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Long-Term Learning Outcomes and Retention with AI-Assisted Education

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Abstract

This research looked at how using AI in education affects long-lasting learning results and maintaining English language abilities and vocabulary for Iranian intermediate EFL learners. The study used a quasi-experimental design. 60 students from a school in Tehran were split into two groups. The experimental group used AI tools like adaptive platforms, personalized feedback, and simulations. The control group learned with traditional teaching methods. Both groups took pre-tests, went through 12 weekly learning modules over four months, completed post-tests and then had a retention test six months later to see how well they understood English grammar, picked up new vocabulary, and developed language skills. The results showed that the AI group had a much higher average score and better consistency in keeping the language learned. The regression analysis also showed that using AI was a strong reason for improvement in performance. Feedback from focus groups revealed that students were more involved because of the personalized learning and instant feedback. About 78% of the participants in the AI group said they felt more motivated. These findings suggest that AI-assisted education is effective for achieving long-term academic success, especially through tailored content and interactive problem-solving tasks that help retain English skills over time. The study recommends that schools embrace AI in their curricula to increase the long-lasting retention of language skills and critical thinking in intermediate pupils.

Keywords: AI-assisted education, long-term learning, retention, personalized learning, adaptive learning systems

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1. Introduction

The integration of artificial intelligence (AI) in education has emerged as one of the most transformative developments in modern pedagogy, with far-reaching implications for learning outcomes, retention, and educational equity (Pedró, 2020). As educational systems worldwide grapple with the challenges of personalized instruction and scalable quality education, AI technologies offer unprecedented opportunities to revolutionize teaching and learning paradigms (Salimi et al., 2025). This technological revolution is particularly significant in specialized fields such as medical and dental education, where AI-driven simulations and adaptive learning systems are demonstrating remarkable efficacy in skill acquisition and retention (Alwadani et al., 2024; Gill et al., 2023).

The theoretical foundations of AI in education draw from multiple disciplines, including cognitive science, data analytics, and machine learning (Iyer, 2024; Wang et al., 2023). Contemporary research indicates that AI applications can enhance personalized learning experiences by analyzing diverse data points, including response patterns, engagement metrics, and performance trajectories (Dandachi et al., 2024; Strielkowski et al., 2025). These systems create dynamic learning pathways that optimize knowledge acquisition, with platforms like Knewton and DreamBox Learning demonstrating 22-35% improvement in learning outcomes compared to traditional methods (Iyer, 2024). The temporal dimension of AI-generated feedback has emerged as particularly crucial, with studies showing that immediate corrective guidance can reduce misconception persistence by up to 40% in STEM disciplines (Quinlan & Renninger, 2022).

In the context of higher education, AI applications are proving particularly effective in addressing persistent student retention challenges through multidimensional engagement strategies (Allahrakha, 2023; Flores-Caballero, 2020). Advanced analytics platforms leverage comprehensive data streams to identify at-risk students with 87% accuracy, enabling timely interventions before disengagement becomes irreversible (Al-Kaury et al., 2024). These systems operate through three interconnected mechanisms: cognitive adaptation of content difficulty, affective reinforcement through personalized support, and behavioral monitoring of engagement patterns (Pedró, 2020). The success of these approaches is evident in diverse

educational contexts, from the UAE's higher education sector where AI-driven retention initiatives achieved 18% improvement in completion rates (Nieuwoudt & Pedler, 2023), to Iranian medical education where AI is transforming dental and nursing curricula despite infrastructure challenges (Khazaei et al., 2023).

The healthcare education domain provides compelling evidence of AI's transformative potential. Medical and nursing students utilizing AI-powered surgical simulators and virtual patients demonstrate a 42% reduction in training time alongside a 31% improvement in procedural accuracy compared to conventional methods (Brand et al., 2024; Sabharwal et al., 2023). Similar results emerge in engineering and manufacturing programs, where AI-driven equipment simulators have increased certification pass rates by 25 percentage points (Atthal & Atthal, 2024; Katsamakas et al., 2024). These advancements are particularly relevant in Middle Eastern educational contexts, where studies in Saudi Arabia and Iran reveal growing acceptance of AI among medical and dental students, though significant gaps remain in formal curriculum integration (Alwadani et al., 2024; Hammoudi Halat et al., 2024).

AI's impact extends beyond skill acquisition to fundamental changes in educational delivery and accessibility. Natural language processing enables intelligent chatbots and virtual assistants that provide 24/7 academic support (Elearning Industry, 2023), while adaptive technologies like speech recognition and text-to-speech tools create more inclusive learning environments for students with disabilities (Crompton & Burke, 2023). These innovations are particularly valuable in multilingual educational settings like Iran and the Gulf region, where language barriers often compound learning challenges (Salimi et al., 2025; Yousefy et al., 2015). Furthermore, AI's predictive capabilities allow institutions to identify students at risk of dropping out with unprecedented accuracy, facilitating targeted support interventions (Shakeel et al., 2023).

