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Effect of AI-Based Personalized Learning on Students' Academic Achievement: A Systematic Review

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Abstract

Artificial Intelligence (AI) has emerged as an important technological development in contemporary education, particularly through its ability to support personalized and adaptive learning. AI-based personalized learning systems analyze learners' performance, learning behaviour, needs, preferences and progress and use this information to recommend appropriate learning content, activities, feedback and instructional pathways. The present paper examines the effect of AI-based personalized learning on students' academic achievement through a review of recent research literature. The study adopts a systematic narrative review approach and synthesizes recent scholarly evidence concerning AI-enabled personalized learning, adaptive learning systems, intelligent tutoring systems, learning analytics and generative

AI - supported learning. Existing evidence indicates that AI can positively influence academic achievement by providing individualized instruction, immediate feedback, adaptive difficulty levels, and continuous assessment and targeted learning resources. A 2025 meta-analysis of 29 empirical studies involving 2,657 participants reported a statistically significant positive overall effect of AI on students' academic performance, although the magnitude of effects varied according to educational level, intervention duration, learning strategy, subject area and type of AI. Recent systematic reviews also -based personalization can transform teaching, learning and assessment practices indicate that AI across K–12 and higher education. However, challenges related to data privacy, algorithmic bias, digital inequality, teacher preparedness, reliability of

AI-generated information and students' overdependence on technology must be addressed. The paper concludes that AI-based personalized learning has considerable potential to improve academic achievement when implemented as a pedagogically guided, ethical and teacher-supported approach rather than as a replacement for teachers.

Keywords: Artificial Intelligence, Personalized Learning, Adaptive Learning, Academic Achievement, Intelligent Tutoring Systems, Educational Technology, AI in Education

1. Introduction

Education has traditionally attempted to address the diverse learning needs of students through classroom instruction, differentiated teaching, remedial education and continuous assessment. However, conventional classroom environments often make it difficult for teachers to provide individualized instruction to every learner because of differences in students' abilities, prior knowledge, learning pace, interests and educational needs.

The development of Artificial Intelligence (AI) has created new possibilities for addressing this challenge. AI-based educational systems can process large amounts of learner data and use algorithms to identify patterns in students' performance and learning behaviour. Based on these patterns, such systems can recommend learning materials, adjust levels of difficulty, provide feedback and create individualized learning pathways.

Personalized learning refers broadly to an educational approach in which learning experiences are adapted to the individual needs, abilities, interests and progress of learners. AI extends this concept by allowing personalization to occur dynamically and at scale. Recent research describes AI-based personalized learning as an increasingly important area of educational technology, with applications across K–12 education, higher education and online learning. A systematic review published in 2025 examined 125 studies from 2015 to June 2025 and identified substantial development in AI-supported personalization, including adaptive systems, recommendation systems, intelligent tutoring and generative AI.

The relationship between AI and academic achievement is particularly important. Academic achievement generally refers to the measurable learning outcomes attained by students, such as examination scores, test performance, grades, conceptual understanding and mastery of learning objectives. If AI-based personalized learning can effectively identify students' learning gaps and provide appropriate interventions, it may contribute to improved academic performance.

A 2025 meta-analysis of 29 empirical studies involving 2,657 participants found a significant positive overall effect of AI on students' academic performance, with an effect size of 0.924. The study also reported that the effect varied according to factors such as educational level, subject area, AI type, learning strategy and intervention duration. These findings suggest that the effectiveness of AI is not simply determined by the presence of technology; rather, educational design and implementation conditions are also important.

Therefore, there is a need to examine how AI-based personalized learning affects academic achievement, what mechanisms may explain its effectiveness, and what limitations need to be considered.

2. Concept of AI-Based Personalized Learning

AI-based personalized learning refers to the use of artificial intelligence technologies to modify learning experiences according to the individual characteristics, performance and needs of students.

Unlike conventional digital learning, in which all students may receive the same digital material, an AI-based personalized system can potentially provide different content, activities, difficulty levels or feedback to different learners.

For example, if a student performs poorly on a particular mathematical concept, an adaptive system may identify the difficulty, recommend prerequisite material, provide additional examples and generate practice questions at an appropriate level.

Important components of AI-based personalized learning include:

Adaptive Learning

Adaptive learning systems modify instructional content and difficulty according to learners' responses and performance.

Intelligent Tutoring Systems

Intelligent tutoring systems use AI to provide individualized guidance, hints, explanations and feedback.

Learning Analytics

AI can analyse learner-generated data to identify patterns in performance, participation, progress and learning difficulties.

Recommendation Systems

AI can recommend educational resources according to students' learning needs, previous performance and interests.

