Research Journal in Advanced Humanities

https://doi.org/10.58256/03h3er30

RJAH

Open Access

Check for updates

RESEARCH ARTICLE **Section:** *Digital Humanities*

The impact of AI-enhanced educational technologies on reading comprehension skills development in students with learning disabilities: Towards individualized future education

Hind Nasser Almutairi[1], Abdulaziz Faleh Al-Osail[2], Mohammed A. Alshehri[3]*, Mohammed Ahmed Elhossiny Mohammed[4,5], Mashael Nasser Ayed Al-Dosari[6], Mohamed Ali Nemt-allah[7] & Mohamed Sayed Abdellatif[6]

[1]Princess Nourah Bint Abdulrahman University, Saudi Arabia
[2]King Faisal University, Al-Ahsa, Saudi Arabia
[3]King Saud University, Saudi Arabia
[4]Northern Border University, Saudi Arabia
[5]Mansoura University, Mansoura, Egypt
[6]Prince Sattam Bin Abdulaziz University, Saudi Arabia
[7]Al-Azhar University, Dakahlia, Egypt
*Correspondence: mshehri2@ksu.edu.sa

ABSTRACT

This study aimed to examine the effectiveness of AI-enhanced educational technologies compared to conventional instruction methods in improving reading comprehension skills among middle school students with learning disabilities through a quasi-experimental design. Twenty middle school students with identified learning disabilities from the Riyadh region, Saudi Arabia, were randomly assigned to experimental (n=10) or control (n=10) groups. The experimental group participated in an eight-week individualized AI-enhanced reading program featuring adaptive learning algorithms, multi-modal content delivery, and real-time personalized feedback. In contrast, the control group received conventional instruction. A comprehensive 25-item Reading Comprehension Skills Test assessed five domains: literal comprehension, vocabulary in context, inferential comprehension, critical analysis, and application/evaluation. Statistical analysis employed non-parametric procedures, including Mann-Whitney U tests for between-group comparisons and Wilcoxon signed-rank tests for within-group changes. Results demonstrated significant improvements for the experimental group across all reading comprehension domains compared to controls, with the most pronounced effects in critical analysis (p=.004) and total reading comprehension (p=.002). Within-group analysis revealed significant

Research Journal in Advanced Humanities

Volume 6, Issue 3, 2025
ISSN: 2708-5945 (Print)
ISSN: 2708-5953 (Online)

ARTICLE HISTORY

Submitted: **18 June 2025**
Accepted: **06 September 2025**
Published: **20 September 2025**

HOW TO CITE

Nasser Almutairi, H., Faleh Al-Osail, A., A. Alshehri, M., Ahmed Elhossiny Mohammed, M., Nasser Ayed Al-Dosari, M., Ali Nemt-allah, M., & Abdellatif, M. (2025). The impact of AI-enhanced educational technologies on reading comprehension skills development in students with learning disabilities: Towards individualized future education. *Research Journal in Advanced Humanities*, 6(3). https://doi.org/10.58256/03h3er30

Published in Nairobi, Kenya by Royallite Global, an imprint of Royallite Publishers Limited

pre-to-post improvements in all domains for the experimental group, with effect sizes indicating substantial gains. Follow-up assessments confirmed sustained improvements without regression, suggesting durable intervention effects. The AI-enhanced platform's personalized, adaptive features effectively addressed the multifaceted nature of reading difficulties in students with learning disabilities, providing evidence for integrating AI technologies in special education interventions to promote individualized learning and long-term academic success.

KEYWORDS: Artificial intelligence, educational technology, reading comprehension, learning disabilities, individualized instruction, adaptive learning

Introduction

Reading comprehension difficulties represent a substantial educational challenge, affecting approximately 10-15% of students globally across diverse educational contexts (Elleman & Oslund, 2019; Kendeou et al., 2016; Nation, 2019; Torppa et al., 2019). This prevalence increases significantly among vulnerable populations, with 20-50% of students with language and learning disorders experiencing comprehension challenges (Capin et al., 2021, 2022). These statistics underscore critical implications for educational systems, including reduced academic achievement in complex reading-dependent subjects, increased risk of lower educational qualifications, and heightened likelihood of being out of education or employment in early adulthood (James et al., 2024). Addressing these challenges necessitates systematic investments in evidence-based interventions, specialized teacher training, and differentiated support mechanisms to ensure equitable educational outcomes for all students.