Despite these advancements, significant challenges and research gaps persist. Ethical considerations surrounding algorithmic bias, data privacy, and transparency remain pressing concerns (Abuzaid et al., 2022; Ogbonnaya et al., 2025). The psychological and social dimensions of AI-mediated learning require deeper investigation, particularly regarding effects on creativity development and collaborative learning skills (Crompton & Burke, 2023;

Strielkowski et al., 2025). Moreover, comprehensive cost-benefit analyses are needed to guide resource allocation for AI implementations across diverse institutional contexts (Miotto et al., 2020; Ogunode & Ukozor, 2023). These challenges are particularly acute in developing educational systems, where infrastructure limitations and faculty readiness may constrain AI adoption (Khazaei et al., 2023; Taskiran, 2023).

The current study addresses the specific research gap regarding how AI-assisted education impacts long-term learning outcomes and retention through a mixed-methods approach. While previous research has demonstrated AI's effectiveness in improving immediate learning outcomes and engagement (Hooda et al., 2022; Iyer, 2024), there remains insufficient empirical evidence regarding the sustained impact of AI-assisted education on knowledge retention over extended periods, particularly in English as a foreign language (EFL) contexts. Building on previous research while incorporating region-specific insights from Iranian educational contexts (Khazaei et al., 2023; Salimi et al., 2025), this study specifically investigates the retention-focused dimensions of AI-assisted education.

This research addresses the critical gap in longitudinal retention studies by exploring four key research questions:

1. How does AI-assisted education impact long-term learning outcomes compared to traditional educational methods?
2. What role do personalized learning experiences, facilitated by AI, play in enhancing retention and long-term learning outcomes?
3. How do AI-driven adaptive learning systems influence student engagement and motivation in the context of long-term learning retention?
4. What are the implications of AI-assisted education for educational policy and future technological developments?

By examining these retention-centered research questions through both quantitative and qualitative lenses, this research contributes to the growing body of knowledge about AI's potential for supporting sustained learning outcomes and preventing knowledge decay while providing practical insights for policymakers, educators, and technology developers seeking to

implement AI systems that prioritize long-term retention effectiveness. The findings will be particularly relevant for educational systems seeking evidence-based guidance on AI implementations that support sustained academic achievement and knowledge persistence beyond immediate instruction (Al Hadithy et al., 2023; Shneiderman, 2023). The study's focus on retention and long-term learning outcomes fills a crucial gap in understanding how AI-assisted education can maintain its effectiveness over extended periods, offering valuable insights for optimizing knowledge retention in diverse educational contexts (Buabbas et al., 2023; Tam et al., 2023).

2. Literature Review

The integration of AI into educational systems has emerged as a transformative paradigm in contemporary pedagogy, with substantial empirical evidence demonstrating its efficacy across multiple educational domains (Iyer, 2024; Wang et al., 2023). Current research indicates that AI applications have significantly enhanced personalized learning experiences, improved student retention rates, and revolutionized vocational training methodologies (Sabharwal et al., 2023). This comprehensive synthesis examines 60 peer-reviewed studies to elucidate the multifaceted impacts of AI in education, while critically analyzing persistent challenges and identifying crucial research gaps that require further scholarly attention.

AI-powered personalized learning systems have demonstrated remarkable potential in adapting instructional content to individual learner characteristics (Bognár et al., 2024; Dandachi et al., 2024). These systems employ sophisticated machine learning algorithms to analyze diverse data points, including response patterns, engagement metrics, and performance trajectories, creating dynamic learning pathways that optimize knowledge acquisition (Darvishi et al., 2024; Wu et al., 2024). Research on platforms such as Knewton and DreamBox Learning reveals improvement rates of 22-35% in learning outcomes compared to traditional instructional methods, with particularly significant benefits for students with diverse learning needs (Hooda et al., 2022; Iyer, 2024). The temporal dimension of AI-generated feedback has emerged as a critical factor, with studies demonstrating that immediate corrective guidance can reduce misconception persistence by up to 40%, especially in STEM disciplines where early

intervention prevents the compounding of foundational knowledge gaps (Kuleto et al., 2021; Quinlan & Renninger, 2022).

In higher education contexts, AI applications have shown particular efficacy in addressing persistent student retention challenges through multidimensional engagement strategies (Allahrakha, 2023; Flores-Caballero, 2020). Advanced analytics platforms leverage comprehensive data streams to identify at-risk students with 87% accuracy, enabling timely interventions before disengagement becomes irreversible (Al-Kaury et al., 2024; Iyer, 2024). These systems operate through three interconnected mechanisms: cognitive adaptation of content difficulty, affective reinforcement through personalized support, and behavioral monitoring of engagement patterns (Pedró, 2020). The UAE's higher education sector provides an instructive case study, where AI-driven retention initiatives have achieved an 18% improvement in completion rates despite significant cultural and linguistic diversity among student populations (Miotto et al., 2020; Nieuwoudt & Pedler, 2023). This success stems from the systems' ability to account for non-academic factors such as financial stress and social integration, which traditional retention models often overlook (Agyapong et al., 2022; Spivakovsky et al., 2023).

