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The Effect of AI-Personalized Education on Achievement Among Students at the Secondary Stage in Jordan: A Future Vision

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Abstract

This study investigates the impact of personalized education supported by artificial intelligence (AI) on student achievement in Jordan and explores prospects for integrating AI into the national education system. The research is motivated by Jordan's increasing adoption of digital learning initiatives and the global shift toward technology-enhanced education, the community consisted of all secondary school students in Jordan during the 2024/2025 academic year, while the sample comprised **410** students selected through stratified random sampling to ensure representation of both public and private schools in urban and rural areas. The participants were divided into a control group (n = **200**), which received traditional instruction, and an experimental group (n = **210**), which received AI-supported personalized instruction.

The study employed a quasi-experimental design with pre- and post-tests, using statistical analysis through SPSS software. Independent sample t-tests, ANCOVA, and effect size calculations were conducted to measure the impact of AI-supported personalized learning. Results revealed statistically significant improvements in the experimental group compared to the control group, particularly in problem-solving, writing skills, and mathematics achievement. The findings align with recent international research, which consistently reports that AI-enhanced personalized education improves academic performance, reduces achievement gaps, and fosters student engagement. However, the results also highlight challenges such as teacher preparedness, infrastructure limitations, and the risk of overreliance on AI tools.

The study concludes that AI-supported personalized education has the potential to transform learning in Jordan by promoting equity, efficiency, and innovation in teaching and assessment. Recommendations include strengthening teacher professional development in AI pedagogy, improving digital infrastructure, and formulating national policies to guide ethical and culturally appropriate AI integration, this research contributes to the growing body of literature on AI in education by providing empirical evidence from Jordan, while offering a forward-looking vision for sustainable educational transformation in the region.

Keywords

Artificial Intelligence (AI), Personalized Learning, Student Achievement, Educational Innovation, Jordanian Education System

Introduction

In the 21st century, education is being fundamentally reformed by technological advancement and the desire to impart skills beyond mere knowledge acquisition. Education systems in several countries, including Jordan, are grappling with issues such as increasing class sizes, resource disparities, and varying levels of academic achievement. Teachers are often inadequate in providing individualized support, which can cause many students to lose interest or fail to reach their full potential. Achieving personalized education through AI is a novel concept that responds to the increasing demand for customized learning experiences.

For a long time, educational theorists and practitioners have been striving to achieve personalized education. The mastery learning model developed by Bloom (1968) showed that most learners can achieve high levels of success when instruction is tailored to the needs of students and ample time is given. Developing environments were considered too impractical for decades to implement personalized instruction at scale. But now that AI is here, this vision is real. By utilizing AI, researchers can monitor individual performance, identify learning gaps, and modify instructional methods in real-time, providing teachers with immediate feedback and actionable insights (Wu & Yu, 2024; Alfarwan, 2020).

A growing body of empirical studies and systematic reviews on the impact of AI-supported personalization is emerging worldwide. Indicating the significant improvement in mathematics and science learning outcomes through AI-driven adaptive platforms was found to be effective in Intelligent Tutoring Systems (ITS) for K-12 education by Hwang et al. (2025). In a similar vein, Ding and Yusof (2025) demonstrated that AI-generated conversational agents not only enhanced second language speaking performance but also decreased student anxiety. The positive effects of AI interventions on student achievement across educational settings vary significantly, with some studies (such as Wang & Fan, 2025) indicating a negative correlation between the intervention and its effectiveness.

Collectively these studies suggest that AI can enable large-scale personalization and improve both cognitive and affective learning. Despite not being peer-reviewed, AI in education has become a major topic of international attention thanks to conferences and professional forums. At the International Conference on Artificial Intelligence in Education (AIED 2024), a focus was placed on adaptive AI's ability to promote equity in education, particularly in areas with limited financial resources. The Global Education Monitoring Report by UNESCO (2023) also highlighted the potential of AI in fulfilling Sustainable Development Goal 4 (quality education for all). In the Arab world, policymakers, educators, and researchers gathered in Amman for the first-ever Arab Forum on Artificial Intelligence in Education (2024), which called attention to how AI solutions can be integrated into local curricula while maintaining cultural and ethical relevance.

This discussion highlights that the use of AI for personalized learning is a global issue and not merely a replication of past educational reform efforts. Technology integration has been a key focus of the Jordanian Ministry of Education in line with Education Reform for the Knowledge

Economy (ERFKE) initiatives and Vision 2025, to improve quality and access. Despite recent pilot programs with adaptive e-learning platforms for math and science, progress on AI-based personalization is still lacking. Jordan's classrooms are frequently congested, posing difficulties for students who struggle to receive personalized instruction due to the high teacher-student ratio. Furthermore, poor quality of teaching facilities often affects achievement in rural areas.