Students with learning disabilities in traditional educational settings encounter multifaceted reading comprehension challenges that significantly impede their academic progress. Core difficulties include decoding and word recognition deficits that prevent effective meaning extraction from text (Antonis, 2022; Brunow & Cullen, 2021) and persistent vocabulary limitations that create developmental gaps compared to typically developing peers (Quinn et al., 2020). These students demonstrate pronounced metacognitive strategy deficits, struggling with planning, monitoring, and evaluating their comprehension processes (Kampylafka et al., 2023; Lazarus & Anwalimhobor, 2023). Additionally, motivational and emotional barriers, including heightened reading anxiety and diminished academic self-concept, create cycles of avoidance that further compromise comprehension development (Dodur & Ceylan, 2025; Kampylafka et al., 2023). Higher-order cognitive processes such as inferential reasoning and critical comprehension remain particularly challenging for this population (Capin et al., 2021; Kocaj et al., 2023).

Reading comprehension challenges create substantial barriers to academic success for students with learning disabilities, with up to 80% experiencing significant difficulties that persist despite average or above-average intelligence (Willcutt et al., 2019). These deficits consistently result in lower academic performance, reduced GPAs, and slower progress across multiple domains including language, mathematics, and writing (Peterson et al., 2021; Quinn et al., 2020). Students demonstrate persistent achievement gaps that widen over time, as they begin with lower reading comprehension skills and fail to catch up to typically developing peers (Kocaj et al., 2023). Longitudinal research reveals these challenges lead to reduced academic attainment, incomplete credit completion, and increased dropout risks in higher education, with comorbid learning disabilities further compounding these adverse outcomes (Dodur & Ceylan, 2025; Howard-Gosse et al., 2023).

Conventional teaching methods, characterized by teacher-centered instruction and standardized curricula, demonstrate significant limitations in addressing students' diverse cognitive, sensory, and physical needs with learning difficulties (Bañados et al., 2024; Damyanov, 2024). These traditional approaches lack sufficient differentiation and personalization capabilities, failing to accommodate individual learning profiles while relying heavily on rote memorization techniques (Cheng & Lai, 2019; Sokpheng & Meng, 2022). The absence of multi-sensory and interactive instructional strategies, inadequate teacher training, and systemic barriers, including policy constraints and funding shortages, particularly affects under-resourced educational settings (Avdonina & Gurieva, 2020; Süer et al., 2021). Consequently, innovative technological solutions have become urgently necessary to create inclusive learning environments that can customize educational experiences, enhance student engagement through interactive content, and facilitate greater independence for students with special educational needs (Daniel et al., 2024; Naz & Murad, 2017).

Educational technology has undergone significant transformation over the past decade, evolving from basic digital tools to sophisticated, AI-driven platforms to support students with learning difficulties (Bozkurt, 2020; Guan et al., 2020). This evolution has been characterized by a shift toward personalized, adaptive learning systems that leverage artificial intelligence and data analytics to provide individualized interventions for students with dyslexia, ADHD, and autism spectrum disorders (Rodríguez-Cano et al., 2022; Wang et al., 2024). Contemporary educational technologies now emphasize inclusivity and accessibility through multilingual platforms, assistive software, and immersive tools such as virtual and augmented reality (Cummins, 2024; GowherHassan et al., 2023). The field has evolved from technology-focused approaches to more theory-driven, evidence-based methodologies prioritizing educational values and addressing ethical considerations in supporting diverse learners (Valtonen et al., 2022).

Artificial intelligence has emerged as a transformative force in modern educational interventions, particularly for students with learning disabilities, by enabling personalized and adaptive learning experiences that address individual cognitive needs and learning profiles (Bressane et al., 2023; Chen et al., 2020). AI-driven systems utilize intelligent tutoring platforms, assistive technologies, and data-driven decision support tools to deliver tailored instructional methods, real-time feedback, and scaffolded learning environments (Hopcan et al., 2022; Kamalov et al., 2023; Papalexandratou et al., 2024; Tapalova & Zhiyenbayeva, 2022; Wang et al., 2024; Zhang et al., 2024). These technological interventions significantly enhance academic outcomes while promoting educational equity and accessibility for diverse learners.

AI-enhanced technologies fundamentally transform assistive learning by offering dynamic, personalized experiences that adapt to individual learners in real-time, contrasting sharply with traditional static tools. While conventional assistive technologies like screen readers and speech-generating devices provide standardized, one-size-fits-all solutions with limited adaptability (Giansanti & Pirrera, 2025; Zdravkova et al., 2022), AI-powered systems leverage machine learning algorithms to analyze learner performance, identify specific weaknesses, and continuously modify content delivery (Akavova et al., 2023; Sumanth et al., 2024). These intelligent systems foster enhanced interactivity through automated questioning, real-time feedback mechanisms, and collaborative learning environments (Redhu et al., 2024; Younas et al., 2025), while simultaneously providing holistic support that encompasses cognitive, communicative, and emotional needs through predictive analytics capabilities (Bhakiyasri, 2024; Hussein et al., 2025).

