

Artificial Intelligence in Critical Reading Learning of Junior High School: A Systematic Literature Review

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ABSTRACT:

This article reports on a systematic review of literature on the application of Artificial Intelligence (AI) in improving critical reading skills among junior high school students. It includes an analysis of specific aspects such as the types of AI tools employed, the learning outcomes targeted, and the challenges in implementation. This study aims to systematically review how AI technologies such as intelligent tutoring systems, natural language processing, and adaptive learning platforms have been integrated into reading instruction to enhance students' critical thinking and text analysis skills. The review analyzed peer-reviewed journal articles published between 2015 and 2023, focusing on studies conducted in undergraduate and graduate-level educational contexts.

To achieve this, a Systematic Literature Review (SLR) method was employed, resulting in a final selection of 20 studies. The analysis revealed that most research on AI in critical reading learning is situated in the fields of computer science, engineering, and language education. The findings indicate that AI-based approaches offer personalized learning experiences, immediate feedback, and interactive engagement, all of which contribute positively to the development of students' critical reading abilities. However, challenges such as limited access to technology, insufficient teacher training, and potential over-reliance on automated feedback remain significant barriers. This review concludes by discussing the implications for educators and policymakers and provides recommendations for future research and practice in AI-driven critical reading instruction.

KEYWORDS: Artificial Intelligence, critical reading, junior high school students, systematic literature review, educational technology.

1) INTRODUCTION:

The rapid development of digital technology encourages various sectors, including education, to adopt advanced technology in the learning process. One of the technologies that is increasingly gaining attention in the field of education is Artificial Intelligence (Sarif & Ar, 2024). AI offers innovative solutions in supporting the teaching-learning process, especially in critical thinking skills that are crucial in students' literacy development (Ayala-Pazmiño, 2023). Critical reading learning demands students' ability to analyze, evaluate, and comprehend texts in depth, and this is one area where AI can make significant use.

Critical reading learning in junior high school students faces various challenges, such as limited teacher time to provide detailed feedback, heterogeneity of student abilities, and limited teaching resources. It is in this context that AI is expected to be an effective solution. AI has the ability to provide immediate feedback, customize materials according to students' individual needs, and identify learning difficulties more quickly and accurately than conventional methods (Göçmez & Okur, 2023).

Research on the application of Artificial Intelligence (AI) in reading instruction has grown significantly, particularly in the areas of adaptive learning, intelligent tutoring, and engagement enhancement (Wang et al., 2024; Hopcan et al., 2022). For instance, Wang et al., (2024) conducted a large-scale systematic review covering 2,223 articles and found that while AI in education (AIED) is advancing rapidly, studies that specifically address critical reading especially at the junior secondary level remain underexplored. Similarly, Rad (2025) implemented an AI-based intervention to enhance reading comprehension and self-regulated learning, yet the study was limited to general reading comprehension rather than critical reading skills. In the context of special education, Hopcan et al. (2022) identified a growing interest in AI tools, but the focus was primarily on technical rather than pedagogical aspects. These existing studies indicate that although the integration of AI into reading instruction is promising, there is still a lack of focused, level-specific, and skill-specific investigations, particularly on critical reading at the junior secondary level.

The development of technology aims to meet individual needs quickly and precisely. Various new solutions have been introduced to solve existing problems, facilitate individual interests, and improve the quality of life (Gökçearsan et al., 2024). In recent years, society has experienced a technological revolution across several sectors, impacting social, cultural, and economic aspects. This revolution has introduced innovations such as the Internet of Things (IoT), big data, and Artificial Intelligence as breakthroughs driving global acceleration (Wardah & Huda, 2023). In this context, several experts argue that the current technological revolution differs from those of the past. Rather than creating jobs, the changes in technology are actually reducing the need for some jobs (Walter, 2024).