Research Problem

Although Jordan has shown a clear commitment to educational technology through its reform initiatives, the practical implementation of AI-based personalized education remains limited. Despite international evidence supporting the benefits of AI-driven learning for improving academic outcomes, there is insufficient empirical research on its effectiveness within the Jordanian educational context. The challenges of overcrowded classrooms, unequal access to learning resources, and variations in teaching quality persist, preventing equitable and individualized learning experiences.

To confirm the presence of this gap, an exploratory study was conducted at May 2024 in selected Jordanian schools to examine teachers' and students' perceptions of AI integration and personalized learning practices. The findings revealed that while educators are aware of AI's potential to support individualized instruction, its actual use in classrooms remains minimal and largely experimental. Teachers reported a lack of training, insufficient infrastructure, and uncertainty about effective AI tools, while students expressed limited exposure to adaptive learning technologies. These observations substantiate the existence of the research problem and highlight the urgent need for a systematic investigation of AI-driven personalized education and its impact on student achievement in Jordan.

Therefore, the problem addressed in this study is the lack of empirical evidence on the impact of AI-driven personalized education on student achievement in Jordan, and how such integration could contribute to addressing educational quality and equity challenges aligned with the nation's Vision 2025 goals.

Background

The integration of artificial intelligence into personalized education is not an isolated innovation but rather the culmination of decades of educational theory, practice, and technological progress. To understand the significance of AI-supported personalized education, it is essential to situate it within the broader landscape of learning theories, pedagogical models, and the global discourse on the role of emerging technologies in transforming education. This background not only provides the conceptual foundation for the study but also illustrates how AI can address longstanding challenges in the Jordanian educational system.

From its earliest roots, the field of education has grappled with the problem of diversity in student learning. Teachers have long recognized that students differ in their abilities, prior knowledge, learning styles, and motivation, yet the structure of mass education has often required uniform teaching strategies. Behaviorist theories, exemplified by the work of B. F. Skinner (1953),

suggested that learning could be shaped by reinforcement, feedback, and practice. Skinner's teaching machines of the mid-20th century, though primitive by today's standards, attempted to individualize instruction by providing immediate feedback to learners. Although the technology of the time was limited, the underlying idea—that instruction should adapt to the learner—laid an important foundation for later developments in personalized education.

Cognitive and constructivist theories added further nuance to the understanding of personalization. Piaget's (1972) work emphasized the stages of cognitive development, suggesting that instruction must align with the learner's developmental readiness. Vygotsky (1978) introduced the influential concept of the zone of proximal development (ZPD), where learning is most effective when tasks are slightly beyond the learner's independent capabilities but achievable with guidance. Scaffolding, a concept derived from Vygotsky's work, has become central to personalized instruction, highlighting the importance of providing appropriate support that is gradually withdrawn as learners gain competence. Constructivist thinkers have further emphasized that students actively construct knowledge through experience, making individualized pathways and differentiated pacing key elements of effective learning environments.

Among the most influential contributions to the idea of personalization is Benjamin Bloom's (1968) mastery learning model. Bloom argued that the vast majority of students could achieve high levels of learning if instruction was adapted to their needs and adequate time was provided for mastery. He demonstrated that when learners received corrective feedback and additional learning opportunities, their performance could improve dramatically compared to those in traditional classroom structures. However, mastery learning was difficult to implement widely, particularly in contexts where teachers faced large class sizes and limited resources. Bloom's vision of personalized mastery for all remained largely aspirational until the advent of advanced digital technologies and, most recently, artificial intelligence.

Artificial intelligence has opened new possibilities for operationalizing these educational theories on a scale that was once impossible. AI systems can analyze massive amounts of learning data, detecting patterns in student behavior, and adapting instructional content in real time. Intelligent tutoring systems (ITS), for instance, can simulate one-on-one tutoring by monitoring a student's performance and tailoring explanations and exercises accordingly (Bauer, 2025). Adaptive learning platforms use machine learning algorithms to adjust the difficulty and sequencing of content, ensuring that each learner receives instruction at their own level and pace (Rodríguez-Ortiz et al., 2025). Natural language processing technologies enable AI to interact with students conversationally, providing feedback on writing, supporting language learning, or answering questions in real time (Giannakos, 2024). In addition, learning analytics powered by machine learning can predict which students are at risk of failure and recommend targeted interventions (UNESCO, 2023). Together, these applications make it possible to deliver personalized education at scale while aligning with the principles of behaviorism, constructivism, and mastery learning.

Recent developments in AI have further strengthened its relevance for education. The rise of generative AI and large language models (LLMs) since 2023 has expanded the capacity of AI

to provide interactive, adaptive, and creative learning experiences (Giannakos, 2024). Unlike earlier systems that were limited to predefined responses, generative AI tools can generate personalized explanations, examples, and practice exercises based on individual learner needs (UNESCO, 2023). Multimodal AI systems now allow for the integration of text, images, and speech, offering richer and more engaging learning environments (Bauer, 2025). AI-based assessment tools are increasingly able to evaluate open-ended tasks, such as essays and problem-solving exercises, providing detailed and timely feedback that supports both learning and teaching (Rodríguez-Ortiz et al., 2025). These developments are not only enhancing cognitive outcomes but also addressing affective and motivational aspects of learning, as students benefit from systems that are responsive, engaging, and supportive of their individual progress.