Individualized learning is crucial for students with learning difficulties because it addresses their unique cognitive profiles and learning needs through tailored instructional approaches that conventional one-size-fits-all methods cannot adequately support. Research demonstrates that individualized instruction produces significant academic gains in foundational skills such as mathematics and reading comprehension, benefiting students at risk for learning disabilities (Admeur & Attariuas, 2024; Kim & Lee, 2025). This personalized approach enhances student engagement, motivation, and self-efficacy by adapting content delivery to individual learning styles, prior knowledge, and emotional needs (Bernacki & Walkington, 2018; Zhang et al., 2019). Furthermore, individualized learning frameworks, including Individualized Education Plans (IEPs), systematically address both academic and personal-social skill development, creating comprehensive support systems that improve overall educational outcomes for students with intellectual and learning disabilities (du Plooy et al., 2024; Ishartiwi et al., 2023; Shanahan et al., 2024; Shemshack & Spector, 2020).

AI technologies facilitate personalized learning experiences through multiple sophisticated mechanisms that adapt to individual student needs and learning patterns. Adaptive learning systems analyze comprehensive student data including performance metrics, preferences, and learning pace to dynamically tailor content delivery, recommend appropriate resources, and adjust difficulty levels in real-time (Gligorea et al., 2023; Maghsudi et al., 2021; Taşkın, 2025). Intelligent tutoring systems and virtual companions provide individualized guidance and explanations, effectively simulating one-on-one instruction while delivering instant, personalized feedback on assignments and assessments (Chen et al., 2020; Tapalova & Zhiyenbayeva, 2022). Furthermore, generative AI creates customized learning materials in various formats and styles to accommodate diverse learning preferences, while predictive analytics identify at-risk students and enable timely interventions (Katiyar et al., 2024; Murtaza et al., 2022; Pesovski et al., 2024; Yu et al., 2017).

Several theoretical frameworks support individualized AI-enhanced educational approaches in addressing diverse learning needs. The Community of Inquiry (CoI) model has been adapted with generative AI to personalize social, cognitive, and teaching presence, dynamically adjusting learning pathways and feedback to individual student requirements (Anderson et al., 2025). Learning sciences theories, grounded in constructivism and cognitive psychology, inform the design of AI algorithms for individualized scaffolding and adaptive feedback mechanisms (Luckin & Cukurova, 2019; Murtaza et al., 2022). Complex adaptive systems theory conceptualizes educational environments as dynamic ecosystems where AI mediates relationships among students, teachers, and content (Xu & Fan, 2021). The Education 4.0 and 5.0 paradigms advocate for personalized, adaptive learning environments that balance technological innovation with humanistic values (Castro et al., 2024; Rane et al., 2023). Cognitive psychology and adaptive learning models also ensure AI systems respond effectively to individual learning styles and abilities (Bhutoria, 2022; Tapalova & Zhiyenbayeva, 2022).

Based on the research evidence, several critical gaps exist in current educational approaches for students with reading comprehension disabilities. The most significant challenge is the research-to-practice gap, where effective interventions tested under controlled conditions fail to translate into typical classroom settings, particularly when delivered by regular teachers rather than researchers (McKenna et al., 2015; Talbott et al., 1994). Students with disabilities consistently demonstrate reading achievement gaps equivalent to more than three years behind their peers, gaps that remain stable over time despite policy interventions (Gilmour et al., 2018; Schulte et al., 2016). Additionally, there is inconsistent implementation of evidence-based practices, especially for students with intellectual disabilities and emergent bilinguals (Joseph et al., 2021; Sarisahin, 2020), while social-emotional factors such as reading anxiety and motivation remain largely unaddressed despite their significant impact on comprehension outcomes (Dodur & Ceylan, 2025; Söğüt & Melekoğlu, 2025).

Within the Saudi Arabian educational context, research has demonstrated the effectiveness of innovative approaches in improving reading comprehension among students with learning disabilities, including graphic organizers (Al-Balwi & Muhaidat, 2019), mind mapping strategies (Al-Harithi, 2019; Al-Saadawi, 2016), and specialized training programs (Alqahtani, 2018). However, implementation barriers continue to limit widespread adoption of these evidence-based strategies (Al-Zahrani, 2023), highlighting the need for scalable, technology-driven solutions that can overcome traditional constraints in the Saudi educational system.

Given these persistent challenges and the promising potential of AI-enhanced educational technologies, this study aims to investigate the impact of AI-enhanced educational technologies on reading comprehension skills development in students with learning disabilities. Through a quasi-experimental design utilizing both experimental and control groups, this research seeks to evaluate the effectiveness of individualized AI-driven interventions in improving reading comprehension outcomes and addressing the specific learning needs of students with disabilities in educational settings.

