. *Interface Magazine*. Retrieved from <https://interfaceonline.co.nz>.
- George, A., & Wooden, B. (2023). Teacher readiness and AI adoption: Exploring barriers and enablers. *International Journal of AI in Education*, 7(3), 101–115.
- George, B., & Wooden, O. (2023). Managing the strategic transformation of higher education through artificial intelligence. *Administrative Sciences*, 13(9), 19.
- Guan, C., Mou, J., & Jiang, Z. (2020). Artificial intelligence innovation in education: A twenty-year data-driven historical analysis. *International Journal of Innovation Studies*, 4(4), 134–147.
- Hwang, S. (2022). Examining the effects of artificial intelligence on elementary students’ mathematics achievement: A meta-analysis. *Sustainability*, 14(20), 13185.
- Jil Center. (2022). Artificial intelligence in education: Transforming classrooms. *Journal of Modern Educational Technology*, 10(3), 67–81.
- Kim, J., Merrill, K., Kun, X., & Sellnow, D. D. (2022). Embracing AI-based education: Perceived social presence of human teachers and expectations about machine teachers in online education. *Human-Machine Communication*, 4, 169–184.
- Kim, K., & Kwon, K. (2023). Exploring the AI competencies of elementary school teachers in South Korea. *Computers and Education: Artificial Intelligence*, 4, 100137.
- Kim, S., Lee, J., & Park, H. (2022). Teachers’ attitudes towards AI integration in classrooms: A qualitative study. *Computers & Education*, 175, 104334. <https://doi.org/10.1016/j.compedu.2021.104334>
- Khosravi, H., Shum, S. B., Chen, G., Conati, C., Tsai, Y. S., Kay, J., ... & Gašević, D. (2022). Explainable artificial intelligence in education. *Computers and Education: Artificial Intelligence*, 3, 100074.
- Lampou, R. (2023). The integration of artificial intelligence in education: Opportunities and challenges. *Review of Artificial Intelligence in Education*, 4, e15–e15.
- Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 33(1), 159–174. <https://doi.org/10.2307/2529310>
- Lawrence, D., & Tar, U. (2018). Educators’ perceptions of AI in teaching: A systematic review. *Education and Information Technologies*, 23(5), 2121–2138. <https://doi.org/10.1007/s10639-018-9704-2>

- Lawrence, J. E., & Tar, U. A. (2018). Factors that influence teachers' adoption and integration of ICT in teaching/learning process. *Educational Media International*, 55(1), 79–105.
- Lin, P. Y., Chai, C. S., Jong, M. S. Y., Dai, Y., Guo, Y., & Qin, J. (2021). Modeling the structural relationship among primary students' motivation to learn artificial intelligence. *Computers and Education: Artificial Intelligence*, 2, 100006.
- Luan, H., Geczy, P., Lai, H., Gobert, J., Yang, S. J., Ogata, H., ... & Tsai, C. C. (2020). Challenges and future directions of big data and artificial intelligence in education. *Frontiers in Psychology*, 11, 580820.
- Maphosa, V., & Maphosa, M. (2023). Artificial intelligence in higher education: A bibliometric analysis and topic modeling approach. *Applied Artificial Intelligence*, 37(1), 2261730.
- McCarthy, J., Minsky, M. L., Rochester, N., & Shannon, S. (1955). A proposal for the Dartmouth Summer Research Project on Artificial Intelligence. *SCIRP*.
- Mohamed Hashim, M. A., Tlemsani, I., & Matthews, R. (2022). Higher education strategy in digital transformation. *Education and Information Technologies*, 27(3), 3171–3195.
- Mousa, A., & Bilal, H. (2019). Artificial intelligence: A revolution in educational technology. *Cairo: The Arab Center for Research and Development*.
- Mutambik, I. (2024). The use of AI-driven automation to enhance student learning experiences in the KSA: An alternative pathway to sustainable education. *Sustainability*, 16(14), 5970.
- Ocaña-Fernandez, Y., Valenzuela-Fernandez, & Garro-Aburto, L. (2019). Artificial intelligence and its implications in higher education. *Propositos y Representaciones*, 7(2), 536–568.
- Petska, A. (2018, August 31). Roanoke County library adds Pepper, a 'community robot'. Retrieved from Roanoke Times.
- Popenici, S., & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. *Research and Practice in Technology Enhanced Learning*, 12(22), 1–.
- Qinghua, Y., & Satar, M. (2020). English as a foreign language learner interaction with chatbots: Negotiation for meaning. *International Online Journal of Education and Teaching (IOJET)*.
- Rachmadtullah, R., Tanod, M. J. T. M. J., Rasmitadila, R., Irawan, N., McNeilly, A., & Suharni, S. (2024). Elementary school teachers' perspectives on utilizing artificial intelligence for developing learning media. *Journal of Integrated Elementary Education*, 4(1), 71–82.
- Rathore, A. A., Sultana, N., Zareen, S. J., & Ahmed, A. (2023). Artificial intelligence and curriculum prospects for elementary school. *Pakistan Journal of Humanities and Social Sciences*, 11(4), 4635–4644.
- Shapin, S. (2018). The scientific revolution. *University of Chicago Press*.
- Shehata, M. (2022). Artificial intelligence in education: Opportunities and challenges. *Educational Development Journal*, 8(2), 45–68.
- Strevens, M. (2020). The knowledge machine: How an unreasonable idea created modern science. *Penguin UK*.
- The Conference on Artificial Intelligence and Education. (2019). Artificial intelligence in education. *UNESCO Digital Library*. Retrieved from <https://unesdoc.unesco.org>
- Tomi, S. H. (2025). Intelligent learning systems in enhancing education through AI: Review research. In *Using AI Tools in Text Analysis, Simplification, Classification, and Synthesis* (pp. 1–3).

- Topal, A. D., Eren, D. C., & Geçer, A. K. (2021). Chatbot application in a 5th-grade science course. *Education and Information Technologies*, 26(5), 6241–626.
- Tredinnick, L. (2017). Artificial intelligence and professional roles. *Business Information Review*, 34(1), 37–41.
- UNESCO. (2019). Virtual conference on artificial intelligence in education and training. Retrieved from unesco.org.
- Virtual Conference on Artificial Intelligence. (2019). Key insights on AI integration in education and training. *UNESCO-UNEVOC Forum*.
- Wadhwa, D. (2017). Using artificial intelligence technologies for personalized learning and responsive teaching: A survey. *International Journal of Advanced Research in Computer Science & Engineering (IJARCSE)*, 6(4), 1–4.
- Yadav, S. (2025). Leveraging AI to enhance teaching and learning in education: The role of artificial intelligence in modernizing classroom practices. In *Optimizing Research Techniques and Learning Strategies with Digital Technologies* (pp. 211–238). IGI Global Scientific Publishing.
- Yim, I. H. Y. (2023). Design of artificial intelligence (AI) education for primary schools: Arts-based approach. *Istes Books*, 65–90.
- Yupeng, L., & Zhonggen, Y. (2024). A bibliometric analysis of artificial intelligence chatbots in educational contexts. *Interactive Technology and Smart Education*, 21(2), 189–213.
- Yusuf, F. A. (2025). Trends, opportunities, and challenges of artificial intelligence in elementary education—A systematic literature review. *Journal of Integrated Elementary Education*, 5(1), 109–127.
- Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education: Where are the educators? *International Journal of Educational Technology in Higher Education*, 16(1), 39.
- Zhang, C., & Lu, Y. (2021). Study on artificial intelligence: The state of the art and future prospects. *Journal of Industrial Information Integration*, 23, 100224

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