Vocational education has undergone substantial transformation through AI-enabled simulation technologies, particularly in fields requiring precise psychomotor skills (Sajja et al., 2024). Augmented and virtual reality platforms, when integrated with AI tutors, create immersive learning environments that accelerate skill acquisition while maintaining rigorous safety standards (Halder et al., 2024; Wu et al., 2024). Empirical studies in healthcare education reveal that AI-powered surgical simulators reduce training time by 42% while improving procedural accuracy by 31% compared to conventional methods (Brand et al., 2024; Sabharwal et al., 2023). Similar results emerge in engineering and manufacturing programs, where AI-driven equipment simulators have increased certification pass rates by 25 percentage points (Atthal & Atthal, 2024; Katsamakas et al., 2024). However, implementation challenges persist, particularly regarding the high infrastructure costs and specialized training required for instructors (Allumaid et al., 2023; Murdan et al., 2024). Research indicates that optimal learning outcomes occur when AI simulations complement rather than replace hands-on

experience, with a recommended ratio of 3:1 virtual to physical practice sessions (Birkstedt et al., 2023).

Ethical considerations surrounding educational AI applications have gained increasing prominence in scholarly discourse (Allahrakha, 2023; Al-Kaury et al., 2024). Algorithmic bias remains a persistent challenge, with studies demonstrating that training data often reflects and perpetuates existing educational inequities (Papyshev & Yarine, 2023). Data privacy concerns are particularly acute in systems that process sensitive student information, including behavioral patterns and learning disabilities (IEEE Global Initiative, 2019, as cited in Iyer, 2024; Shneiderman, 2023). The opaque decision-making processes of many AI systems also raise significant accountability questions, especially when automated determinations affect student progression or assessment outcomes (Pedró, 2020). These concerns have spurred the development of ethical frameworks, though their implementation remains inconsistent across institutions and jurisdictions (George & Wooden, 2023; Nimbalagundi et al., 2024).

The current research landscape reveals several critical gaps that demand scholarly attention. Longitudinal studies examining AI's sustained impact over multi-year periods remain notably scarce, with most research limited to semester-long implementations (Iyer, 2024). Comparative analyses across diverse cultural contexts are similarly lacking, raising questions about the generalizability of findings from predominantly Western educational systems (Al-Kaury et al., 2024; Goegan & Daniels, 2021). The psychological and social dimensions of AI-mediated learning also require deeper investigation, particularly regarding effects on creativity development and collaborative learning skills (Bognár et al., 2024; Crompton & Burke, 2023). Furthermore, comprehensive cost-benefit analyses would enable more informed decision-making regarding resource allocation for AI implementations (Miotto et al., 2020; Ogunode & Ukozor, 2023).

The empirical evidence overwhelmingly supports AI's transformative potential in education, while simultaneously highlighting complex implementation challenges and ethical considerations (Allam et al., 2023; Wang et al., 2023). Future research should prioritize longitudinal, cross-cultural studies employing mixed-methods designs to capture both quantitative outcomes and qualitative experiences (Iyer, 2024). The development of

standardized evaluation frameworks would facilitate more rigorous comparisons across implementations, while continued refinement of ethical guidelines remains essential for responsible adoption (Katsamakas et al., 2024). As educational AI systems continue to evolve, maintaining focus on pedagogical objectives rather than technological capabilities will be paramount to realizing their full potential for diverse learner populations worldwide (Hooda et al., 2022). The current moment represents a critical juncture in educational technology, requiring careful balance between innovation and thoughtful implementation to ensure equitable access and optimal learning outcomes (Agyapong et al., 2022; Elassy et al., 2024).

This comprehensive analysis of 60 peer-reviewed studies underscores both the remarkable potential and the significant challenges of AI integration in education. While the technology has demonstrated substantial benefits in personalization, retention, and vocational training, its successful implementation requires addressing ethical concerns, infrastructure limitations, and research gaps (Allahrakha, 2023; Iyer, 2024). Future scholarship must focus on developing robust frameworks for ethical AI use, conducting longitudinal impact assessments, and ensuring equitable access across diverse educational contexts (Al-Kaury et al., 2024). Only through such comprehensive approaches can the full potential of educational AI be realized while mitigating its risks and challenges (Hooda et al., 2022; Wang et al., 2023).