Method

Participants

This study employed a two-phase sampling approach to establish psychometric properties and evaluate intervention effectiveness. The psychometric validation sample consisted of 43 middle school students from Saudi Arabia, including 17 male students (39.5%) and 26 female students (60.5%). Participants were distributed across seventh grade (n = 19, 44.2%) and eighth grade (n = 24, 55.8%), with ages ranging from 13 to 15 years (M = 13.60, SD = 0.58).

The main study sample comprised 20 middle school students with identified learning disabilities from the Riyadh region, Saudi Arabia, including eight male students (40.0%) and twelve female students (60.0%). Participants' ages ranged from 13 to 14 years (M = 13.40, SD = 0.50). All participants were native Arabic speakers enrolled in public middle schools within the Saudi educational system. Students were identified as having learning disabilities based on formal educational assessments and Individual Education Plan (IEP) documentation maintained by their respective schools.

Instrumentation

Reading Comprehension Skills Test

A comprehensive Reading Comprehension Skills Test was developed specifically for this study to assess multiple dimensions of reading comprehension among students with learning disabilities. The test was designed in Arabic, the participants' native language, to ensure cultural and linguistic appropriateness for the target population.

The instrument consisted of 25 multiple-choice questions distributed across five authentic Arabic texts covering diverse topics, including technology in education, friendship and loyalty, renewable energy, artificial intelligence in medicine, and distance learning. The assessment was designed to be completed within 45 minutes. It evaluated five distinct reading comprehension domains: Literal Comprehension (5 items: questions 1, 6, 11, 16, 21), Vocabulary in Context (5 items: questions 2, 9, 12, 17, 22), Inferential Comprehension (6 items: questions 3, 5, 8, 13, 18, 23), Critical Analysis (5 items: questions 4, 7, 14, 19, 24), and Application and Evaluation (4 items: questions 10, 15, 20, 25).

The Reading Comprehension Skills Test underwent a comprehensive psychometric evaluation to establish its validity and reliability. Content validity was established through expert panel review involving 12 qualified judges who evaluated 28 initially developed items across multiple dimensions including skill-to-variable alignment, question-to-skill correspondence, appropriateness of response alternatives, clarity of item formulation, scoring key accuracy, and overall test length adequacy. Following expert review, three items were eliminated based on consensus feedback, resulting in the final 25-item instrument. The Content Validity Index (CVI) calculations revealed excellent content validity with scores ranging from 0.83 to 1.00 across all evaluated dimensions ($M = 0.923$), indicating strong agreement among experts regarding the test's appropriateness and relevance.

Reliability assessment demonstrated strong psychometric properties across multiple evaluation methods. Internal consistency using Cronbach's alpha coefficient showed acceptable to excellent reliability for all subscales: Literal Comprehension ($\alpha = .728$), Vocabulary in Context ($\alpha = .744$), Inferential Comprehension ($\alpha = .817$), Critical Analysis ($\alpha = .830$), and Application and Evaluation ($\alpha = .822$), with overall test reliability of $\alpha = .844$. Corrected item-total correlations ranged from .376 to .875 across subscales, while inter-subscale correlations with total test score ranged from .477 to .677. Split-half reliability using Spearman-Brown coefficient indicated satisfactory to excellent consistency: Literal Comprehension ($r = .582$), Vocabulary in Context ($r = .706$), Inferential Comprehension ($r = .942$), Critical Analysis ($r = .861$), Application and Evaluation ($r = .879$), and overall test ($r = .916$, Guttman coefficient = .915). Test-retest reliability demonstrated strong temporal stability with correlation coefficients ranging from .687 to .813 for individual subscales and .778 for the total test score (all $p < .001$), confirming the instrument's consistency across time and appropriateness for longitudinal assessment.

Study Design and Procedure

This study employed a quasi-experimental design with both experimental and control groups to evaluate the effectiveness of AI-enhanced educational technologies in improving reading comprehension skills among students with learning disabilities. The 20 participants were randomly assigned to either the experimental group ($n = 10$) or the control group ($n = 10$), with careful attention to maintaining balanced gender and grade-level distribution across both conditions.

The intervention program was implemented over eight weeks during regular school hours, with sessions conducted three times per week for 45 minutes each. The experimental group participated in an individualized AI-enhanced reading comprehension program for students with learning disabilities. This program featured an adaptive learning management system that utilized machine learning algorithms to analyze each student's reading performance in real-time, identifying specific areas of difficulty and automatically adjusting content complexity, pacing, and instructional strategies accordingly. The AI system employed natural language processing capabilities to provide immediate, personalized feedback on reading responses, offering corrective guidance and encouraging reinforcement based on individual error patterns and learning progress.