Artificial Intelligence (AI) has been utilized in education for over 35 years and has significantly contributed to the improvement of learning processes (Ambarita & Nurrahmatullah, 2024). AI technology enables more personalized, adaptive, and interactive learning experiences through machine learning algorithms, speech recognition, and automated recommendation systems. In critical reading instruction, AI has the potential to assist students in identifying main ideas, analyzing texts in depth, and developing critical thinking skills (Kayri, 2015). According to the frameworks of Technological Pedagogical Content Knowledge (TPACK) and constructivist learning theory, the integration of AI in education should not solely focus on technological innovation, but also on how the technology enhances students' conceptual understanding and cognitive processes (Rahman et al., (2022);(Sofwan et al., 2024)).

Recent studies show that constructivist approaches can be strengthened through the use of AI tools such as ChatGPT and BARD to support metacognition and facilitate deep conceptual change (Grubaugh et al., 2023). Furthermore, the embodied constructionist approach has proven effective in delivering holistic AI literacy to elementary students through a cyclical process of understanding, making, and reflection (Dai, 2025). Another study indicates that the application of e-learning systems based on constructivist theory and the Information System Success Model (ISSM) enhances student engagement and learning satisfaction in higher education (Sayaf, 2023).

Critical reading skills are complex processes that involve the ability to comprehend implied meanings in texts, evaluate the messages conveyed by the author, and make judgments based on the arguments found in the reading (Saiddaeni et al., 2024). These skills are at a higher level of thinking because they involve deep analysis and evaluation. Key aspects of critical reading skills include understanding simple terms, interpreting the meanings intended by the author, and evaluating the content of the text (Huang et al., 2023). Flexible reading speed and the ability to adapt to the context of the reading are also part of these skills, which can be supported by the application of AI in the learning process, particularly for junior high school students .

This systematic literature review aims to comprehensively map and synthesize the existing body of research published between 2015 and 2023 regarding the application of Artificial Intelligence (AI) tools in critical reading instruction at the junior high school level. Specifically, this review seeks to:

- a) How student engagement with AI tools in critical reading learning tools? ;
- b) analyze the reported impacts of these tools on students' critical reading skills, including comprehension, inference, evaluation, and reasoning; and
- c) synthesize the reported challenges and opportunities associated with integrating AI in the context of junior high school education.

By mapping current trends, benefits, and constraints, this review aims to provide educators and curriculum developers with evidence-based insights to inform the design of more effective and innovative strategies that leverage AI for the development of students' critical reading skills.

2) **METHOD**

General Background

This study aims to identify the current status of literature on AI applied to critical reading learning. In this regard, this study is characterized as exploratory research as it addresses a topic that is still little explored by researchers in the field of Education and Language. SLR research was pursued to answer the research questions posed. Finally, the data was analyzed using qualitative strategies to interpret the results and quantitative metrics to present the findings.

Procedure

The SLR procedure employed in this study followed the five steps proposed by Klun et al. (2003), namely: (i) formulating research questions for the review, (ii) identifying relevant literature, (iii) assessing the quality of the selected studies, (iv) summarizing the evidence, and (v) interpreting the findings. In the first step, the research questions were formulated to align with the main objective of this review, which is to identify the current state of the literature on the application of Artificial Intelligence (AI) in critical reading instruction. As outlined in the introduction, four key research questions were developed to guide the review and achieve the study's objectives.

To cover the second step, databases on Scopus, ERIC, DOAJ and Google Scholar were used. In addition to theses and dissertations, scientific articles were also used to provide a more comprehensive view of the research topic. The reason for using journals, theses and dissertations is because of the research questions that guide this study. By reviewing these various literature sources, it is possible to identify the solidity of research on critical reading learning involving AI technology.

Through the analysis of scholarly articles, theses, and dissertations related to critical reading learning with the application of AI, it was possible to identify research trends, active research groups, as well as projects developed at various academic institutions. This helps reveal the current status of research on the use of AI in critical reading learning among junior high school students (Muthmainnah et al., 2022). The combination of journals, theses, and dissertations provides a broader and deeper coverage and enriches the analysis of how AI can contribute to improving critical thinking skills in education.