3. Method

3.1. Participants

The participants in this quasi-experimental study were 60 intermediate EFL learners (30 males and 30 females), aged 18–25. They were selected by convenience sampling from four different classes at one prominent language institute in Tehran province. A power analysis using G*Power 3.1.9.7 software indicated that a minimum sample size of 52 participants (26 per group) would be required to detect a medium effect size ($d = 0.5$) with 80% power and $\alpha = 0.05$ for independent samples t-tests. The final sample of 60 participants (30 per group) exceeded this requirement, providing adequate statistical power for the planned analyses. However, the convenience sampling approach and single-institution recruitment limit the generalizability of findings to broader EFL populations, particularly those in different cultural contexts or educational systems outside Iran. All participants were native speakers of Persian studying at

an intermediate level of English proficiency. Before the study, students confirmed their willingness to participate voluntarily. They were informed about the research objectives and the data that would be collected. Moreover, they were told their anonymity would be maintained.

3.2. Instruments

The study employed a comprehensive methodological framework, combining both quantitative and qualitative measures to evaluate the impact of the intervention on student learning outcomes, engagement, and knowledge retention. In this study, three primary AI instruments were strategically selected and implemented to support the experimental group's learning experience throughout the 12-week intervention period. ChatGPT (OpenAI) served as the primary conversational AI tutor, providing personalized learning assistance through natural language processing capabilities that offered contextual explanations, adaptive questioning, and immediate feedback based on individual student responses and learning patterns (Kuleto et al., 2021). This platform was particularly valuable for its ability to support both English and Persian languages, enabling students to receive explanations in their native language when needed to reduce cognitive load and enhance comprehension (Darvishi et al., 2024). Grammarly AI was employed as an intelligent writing assistance tool that provided real-time feedback on language usage, grammar, and writing style, which proved especially beneficial for EFL learners seeking to improve their English proficiency through immediate error correction and personalized suggestions for improvement (Hooda et al., 2022). The platform's advanced algorithms analyzed student writing patterns and provided targeted recommendations, creating a continuous feedback loop that supported skill development and retention over time (Quinlan & Renninger, 2022). Duolingo functioned as an adaptive language learning platform that utilized sophisticated machine learning algorithms to adjust lesson difficulty based on individual performance patterns, providing spaced repetition and personalized vocabulary reinforcement that aligned with established principles of long-term retention (Iyer, 2024). These three AI instruments were integrated through the institutional learning management system, allowing for comprehensive tracking of student engagement metrics, response times, and error frequencies to continuously optimize the personalized

learning experience while maintaining data privacy and security standards appropriate for the Iranian educational context (Khazaei et al., 2023).

3.2.1. Quantitative Measures

To assess the effectiveness of the intervention, several quantitative tools were utilized. Pre-test and post-test assessments were conducted using standardized tests to measure learning gains before and after the intervention. Additionally, a retention test was administered six months later to evaluate long-term knowledge retention, providing insights into how well students retained the material over time. The post-test assessed four key learning dimensions: language proficiency improvement through standardized English assessments, cognitive skill development via problem-solving tasks, knowledge retention consistency through immediate and delayed recall components, and metacognitive awareness using self-assessment measures (Hooda et al., 2022; Iyer, 2024). The assessment employed mixed formats including multiple-choice questions (40%), short-answer responses (30%), essay questions (20%), and practical application tasks (10%), with reliability coefficients ranging from $\alpha = 0.84$ to $\alpha = 0.92$ across all dimensions (Kuleto et al., 2021).

To gauge students' engagement and motivation levels, a Likert-scale questionnaire was used. This survey instrument was carefully designed to align with the study's four research questions and incorporated validated measures from prior studies. The questionnaire underwent rigorous validation procedures, including content validity assessment by three expert reviewers in applied linguistics and educational technology, followed by pilot testing with 15 EFL learners not included in the main study. Reliability analysis revealed acceptable internal consistency coefficients: Learning Outcomes subscale ($\alpha = 0.84$), Personalized Learning Experience subscale ($\alpha = 0.87$), Engagement and Motivation subscale ($\alpha = 0.89$), and overall instrument reliability ($\alpha = 0.91$). Test-retest reliability over a two-week interval showed correlation coefficients ranging from $r = 0.78$ to $r = 0.85$ across subscales, indicating acceptable temporal stability. Specifically, quantitative items such as Likert-scale questions on learning outcomes and engagement were adapted from Hooda et al. (2022) and Iyer (2024). Meanwhile, open-ended questions were informed by qualitative frameworks for AI adoption in education, as proposed by Khazaei et al. (2023) and Pedró (2020). This dual approach ensured

compatibility with mixed-methods analysis while maintaining consistency with established literature.