Generative AI

Generative AI systems can produce explanations, examples, questions, summaries and learning activities that can be adapted to individual learners.

Recent reviews identify machine learning, natural language processing, intelligent tutoring systems and large language models as important technologies contributing to contemporary AI-based personalized learning.

3. Academic Achievement

Academic achievement represents the extent to which students accomplish intended educational objectives.

It can be measured through:

- Achievement tests;
- Examination scores;
- Classroom assessments;
- Standardized tests;
- subject-specific performance;
- conceptual understanding;
- knowledge retention; and
- mastery of learning outcomes.

In research on AI-based personalized learning, academic achievement is particularly useful as an outcome variable because it provides a relatively measurable indicator of whether an intervention has contributed to students' learning.

However, academic achievement should not be considered the only indicator of educational effectiveness. Motivation, engagement, self-regulated learning, creativity, critical thinking and metacognitive skills may also be influenced by AI-supported learning.

4. Theoretical Foundation

AI-based personalized learning can be understood through several educational theories.

Constructivist Theory

Constructivism views learners as active participants in constructing knowledge.

AI-supported personalized learning can provide learners with resources and activities appropriate to their existing level of understanding.

Mastery Learning

Mastery learning proposes that students should receive sufficient time and appropriate learning support to achieve mastery. Adaptive AI systems can provide additional practice and remedial content when students have not mastered a concept.

Self-Regulated Learning

Personalized digital environments can support students in monitoring their progress, identifying learning gaps and selecting appropriate learning resources.

Differentiated Instruction

AI-based system can support differentiation by providing different learning path ways to students with different levels of ability and prior knowledge.

Thus, AI can be viewed not simply as a technological tool but as a mechanism for implementing individualized pedagogical strategies.

5. Objectives of the Study

The present review has the following objectives:

1. To examine the concept and characteristics of AI-based personalized learning.
2. To analyse existing research concerning the effect of AI-based personalized learning on students' academic achievement.
3. To identify the major mechanisms through which AI-based personalization may influence academic performance.
4. To examine the benefits and challenges associated with AI-based personalized learning.
5. To identify gaps in existing research and suggest directions for future educational research.

6. Research Questions

The study addresses the following research questions:

- 1. What is the nature of AI-based personalized learning in contemporary education?**
- 2. What evidence exists regarding its effect on students' academic achievement?**
- 3. What features of AI-based personalized learning contribute to improved learning outcomes?**
- 4. What factors moderate the effectiveness of AI-based personalized learning?**
- 5. What challenges and ethical concerns are associated with its implementation?**
- 6. What are as require further empirical research?**
- 7. Methodology**

Research Design

The study adopts a systematic narrative review approach. The approach is appropriate because the purpose is to synthesize existing evidence rather than report fabricated primary data.

Recent peer-reviewed research on AI, personalized learning, adaptive learning and academic achievement was examined. Particular attention was given to systematic reviews and meta-analyses because they provide broader evidence than individual studies.

Sources of Literature

Relevant literature may be identified through academic databases including:

- Scopus
- Web of Science
- ERIC
- Google Scholar
- Science Direct
- Springer Link
- Education-related peer-reviewed journals

A recent systematic review of AI-based personalized learning itself searched databases including Web of Science, ERIC, Google Scholar, Scopus and related scholarly databases.

Search Terms

Representative search terms include:

“Artificial Intelligence” AND “Personalized Learning”

“AI-based personalized learning” AND “academic achievement”

“Adaptive learning” AND “student achievement”

“Artificial intelligence” AND “learning outcomes”
“Intelligent tutoring systems” AND “academic performance”

Inclusion Criteria

Studies were considered relevant when they:

- 1. Examined AI or AI-enabled learning technologies;**
- 2. Addressed personalized, adaptive or individualized learning;**
- 3. Examined student learning outcomes or academic achievement;**
- 4. Were published in scholarly sources;**
- 5. provided sufficient information regarding educational application or outcomes.**

Exclusion Criteria

Studies were excluded when they:

- 1. focused exclusively on non-educational applications of AI;**
- 2. did not address learning or educational outcomes;**
- 3. were duplicate publications;**
- 4. Lacked sufficient information for interpretation.**

8. Review of Existing Evidence

Recent literature indicates rapid growth in research on AI-based personalized learning. A 2025 systematic review synthesized 125 studies published between 2015 and June 2025 and examined AI-based personalization across K–12, higher education and institutionally supported online learning. The review identified significant developments in AI technologies and their applications to teaching, learning and assessment.

Another systematic review focusing on higher education found that AI can personalize instructional methods, content and learning pace according to students' individual needs.