The global educational community has increasingly recognized the potential of AI for personalized learning. International conferences such as the International Conference on Artificial Intelligence in Education (AIED, 2024) have emphasized the importance of adaptive AI systems in addressing educational inequities, particularly in contexts where teachers are overburdened and resources are scarce. UNESCO's Global Education Monitoring Report (2023) identified AI as a critical tool for achieving Sustainable Development Goal 4, which calls for inclusive and equitable quality education for all. Policy discussions at the World Economic Forum (2024) have further underscored the role of AI in preparing learners for the future of work, where adaptability, self-regulation, and problem-solving will be essential skills. These international discussions reflect a growing consensus that AI is not merely a technological trend but a transformative force in education.

For Jordan, these global developments are especially pertinent. The Jordanian education system faces several challenges, including overcrowded classrooms, limited teacher-student interaction, and significant disparities in achievement between urban and rural areas (Ministry of Education, Jordan, 2024). While initiatives such as the Education Reform for the Knowledge Economy (ERFKE) and Jordan Vision 2025 have prioritized the integration of technology, the use of AI specifically for personalized learning remains underexplored. The application of AI-supported personalized education offers a promising way to address these challenges by enabling large-scale differentiation of instruction, supporting teachers with actionable insights, and ensuring that students receive the individualized attention they need to succeed. In particular, AI systems could help Jordanian schools bridge the gap between theory and practice, making mastery learning and differentiated instruction viable even in large, resource-constrained classrooms.

In conclusion, the theoretical background of this study demonstrates that AI-supported personalized education is grounded in well-established educational theories while also being propelled by cutting-edge technological innovation. The principles of reinforcement, scaffolding, mastery learning, and differentiated instruction, long recognized as essential for effective learning, can now be implemented at scale through AI. The rapid advancement of generative AI, multimodal systems, and adaptive platforms ensures that personalized learning is no longer an abstract ideal but a practical reality. For Jordan, embracing these developments is both timely and necessary, as the country seeks to enhance the quality and equity of its education system in alignment with national priorities and global educational goals. This study therefore situates itself at the

intersection of theory, technology, and practice, evaluating the impact of AI-supported personalized education on student achievement while envisioning its role in shaping the future of education in Jordan.

Importance of the Study

This study holds significant importance on both the theoretical and practical levels. At the theoretical level, it contributes to the growing body of international research on artificial intelligence (AI) in education by providing empirical evidence from the Jordanian context, where few studies have explored AI-supported personalized learning. It enriches educational theory by linking AI applications to foundational learning principles such as Bloom's mastery learning and Vygotsky's zone of proximal development, demonstrating how technology can operationalize individualized instruction and scaffold student learning effectively. The findings also advance understanding of how adaptive algorithms can influence achievement through continuous feedback and differentiated support.

At the practical level, this study provides educators, school leaders, and policymakers in Jordan with concrete data on the effectiveness of AI-based personalization in enhancing student achievement. As Jordan faces persistent challenges such as overcrowded classrooms and limited teacher–student interaction, the study offers evidence that AI can help overcome these barriers by tailoring instruction to learners' needs and providing timely feedback. Moreover, the research supports Jordan's national education reform goals and digital transformation initiatives by illustrating how AI can contribute to equitable, high-quality education for all students.

Finally, this study's outcomes can serve as a model for other Arab and developing countries seeking to integrate AI technologies into their education systems responsibly and effectively. By demonstrating measurable learning gains and highlighting the conditions necessary for successful implementation, the study helps bridge the gap between global innovation trends and local educational realities, paving the way for a future vision of smart, personalized, and inclusive learning in Jordan.

Study Assumptions

1. AI-supported personalized education provides an effective means to address individual differences among students in Jordanian classrooms.
2. The integration of AI-based personalization contributes to measurable improvements in student academic achievement.
3. The implementation of AI-personalized learning aligns with Jordan's educational reform vision and can inform national strategies for improving teaching quality and equity.

Study Questions

1- To what extent does AI-driven personalized education influence student achievement in Jordanian schools?

2- How do teachers and students perceive the use of AI tools for personalized learning in the Jordanian educational context?

3- What are the major challenges and barriers hindering the implementation of AI-based personalized education in Jordan?

4- How can AI-personalized education contribute to achieving Jordan's Vision 2025 goals for educational equity and quality?

Study Objectives

1- To examine the impact of AI-driven personalized education on student academic achievement in Jordan.

2- To explore teachers' and students' perceptions of AI-supported personalized learning environments.

3- To identify the main challenges, infrastructural needs, and readiness levels for implementing AI-based personalization in Jordanian schools.

4- To compare the effectiveness and accessibility of AI-personalized learning between public and private educational settings.

5- To provide evidence-based recommendations to support national educational strategies aligned with Jordan's Vision 2025.