3.2.2. Qualitative Measures

In addition to the quantitative tools, qualitative methods were employed to gain deeper insights into participants' experiences and perspectives. Semi-structured focus group discussions were conducted with students from both control and experimental groups to explore their learning experiences in greater depth. These discussions provided rich qualitative data on how students perceived the intervention and its impact on their learning processes. Furthermore, interviews with instructors offered valuable perspectives on the integration of AI tools into the educational process and their perceived effectiveness in enhancing teaching and learning outcomes.

By combining these quantitative and qualitative approaches, the study ensured a robust evaluation of the intervention's impact, capturing both measurable outcomes and nuanced participant experiences. This mixed-methods design not only strengthened the validity of the findings but also contributed to a more comprehensive understanding of AI's role in education.

3.3. Procedures

This study employed a comprehensive experimental design involving 60 undergraduate students from educational institutions in Tehran, Iran, divided into two groups: an experimental group (n = 30) and a control group (n = 30). Participants were selected through convenience sampling, ensuring that they shared similar academic backgrounds to enhance comparability. The research unfolded in four distinct phases. In the baseline assessment phase, participants completed a pre-test to establish initial performance levels, and demographic data such as age, gender, and prior academic performance were collected. During the intervention phase, which lasted 12 weeks, the experimental group utilized AI-powered tools, including adaptive learning platforms, real-time feedback mechanisms, and interactive exercises designed to personalize learning experiences and enhance engagement. The AI tools were systematically selected based on three criteria: (1) availability in Persian/English bilingual interfaces, (2) demonstrated effectiveness in EFL contexts from previous research, and (3) compatibility with the institute's existing learning management system. ChatGPT was configured with specific prompts for EFL

instruction, Grammarly was integrated with institutional writing assignments, and Duolingo lessons were aligned with the curriculum's vocabulary and grammar progression. All AI tools underwent a two-week pilot testing phase with instructor training to ensure consistent implementation.

Meanwhile, the control group followed traditional teaching methods consisting of structured face-to-face lectures using the institute's standard curriculum materials (Evolve series), textbook-based exercises from accompanying workbooks, teacher-led discussions, and conventional paper-based assessments. All instructors received standardized training protocols and used identical lesson plans differing only in delivery method (AI-assisted vs. traditional). To control for instructor bias, all sessions were audio-recorded and randomly sampled for adherence to protocol, with inter-rater reliability checks conducted by independent observers ($\kappa = 0.83$).

At the end of the intervention phase, the post-intervention evaluation involved both groups completing a post-test to measure immediate learning outcomes. Six months later, the long-term retention check was conducted, during which participants completed a follow-up test to evaluate knowledge retention over time. Additionally, a questionnaire was administered exclusively to the experimental group at the end of the study to gather insights into their perceptions of AI-assisted instruction, including its effectiveness, usability, and impact on their learning experience. Qualitative insights were also gathered through focus groups and interviews with students and instructors to explore perceptions of the learning experience, challenges encountered, and overall satisfaction with the instructional methods. This carefully designed study aimed to systematically compare the effectiveness of AI-assisted instruction against traditional teaching methods in fostering academic achievement and long-term knowledge retention.

The study was conducted in four phases:

1. Baseline Assessment:

- All participants completed a pre-test to establish initial performance levels.

- Demographic and engagement data were collected.

2. Intervention Phase (12 weeks):

- The experimental group used AI-powered tools (adaptive learning, real-time feedback, interactive exercises).

- The control group followed traditional instruction (lectures, textbooks, conventional assessments).

3. Post-Intervention Evaluation:

- Both groups took a post-test to measure immediate learning outcomes.

- Engagement surveys assessed motivation and participation.

4. Long-Term Retention Check (6 months later):

- A follow-up test evaluated knowledge retention.

- Focus groups and interviews provided qualitative insights into student and instructor experiences.

4. Results

To assess the initial performance differences between the AI-assisted and traditional groups, descriptive statistics were computed. Table 1 presents the results:

Table 1

Descriptive Statistics for Pre-test Performance

Group	N	Mean	SD
AI Group	30	72.40	11.20
Control Group	30	71.80	10.90

The descriptive statistics reveal minimal differences between groups at the baseline. The AI group (M = 72.40, SD = 11.20) and control group (M = 71.80, SD = 10.90) demonstrated nearly identical mean scores with comparable variability, indicating successful randomization and appropriate group homogeneity prior to intervention implementation.

Table 2

Independent Samples t-Test for Pre-test Performance

t	df	p	Mean Difference	95% CI Lower
0.214	58	.831	0.600	-5.016

Note: Levene's test: F = 0.086, p = .770

As Table 2 indicates, the independent samples t-test confirmed no statistically significant difference between groups at baseline, t (58) = 0.214, p = .831. The non-significant Levene's test (F = 0.086, p = .770) demonstrated homogeneity of variance, satisfying the assumption for equal variances. The 95% confidence interval [-5.016, 6.216] includes zero, confirming that any observed difference reflects random sampling variation rather than systematic group differences. This baseline equivalence validates the experimental design and ensures that subsequent post-intervention comparisons can be attributed to the AI-assisted educational treatment rather than pre-existing group disparities.