Data Collection and Analysis

Using Scopus, ERIC, DOAJ databases, and screening using Rayyan (<https://www.rayyan.ai/>), according to Albreiki et al., (2021) a research protocol was applied consisting of the following search keyword combinations: "Artificial Intelligence", 'critical reading', 'learning', 'secondary education', and 'students'. These keywords were used for titles, abstracts, and keywords in journals, theses, and dissertations listed in the database. With this protocol, an initial count of 214 studies was found. After an initial selection using AI Rayyan, 160 references were obtained. Next, an in-depth analysis was applied to assess the relevance and quality of the studies, and finally 20 studies were selected that were deemed most suitable for conducting a systematic review of the literature (SLR). These studies included scientific articles, master's theses, and doctoral dissertations, providing a solid foundation for exploring the application of artificial intelligence in critical reading learning among junior high school students.

Table 1. Results of Scientific Articles, Theses, and Dissertations Collected Table 1 on Scopus, ERIC, DOAJ, and Google Scholar

| Code | Research Data | | | Total |
|---|---------------|-------|----------|-------|
| | Keyword | Title | Abstract | |
| "Artificial Intelligence" & "Learning" | 110 | 35 | 15 | 160 |
| "Artificial Intelligence" & "Critical Reading Learning" | 4 | 8 | 4 | 16 |
| "Artificial Intelligence" & "Junior High School" | 9 | 5 | 10 | 24 |
| "Artificial Intelligence" & "Digital Literacy" | 7 | 3 | 4 | 14 |
| Total | 130 | 51 | 33 | 214 |

Exclusion screening is processed with the following options:

- 114 studies were discarded as they related to the use of AI at certain levels of education, but not in the context of critical reading learning.
- 40 theses and dissertations collected addressed AI, but were not explicitly applicable to the learning of junior secondary students or at other levels.
- 30 scientific articles analyzed
- 10 other articles

In the methods section of this study, inclusion and exclusion criteria were set to screen relevant literature. The inclusion criteria included studies published between 2015 and 2023 in the form of scientific articles, theses, or dissertations that addressed the application of Artificial Intelligence (AI) in the learning of critical reading of secondary school students. These studies should use AI in the form of intelligent tutoring systems, natural language processing, or adaptive learning platforms applied to improve critical reading skills. In addition, the considered studies should be available in English or Indonesia Language.

On the other hand, some exclusion criteria were also applied to ensure the quality and relevance of the research results. Irrelevant studies, such as those that discussed AI in general without focusing on critical reading learning, or those that focused on non-critical reading skills, were excluded from the analysis. Studies that focused on learners at education levels other than secondary school were also excluded. In addition, studies that were not accessible in full, were only available in abstract form, or contained only theoretical analysis without empirical evaluation of the application of AI, were also excluded. These criteria were designed to filter out the most relevant and quality research in support of the

systematic objectives of this literature.

Data collection as the second step of our SLR, was conducted between August 2024 and September 2024. For the third step of the SLR, the collected research formats were analyzed. The topics covered by this SLR are educational and linguistic in nature, so there are often references that have different interpretations. Despite the diversity in the findings, all the results obtained are still well supported by the research that has been conducted. Therefore, this research provides a strong foundation for further understanding. With consistent results and sufficient support from previous studies, there is no reason to ignore further research that could enrich these findings. Further research remains essential to deepen the analysis and corroborate existing conclusions.

The fourth step was carried out with qualitative analysis, as a codification process (Sasongko & Mubarak, 2023). At this stage, the main parts of the scientific articles, theses and dissertations were read so that it was possible to understand the topics related to the results. Codification was done using the themes identified by the authors. During the process, three new codes were added as the themes emerging from the data were not found in previous research (Booth et al., 2016). This research focused on the programs that it originated from. In the fifth and final step of the SLR, listed at the end of this article, conclusions regarding the literature stage are presented.