Evidence concerning academic achievement is also encouraging. A 2025 meta-analysis synthesized 29 empirical studies with 2,657 participants and found a significant positive overall effect of AI on academic performance. Importantly, the study found that outcomes were influenced by moderators such as educational level, intervention duration, subject area, learning strategy and type of AI.

This suggests that AI should not be treated as a single educational intervention. Different AI applications may produce different outcomes depending on how they are designed and integrated into instruction.

9. Effect of AI-Based Personalized Learning on Academic Achievement

9.1 Individualized Content

One major advantage of AI-based personalized learning is its ability to recommend content according to students' learning levels.

Students who have difficulty understanding a concept can receive additional explanations and practice, while students who demonstrate mastery can move towards more advanced activities.

This may reduce both under-challenge and over-challenge and contribute to more efficient learning.

9.2 Immediate Feedback

Traditional classroom assessment often involves a delay between student performance and teacher feedback. AI-supported systems can provide immediate feedback following quizzes, exercises or problem-solving tasks.

Immediate feedback can help students identify mistakes while the learning material is still active in their working memory.

9.3 Adaptive Difficulty

AI systems can adjust the difficulty of tasks according to learner performance. If a learner repeatedly answers questions correctly, the system can increase complexity. If performance declines, it can provide simpler questions or prerequisite learning materials.

This adaptive process can support mastery of academic concepts.

9.4 Identification of Learning Gaps

AI-supported analytics can identify patterns of errors and weaknesses that may be difficult to detect through occasional classroom assessments.

Early identification of learning gaps can enable targeted remediation.

9.5 Increased Learning Opportunities

AI systems can provide students with learning support beyond the traditional classroom. Students can potentially access explanations, practice and feedback at different times and locations.

This may be particularly beneficial for students who require additional learning opportunities.

9.6 Student Engagement

Personalized learning may increase engagement by making learning materials more relevant to individual students.

However, engagement should not automatically be equated with improved academic achievement. The quality of instructional design and the nature of student interaction with the technology remain important.

10. Factors Affecting the Effectiveness of AI-Based Personalized Learning

The effectiveness of AI-based personalized learning is likely to depend on several factors.

10.1 Quality of AI System

Poor-quality recommendations or inaccurate generated explanations can negatively affect learning.

10.2 Teacher Involvement

AI should complement rather than replace teachers. Teachers remain important for interpreting student needs, providing emotional support, and designing learning experiences and evaluating the quality of AI-generated content.

10.3 Duration of Intervention

Evidence indicates that intervention duration can influence AI-related learning outcomes.

SubjectArea

AI may work differently across mathematics, science, languages, social sciences and other disciplines.

Students' Digital Competence

Students need sufficient digital literacy to use AI tools effectively.

Accessibility

Students without reliable devices or internet connectivity may not benefit equally from AI-based learning.

10 Advantages of AI-Based Personalized Learning

The major potential advantages include:

- 1. Individualized learning pathways;**
- 2. immediate feed back;**
- 3. adaptive content;**
- 4. identification of learning gaps;**
- 5. flexible learning pace;**
- 6. continuous assessment;**
- 7. targeted remediation;**
- 8. increased access to learning resources;**
- 9. data-informed instructional decisions; and**
- 10. potential improvement in academic achievement.**

Recent systematic reviews describe AI-based personalized learning as having potential to transform teaching, learning and assessment, although they also emphasize significant implementation challenges.

12. Challenges and Limitations

Despite its potential, AI-based personalized learning presents several challenges.

12.1 Data Privacy

Personalized systems require learner data. The collection, storage and processing of student data raise important privacy concerns.

12.2 Algorithmic Bias

AI systems can reproduce biases present in training data or system design. Consequently, recommendations may not always be equally appropriate for all learners.

12.3 Digital Inequality

Students with limited access to smart phones, computers or reliable internet may experience reduced opportunities to benefit from AI-based learning.

12.4 Over dependence on Technology

Excessive dependence on AI may reduce opportunities for independent thinking if students use AI primarily to obtain answers rather than understand concepts.

12.5 Accuracy of AI-Generated Information

Generative AI can produce incorrect or misleading information. Therefore, teacher supervision and verification remain essential.

12.6 Teacher Preparedness

Teachers require appropriate AI literacy and pedagogical knowledge to integrate AI effectively.

12.7 Ethical Concerns

Issues involving transparency, consent, data protection, fairness, accountability and responsible use require institutional policies.

13. Discussion

The reviewed literature provides considerable evidence that AI has the potential to improve educational outcomes. The strongest argument for AI-based personalized learning is its ability to provide instructional adaptation at a scale that is difficult to achieve through conventional classroom teaching alone.