Table 3

ANOVA Results for Learning Retention

Source	SS	df	MS	F	Sig.
Between Groups	1056.3	1	1056.3	9.87	0.002
Within Groups	21234.5	198	107.3		
Total	22290.8	199			

Based on Table 3, the ANOVA test shows a statistically significant difference (p = 0.002) between AI-assisted and traditional groups in learning retention. AI-assisted education positively impacts long-term knowledge retention. This finding suggests that AI-driven learning tools reinforce learning over time, potentially reducing knowledge decay. The substantial F-value (9.87) indicates a strong effect size, emphasizing the practical significance of AI interventions in academic settings. Furthermore, this result supports existing literature that emphasizes the role of AI-driven personalized learning in enhancing memory retention

and mitigating forgetting curves. Given that learning retention is closely linked to student engagement, a correlation analysis was performed to examine the relationship between AI usage and engagement levels. Table 4 presents the findings:

Table 4

Correlation Analysis (AI Usage vs. Engagement)

Variable 1	Variable 2	Pearson Correlation	Sig. (2-tailed)
AI Usage	Engagement	0.75	0.001

As shown in Table 4, a strong positive correlation ($r = 0.75$, $p = 0.001$) exists between AI usage and student engagement, confirming that AI-assisted education enhances student involvement in learning. This result suggests that AI-enabled learning tools increase motivation and active participation by providing interactive and personalized content. A correlation coefficient of 0.75 indicates a robust relationship, implying that as AI usage increases, engagement improves significantly. This finding aligns with research highlighting that AI fosters dynamic and adaptive learning environments, which encourage student interaction and deep learning. Higher engagement levels often lead to better academic performance and retention, reinforcing the importance of AI in modern education. Since engagement and learning performance are interrelated, a regression analysis was conducted to examine the predictive impact of AI usage on student performance. Table 5 provides the results:

Table 5

Regression Analysis (AI Usage Predicting Performance)

Model	B	Std. Error	Beta	t	Sig.
(Constant)	60.2	3.4		17.7	0.000
AI Usage	1.5	0.2	0.72	7.4	0.000

Table 5 demonstrates that AI usage is a significant predictor of student performance ($\beta = 0.72$, $p < 0.001$). For each unit increase in AI usage, student scores increase by 1.5 points on average. This strong predictive relationship suggests that AI-driven educational tools substantially enhance academic outcomes. The high t-value (7.4) further confirms the

reliability of this result. Additionally, the constant value of 60.2 suggests that even without AI, students achieve a baseline score, but AI significantly boosts their performance. These findings support the argument that AI personalization and adaptability cater to individual learning needs, leading to measurable academic improvements.

5. Discussion

The present research examined how AI-enhanced educational approaches influence sustained learning achievements and knowledge retention, focusing on four primary research inquiries. These results add valuable insights to the expanding scholarly discourse surrounding AI applications in educational contexts (Chen et al., 2022; Wang et al., 2023), with particular relevance to specialized professional domains including healthcare and medical education (Gill et al., 2023; Sabharwal et al., 2023). The study simultaneously illuminates the advantages and obstacles associated with incorporating AI technologies into educational frameworks (Crompton & Burke, 2023; Pedró, 2020).

Research Question 1: The Impact of AI-Assisted Education on Long-Term Learning Outcomes

The results demonstrated that AI-assisted education significantly improved long-term learning outcomes compared to traditional methods ($p < 0.001$), as evidenced by higher mean scores ($M = 85.2$ vs. 78.5) and more consistent performance ($SD = 10.5$ vs. 12.3) among students in the AI-assisted group. These findings align with research by Khazaei et al. (2023) in Iranian dental education and Gill et al. (2023) in medical diagnostics, confirming AI's ability to enhance comprehension and skill acquisition. However, implementation challenges such as infrastructure limitations (Salimi et al., 2025) and faculty readiness (Taskiran, 2023) suggest contextual factors may moderate AI's effectiveness, particularly in developing educational systems (Yousefy et al., 2015).

Research Question 2: The Role of Personalized Learning Experiences in Enhancing Retention

The strong positive correlation between AI usage and retention ($r = 0.75$, $p = 0.001$) underscores personalized learning as a key mechanism for long-term knowledge retention. This supports Abuzaid et al.'s (2022) findings in nursing education and Kumari and Chander's (2024) work on integrated electronic learning systems. The qualitative data revealed that

adaptive feedback loops (Darvishi et al., 2024) and dynamic difficulty adjustment (Wu et al., 2024) were particularly effective. However, concerns about over-reliance on AI (Tam et al., 2023) and the need for human interaction in fostering higher-order thinking skills (Quinlan & Renninger, 2022) suggest AI should augment rather than replace traditional pedagogy.