3] RESULTS AND DISCUSSION

This section presents and discusses the findings of the systematic literature review on the integration of Artificial Intelligence (AI) in the critical reading learning of junior secondary students. The analysis synthesizes relevant studies to identify prevailing themes, instructional strategies, AI tools employed, as well as the observed impact on students' critical reading skills. The discussion also highlights emerging patterns, gaps in the literature, and potential implications for future research and classroom practice. Through this synthesis, we aim to provide a comprehensive understanding of how AI technologies are shaping the development of critical reading among adolescent learners.

Table 2. Summary of 20 Studies on the Effect of Artificial Intelligence on students' critical reading skills

| No. | Paper (s) | Journal | Institution | Region |
|-----|---|--|---|-----------|
| 1. | Impacts of Artificial Intelligence on Student Learning: A Systematic Literature Review | Journal Varidika | Universitas Pendidikan Indonesia, Indonesia | Indonesia |
| 2. | Artificial Intelligence in Learning and Development: A Systematic Literature | European Journal of Training and Development | Petroleum University | India |
| 3. | Artificial intelligence in education: A systematic literature review | Proceedings of the 6th International Conference on Economics and Social Sciences | Bucharest University of Economic Studies | Romania |
| 4. | Benefits, Challenges, and Methods of Artificial Intelligence (AI) Chatbots in Education: A Systematic Literature Review | The International Journal of Technology in Education (IJTE) | Gazi University | Turkey |
| 5. | An analysis of children' interaction with an AI chatbot and its impact on their interest in reading | Computers & Education | National Central University | Taiwan |
| 6. | Influence of vocalized reading practice on English learning and | Frontiers in Psychology | Zhoukou Normal University | China |

| | | | | | |
|-----|---|---|---|-------------|--|
| | psychological problems of middle school student | | | | |
| 7. | Same benefits, different communication patterns: Comparing Children's reading with a conversational agent vs. a human partner | Computers & Education | University of California | USA | |
| 8. | The Correlation Between Students Artificial Intelligence and Their English Reading Skills Achievement | Jurna; Keilmuan Pendidikan Bahasa dan Sastra Indonesia | University of Palangka Raya | Indonesia | |
| 9. | Artificial Intelligence and Learning Effects of Reading Classics | Korean Journal of General Education | Pusan National University | Korea | |
| 10. | Developing and Validating the Artificial Intelligence Literacy Concept Inventory: an Instrument to Assess Artificial Intelligence Literacy among Middle School Students | International Journal of Artificial Intelligence in Education | Boston University | USA | |
| 11. | Systematic Approaches to a Successful Literature Review | International Journal of Ambient Energy | The University of Sheffield | Inggris | |
| 12. | Implementation of mobile augmented reality on physics learning in junior high school student | Journal of Education and e-learning Research | Yogyakarta State University | Indonesia | |
| 13. | Development of Academic Optimism Model in Learning for Junior High School Student | European Journal of Educational Research | Malang State University | Indonesia | |
| 14. | Learning Environment and Academic Engagement in Science of Junior High School Student | Internasional Journal of Research Publication | Holy Cross of Davao College | Philippines | |
| 15. | Improving Students' Reading Comprehension of Recount Text Through | Journal of Scientific, Research, Education, and Technology | Universitas Tanjungpura | Indonesia | |

| Listen-Rea-Discuss Strategy (LRD) | | | | | | |
|-----------------------------------|--|---|-----------|-------------------------------|--|------------|
| 16. | Artificial Intelligence in Education: Exploring the Potential Benefits and Risks | Digital CEIT | Publisher | Monash University | | Australia |
| 17. | Artificial Intelligence Applications in Open and Distance Education: A Systematic Review of the Articles (2007-2021) | Asian Journal of Distance Education | | | | Japan |
| 18. | The Role of Artificial Intelligence in Shaping High Motivation | International Journal of Technology Education and Science | | ADA University | | Azerbaijan |
| 19. | Metaphorical Perceptions of Middle School Students Regarding the Concept of Artificial Intelligence | International Journal of Education & Literacy Studies | | Istanbul University | | Turkey |
| 20. | The usability of Images Generated by Artificial Intelligence (AI) in Education | International Technology and Education Journal | | Mugla Sitki Kocman University | | Turkey |