Study Limits

1. Temporal Limits:

The study was conducted during the second semester of the 2024–2025 academic year, spanning approximately 10 weeks from February to April 2025. This period was selected to align with the regular school schedule and to allow sufficient time for the implementation of the AI-personalized learning program and post-assessment.

2. Spatial Limits (Place):

The research was carried out in public secondary schools located in the city of Amman, Jordan. These schools were chosen because they participate in the Ministry of Education's Education Reform for the Knowledge Economy (ERFKE) initiative, which supports the integration of digital and AI-based learning tools. Other schools in rural or private educational settings were not included, which limits the generalization of the findings to similar urban school contexts.

3. Instrumental and Procedural Limits:

The study employed a quasi-experimental design using an AI-powered adaptive learning platform developed specifically for secondary education. Data collection tools included: A pre-test and post-test designed and validated for the study.

Previous Studies

The scientific basis of this research is grounded in the examination of previous studies. With the rise of Artificial Intelligence (AI) in education, scholars worldwide have explored its capacity to enhance the learning experience, improve academic performance, and transform classroom practices. In addition to demonstrating the potential of AI in education, these studies offer insights into its limitations, contextual requirements, and the conditions for successful implementation.

Adaptive systems and intelligent tutoring have demonstrated quantifiable improvements in performance in fields such as mathematics, science, and writing due to AI-supported personalized learning, as shown in the global literature. However, experts caution that effective integration requires teacher involvement, cultural adaptation, and mechanisms to prevent overreliance and bias.

Jordanian researchers and policymakers can benefit from reviewing international and regional studies to identify best practices adaptable to local needs and highlight existing gaps. This review evaluates and analyzes both empirical and theoretical work published between 2024 and 2025, positioning the current study within the global body of knowledge while emphasizing its significance for the future of education in Jordan. The scientific basis of this research is based on the examination of previous studies. With the rise of (AI) in education, academics across the globe have pondered its capacity to enhance learning experience, improve academic performance, and transform classroom practices. Besides demonstrating the potential of artificial intelligence in improving learning, these studies offer insights into its shortcomings and areas where it may be most effective.

Van der Kleij and colleagues (2024) investigated AI-assisted rubric feedback in K–12 writing classes. Their study revealed that AI-generated scoring aligned strongly with teacher evaluations, reducing grading workload by nearly 40%. Students benefited from timely and structured feedback, which improved the quality of their revisions. Teachers emphasized the need for transparency in AI algorithms and rubrics to ensure fairness and maintain trust. This early study marked one of the first rigorous attempts to integrate AI into authentic classroom assessment practices.

Through a systematic review of 58 K–12 studies on Intelligent Tutoring Systems (ITS), Hwang and colleagues (2025) reported consistent learning gains, particularly in mathematics and science. The review concluded that the most effective ITS platforms were those aligned with national curricular standards and adapted to students' cultural contexts. It emphasized that ITS should be integrated into formal instruction rather than used as stand-alone tools.

Li (2025) examined the effect of AI-generated feedback on student essay revisions among a large Chinese sample. The findings showed that students using AI writing assistants produced essays with superior grammar, structure, and coherence. The impact was greatest when students were trained to critically assess AI-generated responses rather than accept them passively. The

study highlighted the importance of reflective pedagogy in enhancing the value of AI-supported writing tools.

Ivanov and colleagues (2025) compared AI-driven automated feedback with traditional human instructor feedback in university-level programming courses. The results indicated that AI feedback improved accuracy, speed, and error detection, outperforming human feedback in consistency. Nevertheless, students reported valuing human input more for motivational and contextual reasons. The researchers concluded that AI feedback is effective for technical precision but should serve as a complement—not a replacement—for instructor guidance.

Wu and Yu (2025) conducted a meta-analysis of 25 studies involving generative AI interventions in education. They found small-to-moderate overall effect sizes ($g = 0.28$), with stronger outcomes in studies incorporating structured scaffolding and robust teacher training. The authors emphasized that the success of AI interventions depends heavily on implementation fidelity and contextual adaptation.

A systematic review published in Frontiers in Education (2025) focused on generative AI applications in K–12 education. The review reported moderate improvements in creativity, critical thinking, and subject mastery, although the quality of evidence varied. It also noted risks such as bias in training data, ethical concerns, and potential student overreliance on AI-generated content. Teacher oversight was identified as a key factor in maximizing benefits and minimizing risks.

In a multi-country randomized controlled trial (2025), AI-driven tutoring in mathematics was implemented using dialog-based instructional methods. Lower-performing students showed significant improvement in problem-solving skills, with an average effect size of $d = 0.42$. The study highlighted the role of teacher participation, finding that outcomes were stronger in blended settings (AI plus teacher guidance) than in AI-only environments.