The AI-enhanced platform incorporated multi-modal learning approaches, presenting text materials through various sensory channels, including visual text display with adjustable font sizes and colors, synchronized audio narration with highlighting features, and interactive graphic organizers that supported comprehension monitoring. The system's intelligent tutoring component provided scaffolded reading experiences by breaking complex texts into manageable segments, offering vocabulary support through contextual definitions and visual associations, and guiding students through systematic comprehension strategies such as prediction, questioning, clarification, and summarization. Additionally, the platform featured gamification elements, including progress tracking, achievement badges, and adaptive difficulty levels that maintained optimal challenge while preventing

frustration, thereby enhancing student motivation and engagement throughout the intervention period.
The AI system continuously collected and analyzed student interaction data, including response accuracy, time-on-task, help-seeking behaviors, and comprehension strategy usage patterns. This data informed the system's decision-making algorithms, enabling dynamic personalization of learning pathways and immediate intervention when students encountered difficulties. The platform also provided detailed progress reports for students and instructors, facilitating ongoing monitoring and adjustment of individualized learning goals.

In contrast, the control group received conventional reading comprehension instruction following the standard curriculum guidelines established by the Saudi Ministry of Education. These sessions involved teacher-led discussions of Arabic texts, traditional comprehension questioning techniques, vocabulary instruction through direct explanation methods, and paper-based reading exercises focused on literal and basic inferential comprehension skills. Control group participants used standard textbooks and worksheets, with instruction delivered through whole-group and small-group configurations typical of traditional classroom environments. Both groups completed pre-test and post-test assessments using the developed Reading Comprehension Skills Test, administered under standardized conditions by trained research assistants blind to group assignment.

Data Analysis

Data analysis employed non-parametric statistical procedures to accommodate the characteristics of the sample and data distribution. The Mann-Whitney U test was used to examine between-group differences in reading comprehension performance, comparing experimental and control groups on pre-test and post-test measures across all five reading comprehension domains. The Wilcoxon signed-rank test was applied to evaluate within-group changes from pre-test to post-test, assessing the significance of improvements in reading comprehension skills for both experimental and control groups. Data analysis was conducted using SPSS software, with detailed examination of changes in each reading comprehension subscale to identify specific areas of improvement resulting from AI-enhanced interventions.

Results

Prior to implementing the intervention, baseline comparisons were conducted to ensure equivalence between the experimental and control groups across all reading comprehension domains. The Mann-Whitney U test revealed no statistically significant differences between groups at pre-test, confirming successful randomization and establishing comparable starting points for both conditions. As presented in Table 1, the experimental and control groups demonstrated similar performance levels across all five reading comprehension subscales: literal comprehension (U = 44.000, p = .684), vocabulary in context (U = 44.500, p = .684), inferential comprehension (U = 41.000, p = .529), critical analysis (U = 34.000, p = .247), and application and evaluation (U = 43.500, p = .631). The total reading comprehension scores also showed no significant baseline differences between groups (U = 46.000, p = .796), indicating that post-intervention differences could be attributed to the AI-enhanced educational technology intervention rather than pre-existing group disparities.

Table 1 *Pre-test Comparisons Between Experimental and Control Groups Using Mann-Whitney U Test*

Domain	Group	N	Mean Rank	Mann-Whitney U	Z	p-value
Literal Comprehension	Experimental	10	11.10	44.000	-.466	.684
	Control	10	9.90			
Vocabulary in Context	Experimental	10	11.05	44.500	-.432	.684
	Control	10	9.95			
Inferential Comprehension	Experimental	10	9.60	41.000	-.711	.529
	Control	10	11.40			
Critical Analysis	Experimental	10	12.10	34.000	-1.247	.247
	Control	10	8.90			
Application and Evaluation	Experimental	10	11.15	43.500	-.516	.631
	Control	10	9.85			

Total Reading Comprehension	Experimental	10	10.90	46.000	-.306	.796
	Control	10	10.10			

Note: All p-values are two-tailed exact significance values

Following the eight-week AI-enhanced educational technology intervention, substantial and statistically significant differences emerged between the experimental and control groups across all reading comprehension domains. As detailed in Table 2, the experimental group consistently outperformed the control group on all post-test measures, with effect sizes ranging from moderate to large across different comprehension skills. The most pronounced differences were observed in critical analysis (U = 13.000, p = .004) and total reading comprehension scores (U = 11.500, p = .002), indicating that the AI-enhanced intervention was particularly effective in developing higher-order thinking skills and overall reading comprehension abilities.