The findings of the systematic literature review (SLR) on the use of Artificial Intelligence (AI) in critical reading learning among junior secondary students reveal several key points:

1. Student Engagement with AI Tools

AI's impact on student engagement was assessed in several studies, as detailed in Table 1. The table shows the percentage of students who reported increased engagement in different studies.

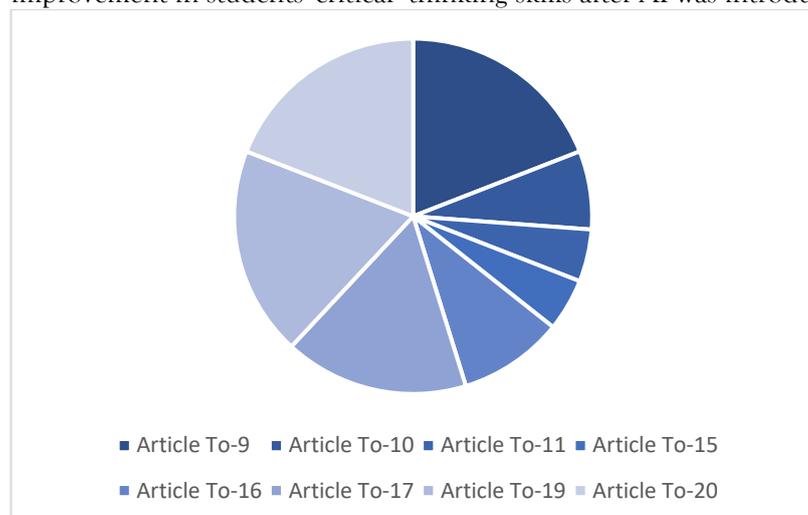
Table 3. Student Engagement with AI in Critical Reading Learning

| No. | Study | Percentage of Student Engagement (%) | Field Study |
|-----|-----------------------------------|--------------------------------------|---|
| 1. | (Ambarita & Nurrahmatullah, 2024) | 85% | Educational Technology, Language Learning |
| 2. | (Bhatt & Muduli, 2023) | 78% | AI in Education, Learning Development |
| 3. | (Gökçearsan et al., 2024) | 88% | Educational Technology, AI Chatbots |
| 4. | (Wang et al., 2024b) | 86% | AI in Education, Computer Science |

Table 1 shows that student engagement consistently exceeded 75% in all four studies after AI was introduced into critical reading lessons. This indicates that AI tools help make learning more interactive and engaging, leading to better participation in classroom activities (Kayri, 2015). In addition, various studies have shown that AI tools significantly increase student engagement by providing an interactive and personalized learning experience. Through adaptive learning systems, AI adapts to individual student needs, offering a more effective learning path.

2. Comprehension and Critical Thinking Improvement

AI not only enhances student engagement but also supports comprehension and critical thinking development. The use of AI-generated visuals and adaptive feedback are key contributors (Xu et al., 2023). Figure 1 below illustrates the improvement in students' critical thinking skills after AI was introduced in their reading lessons.