Collectively, these studies from 2024 to 2025 demonstrate that AI-driven personalized education can significantly enhance student performance, engagement, and feedback efficiency across various disciplines. However, they also highlight that effective adoption depends on teacher involvement, contextual adaptation, and ethical implementation. These findings provide a solid empirical foundation for investigating AI-personalized education within the Jordanian context, where empirical evidence remains scarce despite national policy interest and reform initiatives.

Previous Studies General Comment

A synthesis of the reviewed studies reveals several converging trends. First, AI-supported personalized education consistently demonstrates positive effects on student achievement, particularly in mathematics, science, and writing. Whether through Intelligent Tutoring Systems (Hwang, 2025; Kim, 2024), generative AI applications (Wu & Yu, 2025; Tai & Chen, 2025), or

AI-driven formative feedback (Ivanov, 2025; Van der Kleij et al., 2024), the evidence points to measurable improvements in learning outcomes compared to traditional approaches.

Second, a recurring finding is that the most impactful AI interventions are those integrated into teacher- led instruction rather than applied in isolation. Multiple studies (Ding, 2025; Li, 2025) emphasize the importance of teacher mediation and student critical engagement with AI-generated content. This suggests that AI's role is best conceived as augmentative, amplifying human teaching rather than replacing it.

Third, several studies caution against risks and limitations, including ethical concerns (Frontiers in Education, 2025), potential biases in AI feedback, student overreliance on AI-generated responses, and lack of transparency in algorithmic decision-making (BJET, 2025). These findings highlight the need for teacher training, ethical frameworks, and culturally sensitive AI adaptation — especially critical in regions like Jordan, where educational equity and digital infrastructure remain central challenges.

Finally, the literature suggests a trajectory of AI in education moving from augmentation toward transformation. While current AI applications mainly support efficiency (e.g., faster grading, individualized practice), the emerging vision includes AI-enabled learning redefinition — creating learning experiences that were previously unattainable, such as adaptive simulations and AI-driven collaborative problem-solving (Kim, 2024). In conclusion, the reviewed studies provide strong evidence that AI-supported personalized education can enhance student achievement, but its effectiveness depends on thoughtful integration, cultural contextualization, and robust teacher involvement. For Jordan, this implies that AI adoption should be aligned with national priorities, teacher professional development, and equitable access to ensure sustainable educational transformation. Each of these studies reinforces the notion that AI-personalized education enhances student learning when effectively designed, localized, and supervised.

Methodology and Statistical Method

This study employs a quasi-experimental design involving treatment (AI-personalized tutoring) and control groups (traditional instruction). The sample will consist of 40 schools stratified by urban-rural distribution, gender, and socioeconomic background. Participants will include grades 7–9 for mathematics and grade 9 for Arabic writing. Instruments will include standardized achievement tests, engagement surveys, and teacher logs. Statistical analysis will be conducted using SPSS. Data preparation will involve coding IDs and cleaning. Descriptive statistics will summarize performance, followed by ANCOVA to control for pre-test scores. Multilevel modeling will account for clustering within classes and schools. Effect sizes (Cohen'sd, partial eta^2) will be reported. Validity will be ensured through expert review of instruments, while Cronbach's alpha will test reliability of survey scales.

Study Instruments

To achieve the objectives of this study, a combination of quantitative and qualitative instruments was developed and employed to measure the core variables: the degree of implementation of AI-personalized education, and its effect on students' academic achievement at

the secondary stage in Jordan. The instruments were carefully constructed, validated, and tested for reliability to ensure accuracy and consistency of the collected data.

1. AI-Personalized Education Scale

This scale was designed by the researcher to assess the extent to which AI-supported personalized learning practices are applied in secondary schools. The instrument consists of 30 items distributed over three dimensions:

Adaptive Learning and Feedback (10 items)
AI-Based Assessment and Support Systems (10 items)
Student Engagement and Motivation through AI Tools (10 items)

Responses were measured on a five-point Likert scale ranging from (1 = Strongly Disagree) to (5 = Strongly Agree).
To verify its content validity, the instrument was reviewed by a panel of seven experts in educational technology and measurement from Jordanian universities. Their comments led to minor modifications in wording and item clarity. The construct validity was examined using exploratory factor analysis (EFA) on a pilot sample of (n = 60) students, where all items loaded above 0.50 on their intended factors.
The reliability coefficient (Cronbach's Alpha) for the entire scale was 0.91, indicating high internal consistency, with sub-dimension alphas ranging from 0.86 to 0.89.

2. Academic Achievement Test

To measure students' achievement in selected subjects (Mathematics, Science, and English), a researcher-developed standardized test was constructed. The test comprised 40 multiple-choice items covering different levels of Bloom's taxonomy (knowledge, comprehension, application, and analysis).
Items were validated by subject-matter experts and curriculum supervisors in the Ministry of Education. The item difficulty indices ranged between 0.35 and 0.75, and discrimination indices exceeded 0.40 for all retained items.
The content validity ratio (CVR) according to Lawshe's method was 0.82, confirming the adequacy of the test content. The reliability of the test was confirmed using Kuder-Richardson Formula 20 (KR-20), yielding a coefficient of 0.88, which reflects a high level of consistency suitable for research purposes.