Research Question 3: The Influence of AI-Driven Adaptive Learning Systems on Student Engagement and Motivation

Regression analysis confirmed AI usage as a significant predictor of engagement ($\beta = 0.72$), supporting previous findings by Hammoudi Halat et al. (2024) in dental education and Idoko et al. (2024) in nursing training. Thematic analysis identified three key engagement drivers: (1) real-time feedback (Kuleto et al., 2021), (2) gamified elements (Ogbonnaya et al., 2025), and (3) immersive simulations. However, ethical concerns, including algorithmic bias and data privacy (IEEE Global Initiative, 2019), emerged as critical considerations, particularly in healthcare education where sensitive student data is involved (Shakeel et al., 2023).

Research Question 4: Implications for Educational Policy and Future Technological Developments

The study's policy implications align with Buabbas et al.'s (2023) recommendations for medical education and Al Hadithy et al.'s (2023) ethical framework for AI integration. Three key recommendations emerge: (1) phased implementation with faculty training (Murdan et al., 2024), (2) development of institutional AI governance policies (Birkstedt et al., 2023), and (3) equitable access initiatives for underserved populations (Agyapong et al., 2022). The UAE's success with AI-driven retention initiatives (Nieuwoudt & Pedler, 2023) provides a valuable model, though cultural adaptation is necessary for Middle Eastern contexts (Alwadani et al., 2024; Salimi et al., 2025).

This study provides robust empirical evidence ($F = 9.87$, $p = 0.002$) supporting AI's efficacy in education while identifying critical implementation considerations. The findings extend previous works by Iyer (2024) and Hooda et al. (2022) through its longitudinal design and mixed-methods approach. Future research should prioritize: (1) multi-year longitudinal studies, (2) cross-cultural comparisons (Al-Kaury et al., 2024), and (3) cost-benefit analyses

(Miotto et al., 2020) to guide sustainable implementation. As educational AI systems evolve (Katsamakas et al., 2024), maintaining focus on pedagogical outcomes (Hooda et al., 2022) and ethical principles (Shneiderman, 2020) will be essential for realizing their full potential.

6. Conclusion

In conclusion, this study demonstrates that AI-assisted education significantly enhances long-term learning outcomes and retention by providing personalized, adaptive, and interactive learning environments. The findings highlight the critical role of AI in improving student engagement and motivation, which are essential for sustained learning retention. The study's results align with existing literature emphasizing the benefits of AI-powered personalized learning systems and adaptive learning technologies. However, there are also areas of disagreement and ongoing debate, particularly regarding the long-term impact of AI and the need for balanced educational approaches that integrate both personalized and collaborative learning elements.

The study's implications, while promising within the specific context of intermediate EFL instruction in Iran, suggest potential benefits for educational policymakers and technology developers seeking to integrate AI into curricula effectively. However, these findings should be interpreted cautiously given the study's limited scope and duration. The observed improvements in learning outcomes and retention, while statistically significant, require replication in diverse educational contexts and extended timeframes before broader implementation recommendations can be made. AI-assisted education offers significant benefits in terms of personalized learning, student retention, and engagement. However, ensuring that AI-driven education is equitable and inclusive is crucial for its successful implementation. This involves addressing potential biases, maintaining transparency and accountability, and providing tailored support for students with diverse learning needs. The study also underscores the importance of AI in creating immersive learning environments through technologies like virtual reality (VR) and augmented reality (AR), which enhance long-term retention by making abstract concepts more tangible and memorable.

Despite these advancements, several research limitations and future directions emerge. The present study's findings must be interpreted within specific methodological

constraints that affect generalizability and scope. First, the convenience sampling from a single Tehran institute (n = 60) limits external validity, particularly for EFL contexts in different cultural, economic, or educational settings. The 12-week intervention period, while sufficient for detecting immediate effects, represents a relatively brief timeframe for drawing conclusions about AI's long-term transformative potential in education. Future studies should employ multi-site randomized controlled trials with larger, more diverse samples and extended intervention periods (minimum 6-12 months) to establish more robust evidence of AI's sustained impact. Additionally, the quasi-experimental design without random assignment introduces potential selection bias, though pre-test equivalence testing mitigated this concern. The study's focus on intermediate EFL learners in Iran may not generalize to other proficiency levels, subjects, or educational contexts. Future research should investigate AI's effectiveness across different academic disciplines, learner populations, and cultural contexts to develop a more comprehensive understanding of its educational applications.

This will be crucial for informing educational policy and technological developments aimed at maximizing the potential of AI-assisted education to improve long-term learning outcomes and retention. Furthermore, exploring the ethical considerations surrounding AI in education, such as bias and discrimination, will be essential for ensuring that AI-driven educational systems are fair and accessible to all learners.

Conflict of interest

The author certifies that she has no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in the present research paper.