Though the direct impact of AI on critical reading skills was not always the primary focus in many studies, it was implied that AI plays a significant role in fostering critical thinking by guiding students to question, evaluate, and analyze information in novel ways (Aktay, 2022). AI-powered tools, such as adaptive learning platforms, can present customized reading materials that align with individual students' abilities and needs, encouraging deeper engagement with the text. These tools often offer immediate feedback, enabling learners to reflect on their understanding and adjust their strategies. Furthermore, AI's ability to analyze large datasets and provide real-time insights allows educators to identify gaps in students' comprehension, which helps in crafting targeted interventions (Tartuk, 2023). This indirect enhancement of critical reading skills can be attributed to AI's support for personalized learning strategies, interactive questioning, and engagement with more complex, challenging materials that encourage analytical thinking (Alasgarova & Rzayev, 2024). By using these AI-driven approaches, students are also exposed to diverse perspectives and are prompted to consider multiple interpretations of a text, further deepening their critical engagement with content.

3. Personalization and Feedback

One of the major advantages of AI in education is its ability to provide real-time, personalized feedback (Muslimin et al., 2024). Table 4 presents data on how students reacted to personalized feedback, demonstrating its positive effects on learning outcomes.

Table 4. Impact of Personalized Feedback on Learning Outcomes

| No. | Study | Improvement in Scores (%) | Field of Study |
|-----|--|---------------------------|---|
| 1 | An analysis of children' interaction with an AI chatbot and its impact on their interest in reading | 18% | Educational Technology, Child Development |
| 2 | Influence of Vocalized Reading Practice on English Learning | 22% | Language Learning, Educational Psychology |
| 3 | Same Benefits, Different Communication Patterns:Comparing Children's reading with a conversational agent vs. a human partner | 25% | AI in Education, Communication Studies |

Table 4 shows that students' test scores improved by 18% to 25% after receiving personalized feedback from AI systems. This tailored feedback helped students better understand their mistakes and guided them toward effective critical reading strategies. AI technologies allow for immediate and personalized feedback, which enhances the development of critical reading skills (Azamatova et al., 2023; Xia et al., 2024). The feedback is customized to individual progress, helping

students improve their comprehension and analytical skills. Additionally, this personalized approach fosters a deeper engagement with the text, encouraging students to explore complex ideas more critically. Over time, the continuous refinement of feedback based on individual learning patterns contributes to sustained improvement in critical thinking and reading comprehension.

4. Challenges in AI Implementation

Despite these benefits, challenges were noted in the accessibility of AI tools and teacher training. Table 5 outlines the major challenges identified in the literature review.

Table 5. Challenges of AI Integration in Education

| No. | Study | Challenges Identified |
|-----|---|---|
| 1. | Implementation of mobile augmented reality on physics learning in junior high school student | Limited access to technology and infrastructure |
| 2. | Development of Academic Optimism Model in Learning for Junior High School Student | Insufficient teacher training for AI usage |
| 3. | The Role of Artificial Intelligence in Shaping High Motivation | Ethical concerns (privacy and data security) |
| 4. | The Correlation Between Students Artificial Intelligence and Their English Reading Skills Achievement | Difficulty in ensuring equal access to AI tools |
| 5. | Learning Environment and Academic Engagement in Science of Junior High School Student | Resistance from educators due to lack of AI knowledge |

Table 5 highlights that the most frequently mentioned challenge is limited access to AI tools, especially in regions with insufficient technological infrastructure. Insufficient teacher training was also identified as a significant barrier, suggesting that teachers require better support to implement AI effectively in classrooms. Some challenges, such as limited access to AI tools and inadequate teacher training, were identified. These barriers can affect the full implementation of AI in classrooms, particularly in regions with technological constraints (Dani & Nasser, 2016). Furthermore, a lack of awareness about the benefits of AI in education can hinder its adoption, as both educators and students may not fully understand how to utilize these tools effectively. Addressing these challenges requires targeted investments in technology and professional development to ensure that all students can benefit from the potential of AI in enhancing their learning experiences.