3. Teacher Interview Guide

A semi-structured interview guide was designed to obtain qualitative insights from AI-integrating teachers about their perceptions, challenges, and observed changes in student performance. The guide included 10 open-ended questions validated by three experts in qualitative research for clarity and alignment with study objectives. The pilot testing with four teachers confirmed the appropriateness and comprehensibility of the questions.

Study Community and Sample

The study community consisted of all secondary school students enrolled in Jordanian public and private schools during the academic year 2024/2025. This population was chosen for three main reasons: (1) secondary education represents a decisive stage in shaping academic achievement and readiness for higher education, (2) the Jordanian Ministry of Education has started to pilot digital transformation projects at this level, including initiatives related to artificial intelligence (AI), and (3) students at this age are more capable of interacting with digital and AI-based learning tools compared to younger learners.

This study was limited to male students in secondary schools. The decision to focus exclusively on males was taken for both practical and methodological reasons. First, in many Jordanian schools, male and female students are taught in separate institutions, which makes it difficult to apply the same AI-supported instructional tools across both genders within a single experimental design. Second, to ensure the reliability of findings and minimize confounding variables, the research team chose to work within a more homogeneous group (male students only), thereby controlling for potential gender-related differences in technology adoption, learning styles, or digital access.

By narrowing the scope to males, the study maintained stronger internal validity, allowing for a more precise measurement of the effects of AI-supported personalized education. At the same time, this limitation indicates the need for future research that explicitly includes female students, to ensure generalizability of findings across genders in the Jordanian context

The study sample was determined using a stratified random sampling method to ensure fair representation of the population. The community was divided into strata according to two main variables: type of school (public vs. private) and geographical location (urban vs. rural). From each stratum, a proportional random sample was drawn included 410 students, distributed as follows:

- **200** students from public schools (**120** urban, **80** rural).
- **210** students from private schools (**140** urban, **70** rural).

To allow for comparative analysis, the sample was divided into two groups:

1. Control Group **(n = 200):** Received instruction using traditional teaching methods.
2. Experimental Group **(n = 210):** Received instruction supported by AI-based personalized

learning platforms (adaptive learning systems, AI-driven feedback applications, and data analytics dashboards).

To measure the impact of AI-supported personalized education on student achievement, the study employed a pre-test and post-test design. The pre-test was administered to both the control and experimental groups prior to the implementation of the intervention, to assess their initial level of academic achievement and ensure group equivalence. Following the instructional period, a post-test was conducted for both groups to measure learning gains. The test was designed by subject-matter specialists and covered the same learning objectives taught during the study period. Validity of the test was established through expert review, while reliability was verified using Cronbach's Alpha coefficient via SPSS. This approach allowed for the comparison of mean scores between groups, as well as the measurement of progress within each group, thereby providing robust evidence on the effectiveness of AI-supported personalized learning.

This design ensured that the sample was both representative and diverse, covering variations in gender, type of school, and regional distribution, thereby strengthening the validity and generalizability of the study's findings.

Outcomes and Discussion

The statistical analysis of the data revealed significant differences in achievement between the control group, which received traditional instruction, and the experimental group, which experienced AI-supported personalized education. The ANCOVA results table 1 indicated that pre-test scores, used as a covariate, significantly predicted post-test performance, **$F(1,208) = 12.54, p < .05$.** This finding confirmed that students' prior knowledge had an impact on their later achievement. More importantly, after controlling for this covariate, the treatment effect remained significant, **$F(1,208) = 33.12, p < .01$.** This demonstrates that AI-supported personalized instruction had a strong positive influence on student learning outcomes, above and beyond differences in prior achievement.

Table 1: ANCOVA Results

Comparison	F	Sig.
Pre-test (Covariate)	12.54*	$p < .05$
Control vs. Experimental	33.12**	$p < .01$

The effect sizes further emphasize the educational importance of these findings. The partial eta squared value **($\eta^2 = 0.14$)** suggests that approximately **14%** of the variance in achievement was explained by the treatment condition, which constitutes a moderate to large effect in educational research.

Table 2 (ANCOVA) Results

Source	SS	Df	MS	F	Sig.
Pre-test (Covariate)	1456.72	1	1456.72	12.54*	p < .05
Group (Treatment)	3987.65	1	3987.65	33.12**	p < .01
Error	24890.23	208	119.76		
Total	34890.60	210			

*p < .05, **p < .01

In practical terms, this means that the use of AI personalization was not only statistically significant but also meaningful in terms of real-world classroom impact. Similarly, Cohen's d value of **0.65** indicates a medium-to-large effect, showing that the average student in the experimental group outperformed **74%** of the students in the control group. Such an improvement is substantial in education, where effect sizes often fall below **0.30** in intervention studies.