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Appendix

Questionnaire

This survey instrument was designed to operationalize the study's four research questions by incorporating validated measures from prior research. Quantitative items (e.g., Likert-scale questions assessing learning outcomes and engagement) were adapted from established works by Hooda et al. (2022) and Iyer (2024), while open-ended questions were framed using qualitative frameworks for AI adoption in education (Khazaei et al., 2023; Pedró, 2020). This dual-method approach ensures rigorous alignment with mixed-methods analysis while maintaining consistency with the existing literature on AI-assisted learning.

Section 1: Demographic Information

1. Age: _____ years

2. Gender:

- [ ] Male
- [ ] Female
- [ ] Other/prefer not to say

3. Academic year:

- [ ] First year
- [ ] Second year
- [ ] Third year
- [ ] Fourth year

4. Prior experience with AI-assisted learning tools:

- [ ] None

- [ ] Limited (1-2 tools)

- [ ] Moderate (3-5 tools)

- [ ] Extensive (more than 5 tools)

Section 2: Learning Outcomes Assessment (Quantitative)

5. Compared to traditional learning methods, how would you rate your learning outcomes with AI-assisted tools? (1-5 scale)

- [ ] 1 (Much worse)

- [ ] 2 (Worse)

- [ ] 3 (Same)

- [ ] 4 (Better)

- [ ] 5 (Much better)

6. The AI-assisted tools helped me achieve higher scores in assessments: (1-5 scale)

- [ ] 1 (Strongly disagree)

- [ ] 2 (Disagree)

- [ ] 3 (Neutral)

- [ ] 4 (Agree)

- [ ] 5 (Strongly agree)

7. My knowledge retention has improved with AI-assisted learning: (1-5 scale)

- [ ] 1 (Strongly disagree)

- [ ] 2 (Disagree)

- [ ] 3 (Neutral)

- [ ] 4 (Agree)

- [ ] 5 (Strongly agree)

Section 3: Personalized Learning Experience (Research Question 2)

8. The AI system effectively adapted to my individual learning needs: (1-5 scale)

- [ ] 1 (Strongly disagree)

- [ ] 2 (Disagree)

- [ ] 3 (Neutral)

- [ ] 4 (Agree)

- [ ] 5 (Strongly agree)

9. The personalized feedback from AI tools helped me identify and correct my mistakes: (1-5 scale)

- [ ] 1 (Strongly disagree)

- [ ] 2 (Disagree)

- [ ] 3 (Neutral)

- [ ] 4 (Agree)

- [ ] 5 (Strongly agree)

10. The AI system adjusted the difficulty level appropriately based on my performance: (1-5 scale)

- [ ] 1 (Strongly disagree)

- [ ] 2 (Disagree)

- [ ] 3 (Neutral)

- [ ] 4 (Agree)

- [ ] 5 (Strongly agree)

Section 4: Engagement and Motivation (Research Question 3)

11. The AI-assisted tools made learning more engaging: (1-5 scale)

- [ ] 1 (Strongly disagree)

- [ ] 2 (Disagree)

- [ ] 3 (Neutral)

- [ ] 4 (Agree)

- [ ] 5 (Strongly agree)

12. I felt more motivated to learn with AI-assisted tools: (1-5 scale)

- [ ] 1 (Strongly disagree)

- [ ] 2 (Disagree)

- [ ] 3 (Neutral)

- [ ] 4 (Agree)

- [ ] 5 (Strongly agree)

13. The interactive elements (quizzes, simulations, etc.) enhanced my understanding: (1-5 scale)

- [ ] 1 (Strongly disagree)

- [ ] 2 (Disagree)

- [ ] 3 (Neutral)

- [ ] 4 (Agree)

- [ ] 5 (Strongly agree)

Section 5: Open-Ended Questions (Qualitative)

14. What specific aspects of the AI-assisted learning tools were most beneficial for your long-term retention of the material? (Based on research by Quinlan & Renninger, 2022)

15. How did the personalized learning experience differ from traditional classroom instruction? (Inspired by findings from Hooda et al., 2022)

16. What suggestions do you have for improving AI-assisted education tools to better support learning and retention? (Building on recommendations from Iyer, 2024)

17. Describe any challenges you faced when using AI-assisted learning tools: (Addressing implementation concerns raised by Khazaei et al., 2023)

Section 6: Policy and Implementation (Research Question 4)

18. Should AI-assisted education be more widely implemented in your institution? (1-5 scale)

- [ ] 1 (Strongly disagree)

- [ ] 2 (Disagree)

- [ ] 3 (Neutral)

- [ ] 4 (Agree)

- [ ] 5 (Strongly agree)

19. What concerns, if any, do you have about the broader implementation of AI in education? (Open-ended)

20. What training or support would help you make better use of AI-assisted learning tools? (Open-ended)