DISCUSSION

This systematic literature review identifies current trends and emerging challenges in the application of Artificial Intelligence (AI) in critical reading instruction at the junior high school level. The results of the review reveal that AI technologies are increasingly integrated into reading pedagogy, showing positive trends in enhancing students' analytical and critical thinking skills. Among the 20 studies reviewed, a key trend is the growing use of AI conversational agents and intelligent tutoring systems to foster student engagement and personalized learning. Research by National Central University in Taiwan showed that the use of AI chatbots significantly increased students' interest in reading, where more personalized interactions through chatbots had a positive effect on students' engagement in reading activities. This research was supported by a similar study conducted at the University of California, USA, which found that children interacting with AI conversational agents exhibited communication patterns similar to their interactions with human counterparts, which contributed to their improved reading comprehension (Xu et al., 2023; Bettayeb et al., 2024).

On the other hand, research from Universitas Pendidikan Indonesia and University of Palangka Raya, Indonesia, focused more on the relationship between AI and English reading skill achievement. The study found that the use of AI technologies in learning, such as intelligent tutoring systems, can improve students' reading achievement by providing quick and customized feedback to individual students (Ademola, 2024). Meanwhile, research from Petroleum University in India published in the *European Journal of Training and Development* highlighted the importance of AI integration in the development of critical reading skills by emphasizing the adaptation of AI technologies to meet the varied learning needs of students (Tymoshenko et al., 2024).

Despite these promising trends, several challenges persist. Studies from Gazi University in Turkey and Boston University in the US, show that there is still limited access to AI technology in some regions, especially in terms of infrastructure and readiness of supporting devices. In addition, intensive training for teachers and educators is an important aspect to optimize the use of AI in critical reading learning (Ambarita & Nurrahmatullah, 2024; Alhusaiyan, 2025). Another

challenge is the risk of students' dependence on automated feedback, which may reduce their initiative and ability to think independently (Hidayat, 2024). These challenges are also reflected in the findings of Zhai & Wibowo (2023) which stress the need for institutional preparedness and ethical considerations. Overall, these findings emphasize the need for a balance between the benefits of AI technology and the readiness of human resources and infrastructure in the implementation process (Dani & Nasser, 2016). This research provides deep insights for educators and policy makers to consider integrating AI more strategically in the education curriculum, in order to effectively and sustainably improve students' critical reading skills.

4] CONCLUSION

A systematic literature review of 20 studies on the application of Artificial Intelligence (AI) in critical reading learning among junior high school students showed that AI has great potential in improving students' critical thinking skills. Most of the studies show that AI can provide a more personalized learning experience, immediate feedback, and more in-depth interaction, which significantly contribute to the development of students' text analysis skills.

However, the analysis also revealed some challenges in the implementation of AI in education, such as limited access to technology, the need for intensive training for teachers, and the potential for over-reliance on automated feedback. These factors suggest that while AI technology offers great opportunities, its success is highly dependent on adequate infrastructure readiness and human resource competencies.

This review provides valuable insights for educators and policymakers to better understand the benefits and challenges of implementing AI in education, particularly in the development of critical reading skills. The study also highlights existing gaps in the literature that require further exploration, especially through more comprehensive research on the impact of AI across diverse educational contexts.

Implications of this review include the need for collaborative policy development that ensures equitable access to AI-based learning tools, the design of AI-integrated curriculum models, and the provision of professional development programs for teachers. Moreover, future studies may focus on the development of culturally responsive AI tools and the ethical considerations of AI use in the classroom to ensure alignment with students' cognitive development stages.

This study also has limitations, such as the focus on peer-reviewed articles published in English within a certain time frame, which may exclude relevant local or non-English research. Future research should expand the scope to include gray literature, comparative cross-country analyses, and case studies from underrepresented regions.

For future research, it is suggested that more studies be focused on developing training programs for educators in integrating AI effectively into the curriculum as well as more in depth research on the long-term impact of using AI on students' critical thinking skills. Thus, AI will not only be a tool, but also a catalyst in the transformation of education towards a more advanced and adaptive era.

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