Table3: Source/Comparison

Pre-test (Covariate)	**1456.72**	**1**	**1456.72**	**12.54***	**p < .05**	**-**	**0.06**
Group (Control vs. Experimental	3987.65	1	3987.65	33.12**	p < .01	0.65	0.14
Error	24890.23	208	119.76			-	-

*p < .05, **p < .01

The Source/Comparison table presents the results of the ANCOVA analysis, illustrating the impact of AI-supported personalized education on student achievement while controlling for pre-test scores. The pre-test covariate shows a significant effect, indicating that students' initial knowledge contributed to post-test outcomes, which confirms the importance of accounting for baseline differences. More importantly, the treatment effect—comparing the experimental group with AI-supported instruction to the control group—was statistically significant, with $F(1,208) = 33.12$, $p < .01$, demonstrating a strong positive influence of personalized AI learning on achievement. The effect size indicators reinforce this conclusion: Cohen's $d = 0.65$ suggests a medium-to-large practical impact, while partial $\eta^2 = 0.14$ indicates that approximately 14% of the variance in post-test scores can be attributed to the treatment. These findings not only provide robust evidence that AI-supported personalized education can meaningfully enhance student learning but also align with previous research highlighting the effectiveness of adaptive learning systems in improving academic outcomes. The table clearly illustrates that AI personalization contributes both statistically and practically to student

achievement, validating its potential as a transformative instructional tool in classrooms.

These results align with a growing body of international literature demonstrating the effectiveness of AI- supported personalized education. For instance, Hwang et al. (2025) found that intelligent tutoring systems significantly improved science achievement among middle school students, with effect sizes comparable to or even exceeding those observed in this study. Likewise, Ding and Yusof (2025) reported that AI-driven conversational agents improved both performance and motivation in language learning, consistent with our findings that AI personalization supports not only cognitive outcomes but also engagement and persistence. Wu and Yu (2024) similarly highlighted that adaptive platform can accelerate progress in mathematics by targeting specific weaknesses, a mechanism that may explain the gains observed in Jordanian students in this study.

At the same time, the results of this research provide important contextual evidence from Jordan, where empirical studies on AI in education are still scarce. Previous research in Jordan has often emphasized digital learning tools broadly but has rarely evaluated AI-powered systems that actively adapt to student needs. The present findings therefore extend global evidence into a new cultural and educational context, confirming that the benefits of AI personalization are not limited to Western or East Asian school systems but are also applicable in Middle Eastern classrooms with their own unique challenges, such as larger class sizes and resource constraints.

An important aspect of the findings is their connection to Bloom's mastery learning theory, which argued that virtually all students can achieve high levels of performance when instruction is individualized, and adequate time is provided. The results of this study demonstrate that AI can operationalize this theoretical principle in practical classroom settings. By giving students adaptive exercises, immediate feedback, and opportunities to correct errors, the AI system ensured that students did not simply move on without mastering key concepts. This reflects precisely the type of scaffolding and corrective support that Bloom envisioned but which has historically been difficult to implement in traditional classroom environments.

Furthermore, the findings resonate with Vygotsky's socio-constructivist framework, especially the notion of the zone of proximal development (ZPD). AI-supported learning environments functioned as a "more knowledgeable other," offering hints, explanations, and feedback just beyond students' current abilities, thereby facilitating optimal learning. This study demonstrates that such theoretical ideas are not merely abstract concepts but can be translated into tangible learning gains through modern AI technologies.

The results also highlight the practical implications for Jordanian education policy and practice. Jordan has long faced the challenge of overcrowded classrooms, which limits teachers' ability to offer individualized support.

AI-supported personalized education provides a scalable way to address this issue by supplementing teacher instruction with technology that can respond to each learner's needs. The improvements in student achievement observed in this study suggest that adopting such systems could significantly raise academic performance across schools, particularly in subjects where students typically struggle. Moreover, given that the

experimental group consisted of male students only, the findings open avenues for further exploration with female students, potentially broadening the evidence base to encompass the entire student population.

When compared with previous studies, the results are also consistent with broader international discussions on the future of education. The UNESCO (2023) Global Education Monitoring Report emphasized that AI could play a central role in achieving equitable education by personalizing learning at scale. Similarly, the Arab Forum on Artificial Intelligence in Education (Amman, 2024) stressed the need to adopt AI-driven solutions that reflect local educational needs and contexts. This study provides empirical evidence that supports those policy discussions by showing measurable gains in achievement when AI is implemented in Jordanian schools.

It is also worth noting that while the results are encouraging, they must be interpreted considering certain limitations. The sample was restricted to male students, meaning that further research is needed to confirm whether the findings generalize to female students. In addition, the study focused on short-term achievement outcomes; future research should examine whether the observed benefits persist over time and whether they extend to higher-order skills such as critical thinking and creativity. Nonetheless, the consistency of these findings with previous studies internationally strengthens their validity and points to a clear role for AI in enhancing learning outcomes. In conclusion, the results of this study provide strong evidence that AI-supported personalized education significantly improves student achievement in Jordan. The findings not only confirm global trends but also demonstrate their applicability in the Jordanian context, where systemic challenges make personalized instruction particularly valuable. By linking the results to established theories of learning and mastery, as well as to contemporary policy discussions, the study highlights the transformative potential of AI in bridging the gap between educational ideals and classroom realities.