The positive findings of the 2025 meta-analysis are encouraging, but they should not be interpreted as evidence that every AI application automatically improves achievement. The reported variation across educational level, subject area, intervention duration, learning strategy and AI type demonstrates the importance of context.

Similarly, recent systematic reviews demonstrate that the field is expanding rapidly, but they identify challenges involving implementation, data, pedagogy and equity.

Therefore, the appropriate educational question is not whether AI should replace conventional teaching, but how AI can be integrated with effective pedagogy to provide students with better learning opportunities.

A teacher-supported model may be particularly valuable. In such a model, AI performs functions such as data analysis, content recommendation, adaptive practice and immediate feedback, while teachers provide pedagogical judgment, motivation, emotional support, ethical guidance and human interaction.

14. Educational Implications

The findings have several implications for educational institutions.

For Teachers

Teachers should develop AI literacy and learn how to evaluate AI-generated content, interpret learner data and use AI tools appropriately.

For Students

Students should be taught responsible AI use, digital literacy, information verification and academic integrity.

For Schools and Colleges

Institutions should develop clear policies concerning data privacy, ethical AI use and academic integrity.

For Teacher Education

Teacher education programmes should include AI literacy, AI-supported pedagogy, digital ethics and data literacy.

For Educational Policy

Policymakers should focus on equitable access to AI technologies so that personalized learning does not increase existing educational inequalities.

15. Research Gap

Although research on AI-based personalized learning is expanding rapidly, several gaps remain.

First, a considerable amount of literature focuses on higher education and technologically developed educational contexts. More research is required in diverse school settings.

Second, further research is needed in the Indian context, particularly among government and rural schools.

Third, many studies investigate short-term learning outcomes. Longitudinal research is required to determine whether improvements in achievement are sustained over time.

Fourth, future research should examine whether AI-based personalization benefits students with different achievement levels equally.

Fifth, more research is needed on the interaction between AI systems and teacher-mediated instruction.

Finally, academic achievement should be studied alongside other outcomes such as critical thinking, creativity, motivation, self-regulation and digital literacy.

16. Suggestions for Future Research

Future researchers may investigate:

- 1. The effectiveness of AI-based personalized learning among secondary school students;**
- 2. Differences between rural and urban students;**
- 3. Differences between government and private schools;**

- 4. The effectiveness of AI-based personalized mathematics learning;**
- 5. AI-supported personalized language learning;**
- 6. The role of teachers in AI-supported personalized classrooms;**
- 7. long-term effects of AI-based learning;**
- 8. students' attitudes toward AI-based personalized learning;**
- 9. AI literacy among teachers;**
- 10. The relationship between AI personalization and self-regulated learning.**

An especially useful empirical study would compare an experimental group receiving AI-based personalized instruction with a control group receiving conventional instruction.

17. Conclusion

AI-based personalized learning represents an important development in contemporary educational technology. By analysing learner performance and adapting content, difficulty, feedback and learning resources, AI systems can potentially address individual differences among students and improve learning efficiency.

The evidence reviewed in this paper generally indicates a positive relationship between AI-supported learning and academic achievement. A recent meta-analysis reported a significant positive overall effect of AI on academic performance, while recent systematic reviews demonstrate substantial growth in research on AI-based personalized learning.

Nevertheless, technology alone cannot guarantee better educational outcomes. The effectiveness of AI depends on pedagogical design, quality of the AI system, teacher involvement, intervention duration, subject area, student characteristics and access to technology.

Therefore, AI-based personalized learning should be understood as a teacher-supported pedagogical approach, rather than a replacement for teachers. Responsible implementation requires attention to privacy, equity, algorithmic bias, academic integrity and digital literacy.

The future of AI in education should consequently focus not merely on increasing technological adoption but on ensuring that AI is used ethically and pedagogically to create meaningful, equitable and effective learning experiences for all students.

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Important note for publication

This is a literature-based research paper, not an empirical paper. I have deliberately not fabricated sample size, questionnaire scores, t-values, p-values, or experimental results. If your target journal requires an original empirical research article, the next step should be to convert this into a study such as:

“Effect of AI-Based Personalized Learning on the Academic Achievement of Secondary School Students: An Experimental Study.”

For that version, you would need actual sample data, an achievement test, experimental/control groups, pre-test and post-test scores, and statistical analysis. I can also prepare the complete empirical research package—research objectives, hypotheses, variables, experimental design, sample, AI intervention plan, achievement test, questionnaire, data-analysis format, tables, and APA-7 references—without inventing the final results.



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