Significant improvements were also evident in inferential comprehension (U = 18.000, p = .015) and application and evaluation skills (U = 18.000, p = .015), demonstrating the intervention's effectiveness in enhancing complex cognitive processes essential for deep text understanding. Additionally, foundational skills showed marked improvement, with vocabulary in context (U = 22.000, p = .035) and literal comprehension (U = 23.500, p = .043) reaching statistical significance. These comprehensive improvements across all reading comprehension domains suggest that the AI-enhanced educational technology provided effective individualized support that addressed the multifaceted nature of reading difficulties experienced by students with learning disabilities.

Table 2 *Post-test Comparisons Between Experimental and Control Groups Using Mann-Whitney U Test*

Domain	Group	N	Mean Rank	Mann-Whitney U	Z	p-value
Literal Comprehension	Experimental	10	13.15	23.500	-2.056	.043*
	Control	10	7.85			
Vocabulary in Context	Experimental	10	13.30	22.000	-2.189	.035*
	Control	10	7.70			
Inferential Comprehension	Experimental	10	13.70	18.000	-2.490	.015*
	Control	10	7.30			
Critical Analysis	Experimental	10	14.20	13.000	-2.870	.004**
	Control	10	6.80			
Application and Evaluation	Experimental	10	13.70	18.000	-2.517	.015*
	Control	10	7.30			
Total Reading Comprehension	Experimental	10	14.35	11.500	-2.918	.002**
	Control	10	6.65			

*Note: * p < .05, ** p < .01; All p-values are two-tailed exact significance values*

The Wilcoxon signed-rank test was employed to examine pre-test to post-test changes within the experimental group, revealing statistically significant improvements across all reading comprehension domains following the AI-enhanced intervention. As shown in Table 3, all participants who demonstrated change showed improvement, with no negative ranks observed across any of the measured domains. The most substantial improvements occurred in inferential comprehension (Z = -2.842, p = .004), where all ten participants showed measurable gains, indicating the intervention's effectiveness in developing students' ability to draw conclusions and make connections beyond explicitly stated information.

Critical analysis skills also significantly enhanced (Z = -2.724, p = .006), with nine of ten participants improving and one participant maintaining their baseline level. This finding suggests that the AI-enhanced platform's emphasis on higher-order thinking skills and personalized feedback mechanisms effectively supported students in developing analytical reasoning abilities. Application and evaluation skills showed significant improvement (Z = -2.392, p = .017), with seven participants demonstrating gains, indicating enhanced ability to apply reading strategies and evaluate text content. Foundational skills also improved significantly, with vocabulary in context (Z = -2.214, p = .027) and literal comprehension (Z = -2.041, p = .041) both showing meaningful gains. The total reading comprehension scores demonstrated highly significant improvement (Z = -2.812, p = .005), with all participants showing positive change, confirming the comprehensive effectiveness of the AI-enhanced educational technology intervention.

Table 3 *Within-Group Pre-test to Post-test Changes in Experimental Group Using Wilcoxon Signed-Rank Test*

Domain	Negative Ranks	Positive Ranks	Ties	Z	p-value
Literal Comprehension	0	5	5	-2.041	.041*
Vocabulary in Context	0	6	4	-2.214	.027*
Inferential Comprehension	0	10	0	-2.842	.004**
Critical Analysis	0	9	1	-2.724	.006**
Application and Evaluation	0	7	3	-2.392	.017*
Total Reading Comprehension	0	10	0	-2.812	.005**

*Note: * $p < .05$, ** $p < .01$; Positive ranks indicate improvement from pre-test to post-test*

To evaluate the sustainability of intervention effects, follow-up assessments were conducted with the experimental group to examine whether improvements were maintained over time. The Wilcoxon signed-rank test comparing post-test to follow-up scores revealed no statistically significant changes across any reading comprehension domain, as presented in Table 4. This pattern of non-significant results indicates that the gains achieved through the AI-enhanced educational technology intervention were successfully maintained during the follow-up period. The stability of improvements was evident across all domains: literal comprehension (Z = -.577, p = .564), vocabulary in context (Z = -.816, p = .414), inferential comprehension (Z = -.447, p = .655), critical analysis (Z = -1.414, p = .157), and application and evaluation (Z = -.577, p = .564). Total reading comprehension scores also remained stable (Z = -1.098, p = .272), with the slight positive trend suggesting potential continued growth rather than skill deterioration. The mixed pattern of positive and negative ranks across domains, combined with the predominance of tied scores, indicates that most participants maintained their post-intervention performance levels without significant regression, supporting the durability of the AI-enhanced intervention effects.