Recommendations

- Integration of AI Systems: The Jordanian Ministry of Education should begin integrating AI-supported personalized learning systems into classrooms, especially in core subjects such as mathematics, science, and languages.
- Pilot Implementation: Start with pilot projects in a representative sample of schools, with measurable targets such as equipping 30% of public schools with adaptive AI platforms within three years.
- Teacher Training: Provide continuous professional development for teachers on the effective use of AI tools, competency levels should be monitored through annual training assessments.

- Curriculum Alignment: Ensure AI systems align with Jordan's national curriculum, develop localized content that reflects the cultural and linguistic context of Jordanian students.
- Monitoring and Evaluation: Embed monitoring and evaluation mechanisms throughout implementation, the Ministry should publish annual "AI in Education Impact Reports" tracking achievement, engagement, and equity of access.
- Equity and Infrastructure: Address equity concerns in rural and under-resourced schools, provide devices and internet connectivity to avoid widening the digital divide.
- Student Feedback: Include mechanisms for regular student feedback within AI systems to ensure personalization enhances motivation, socio-emotional development, and academic growth
- Partnerships: Form collaborations with universities and EdTech companies to develop localized AI solutions tailored to Jordan's context, establish at least three formal partnerships within two years.
- Future Research: Expand research to include female students, different grade levels, and longitudinal outcomes, aim to produce five peer-reviewed studies within five years to build a strong evidence base for AI-supported personalized education in Jordan.

. Study Limitations

It should be noted, however, that the study was limited to male students in selected Jordanian schools. Thus, the future research should extend to female students and diverse contexts to ensure generalizability.

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التعليم المخصص بالذكاء الاصطناعي في الأردن: آثاره على التحصيل الدراسي
رؤية مستقبلية

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الملخص:

تبحث هذه الدراسة في تأثير التعليم المخصص والمدعوم بالذكاء الاصطناعي (AI) على التحصيل الدراسي للطلاب في الأردن، كما تستكشف آفاق دمجه في النظام التعليمي الوطني. وانطلقت الدراسة من دوافع تتعلق بتوسع مبادرات التعلم الرقمي في الأردن، والاتجاه العالمي نحو التعليم المعزز بالتكنولوجيا. استهدفت الدراسة جميع طلاب المرحلة الثانوية خلال العام الدراسي ٢٠٢٤/٢٠٢٥، حيث تم اختيار عينة مكونة من (٤١٠) طالبًا بطريقة العينة الطبقية العشوائية لتمثل المدارس الحكومية والخاصة في المناطق الحضرية والريفية. وقُسِّم المشاركون إلى مجموعتين: مجموعة ضابطة (n = 200)تلقت تعليمًا تقليديًا، ومجموعة تجريبية (n = 210) تلقت تعليمًا مخصصًا قائمًا على الذكاء الاصطناعي.

اعتمدت الدراسة التصميم شبه التجريبي باستخدام اختبارات قبليّة وبعديّة، وتم تحليل البيانات باستخدام برنامج SPSSمن خلال اختبارات (t) المستقلة، وتحليل التباين المصحح(ANCOVA) ، وحساب حجم الأثر. كشفت النتائج عن تحسن ذي دلالة إحصائية لدى طلاب المجموعة التجريبية، خصوصًا في مهارات حل المشكلات، والكتابة، والتحصيل في مادة الرياضيات. وتتوافق هذه النتائج مع أبحاث دولية تشير إلى أن التعلم المخصص بالذكاء الاصطناعي يعزز الأداء الأكاديمي، والمشاركة، والعدالة التعليمية، ويساهم في تقليص فجوات التحصيل.

ومع ذلك، أظهرت الدراسة بعض التحديات مثل ضعف جاهزية المعلمين، ومحدودية البنية التحتية، والاعتماد المفرط المحتمل على أدوات الذكاء الاصطناعي. وخلصت الدراسة إلى أن التعليم المخصص المدعوم بالذكاء الاصطناعي يمكن أن يُحدث تحولًا جذريًا في عملية التعلم في الأردن، من خلال تعزيز الابتكار والكفاءة والعدالة في التعليم والتقويم. كما أوصت بالاستثمار في تدريب المعلمين، وتقوية البنية التحتية الرقمية، ووضع سياسات وطنية تضمن دمجًا أخلاقيًا وملائمًا ثقافيًا لتقنيات الذكاء الاصطناعي.

تسهم هذه الدراسة في تقديم دليل تجريبي من الأردن يُثري النقاشات العالمية حول التحول التعليمي القائم على الذكاء الاصطناعي.

الكلمات المفتاحية:
الذكاء الاصطناعي (AI)؛ التعلم المخصص؛ التحصيل الدراسي؛ الابتكار التعليمي؛ النظام التعليمي الأردني