Table 4 *Follow-up Assessment: Post-test to Follow-up Changes in Experimental Group Using Wilcoxon Signed-Rank Test*

Domain	Negative Ranks	Positive Ranks	Ties	Z	p-value
Literal Comprehension	1	2	7	-.577	.564
Vocabulary in Context	1	2	7	-.816	.414
Inferential Comprehension	2	3	5	-.447	.655
Critical Analysis	0	2	8	-1.414	.157
Application and Evaluation	1	2	7	-.577	.564
Total Reading Comprehension	3	5	2	-1.098	.272

These results demonstrate that the AI-enhanced educational technology intervention produced significant, comprehensive, and sustained improvements in reading comprehension skills among students with learning disabilities, with effects maintained over the follow-up period.

Discussion

The findings demonstrate that AI-enhanced interventions yield comprehensive improvements across all five reading comprehension domains for students with learning disabilities, contrasting with the selective gains reported in traditional assistive technology research. While conventional technologies like text-to-speech and word processors show moderate improvements in literal comprehension and vocabulary acquisition (Lewis & Lewis, 1998; Svensson et al., 2019), their impact on higher-order skills remains limited (Perelmutter et al., 2017). In contrast, AI-driven personalized interventions significantly improve literal comprehension, vocabulary, inferential reasoning, critical analysis, and application/evaluation domains (Deckker & Sumanasekara, 2025; Yang et al., 2024). This effectiveness suggests AI-based approaches address the multifaceted nature of learning disabilities more holistically than traditional methods, which target specific deficits rather than offering integrated support across comprehension domains (Fernández-Batanero et al., 2022). The improvements align with theoretical frameworks emphasizing individualized, multi-modal interventions for students with learning disabilities, where adaptation to cognitive profiles is essential for academic progress.

The sustained improvements with AI-enhanced educational technology, without significant regression during follow-up, stem from key factors distinguishing these interventions from traditional approaches. AI tools' personalized, adaptive nature ensures continuous adjustment to each student's learning pace and progress, preventing plateauing seen in static interventions (Alkhawaldeh et al., 2023; Yang, 2022). AI-based interventions also target cognitive processes like working memory and selective attention, which are fundamental to reading comprehension sustainability (Almahdawi et al., 2024; El-Zeiny et al., 2024). Integrating self-regulated learning features—goal-setting, monitoring, and gamified elements—enhances motivation and engagement, strongly linked to long-term academic success (Rad, 2025). Additionally, AI systems offer immediate feedback and repeated practice that reinforce learning and reduce instructional variability, contributing to inconsistent maintenance of gains (Adjiovski et al., 2024; Liu et al., 2024). This sustainability addresses a persistent challenge in special education, where initial gains often fade due to limited reinforcement in traditional settings.

The superior performance of AI-enhanced interventions in developing higher-order thinking skills, especially critical analysis and inferential comprehension, stems from their personalized, adaptive, and interactive learning experiences that transcend traditional pedagogical limits (Dibek et al., 2025; Huang et al., 2024). Unlike conventional approaches focusing on foundational skills due to standardization constraints, AI systems provide sophisticated scaffolding and consistent implementation of complex strategies at scale (Lu et al., 2024; Walter, 2024). These technologies use multimodal environments and real-time feedback to stimulate deeper cognitive processing essential for higher-order thinking (Liu & Wang, 2024; Wang et al., 2022). AI's ability to enhance self-efficacy and metacognitive awareness fosters optimal conditions for complex engagement (Gerlich, 2025; Wu, 2024). This advancement helps bridge the research-to-practice gap by enabling evidence-based interventions previously difficult to implement consistently. Developing critical analysis and inferential skills is especially important, as these processes are challenging for students with learning disabilities and vital for academic success.

The improvements also reflect the theoretical foundations of individualized learning, recognizing that students with learning disabilities need differentiated instruction tailored to their cognitive profiles and strengths. The AI-enhanced platform's ability to address multiple comprehension domains suggests these technologies offer the intensive, individualized intervention consistently identified as necessary for meaningful progress. The vocabulary-in-context gains show how AI systems provide contextual support and scaffolding that help students overcome persistent vocabulary limitations contributing to developmental gaps with typically developing peers. Likewise, the gains in inferential comprehension indicate that AI-enhanced interventions effectively address metacognitive strategy deficits common among students with learning disabilities in planning, monitoring, and evaluating comprehension.

The maintenance of gains during the follow-up period provides compelling evidence for the effectiveness of AI-enhanced interventions, as skill maintenance has been identified as a critical challenge in special education research. Traditional interventions often show promise but fail to produce lasting effects, particularly when students return to conventional instructional environments. The stability of improvements across all reading comprehension domains suggests that the AI-enhanced intervention succeeded in developing surface-level skills and fundamental cognitive competencies that students could transfer and apply independently. This finding has important implications for educational practice, as it suggests that AI-enhanced interventions may solve the persistent challenge of ensuring that intervention gains translate into long-term academic success for students with learning disabilities.

The findings of this study have important implications for educational practice, policy, and the use of assistive technologies in schools serving students with learning disabilities. It suggests that AI-enhanced technologies be integrated into IEPs as evidence-based interventions for students with reading comprehension difficulties. Administrators and special education coordinators should consider investing in AI-driven platforms as cost-effective solutions for consistent, high-quality individualized instruction. These interventions could serve as transitional tools, helping students develop independent reading skills that benefit them across academic subjects and levels. The results indicate that traditional whole-group instruction models may need reconceptualization to include more individualized, technology-enhanced approaches. Teachers should receive professional development to understand how AI systems complement instruction and support differentiated learning in inclusive classrooms.

Several limitations must be acknowledged when interpreting this study's findings. The research on AI-enhanced interventions for students with learning disabilities in Saudi Arabia is limited by its small sample size of 20 participants and focus on Arabic-speaking students. Effectiveness may vary across languages, cultures, and educational systems. The eight-week intervention may not reflect the long-term challenges schools face when adopting large-scale AI technologies. The quasi-experimental design introduces threats to internal validity, as the lack of a waitlist control means control participants received no enhanced intervention. The study did not analyze specific features of the AI platform responsible for improvements, limiting insight into the active ingredients of effective intervention. The brief follow-up period calls for longer-term studies to determine whether improvements persist and lead to broader academic success. Technical limitations regarding the platform's adaptability to individual learning profiles may not have been fully addressed in the design.

Future research should address several key areas to build upon the promising findings of this study and advance our understanding of AI-enhanced educational interventions for students with learning disabilities. Large-scale randomized controlled trials are needed to establish AI-enhanced reading interventions' generalizability and external validity. Longitudinal studies should follow participants for extended periods to understand the long-term sustainability of intervention effects and their impact on academic outcomes. Component analysis studies should identify the features and mechanisms within AI-enhanced platforms that contribute most significantly to reading comprehension improvements. Future investigations should explore the optimal dosage, duration, and implementation models for AI-enhanced reading interventions, comparing them with other evidence-based approaches. Research should also examine the effectiveness of AI-enhanced interventions for students with different learning disabilities and comorbid conditions.

Conclusion

This study provides compelling evidence that AI-enhanced educational technologies can significantly improve reading comprehension skills across multiple domains for students with learning disabilities, with comprehensive and sustained effects over time. The intervention's success in developing foundational skills and higher-order thinking abilities represents a meaningful educational technology advancement for special populations. The sustained improvements observed during follow-up assessments suggest these technologies may bridge the research-to-practice gap by providing individualized, adaptive support that translates into long-term academic success. While limitations exist and further research is needed, this study demonstrates that AI-enhanced interventions hold significant promise for enhancing educational outcomes and promoting academic success for students with learning disabilities.

Acknowledgment

- The authors extend their appreciation to Prince Sattam bin Abdulaziz University for funding this research work through the project number (PSAU/2025/R/1447)"

- This work was supported by the Deanship of Scientific Research, Vice Presidency for Graduate Studies and Scientific Research, King Faisal University, Saudi Arabia [KFU253129]

- The authors gratefully acknowledge the approval and the support of this research study by Grant No. NBU-FFR-2025-260-06 from the Deanship of Scientific Research in Northern Border University, Arar, KSA.

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

Authorship and Level of Contribution

All authors contributed to the research of the literature, collection of data, analysis, and interpretation of the collected data.

References

Adjiovski, B., Bogatinoska, D. C., Ismajloska, M., & Malekian, R. (2024). Enhancing educational technology in lectures for school students with learning disabilities: A comprehensive analysis. *SN Computer Science*, *5*(6), 716. https://doi.org/10.1007/s42979-024-03049-z

Admeur, S., & Attariuas, H. (2024). Personalizing learning Strategies for students failing in school. *Contemporary Research Analysis Journal.*, *01*(06), 229-235. https://doi.org/10.55677/craj/09-2024-vol01i6

Akavova, A., Temirkhanova, Z., & Lorsanova, Z. (2023). Adaptive learning and artificial intelligence in the educational space. In *E3S Web of Conferences (Vol. 451, Article 06011). 2nd International Conference on Environmental Sustainability Management and Green Technologies* (ESMGT 2023). https://doi.org/10.1051/e3sconf/202345106011

Al-Balwi, M., & Muhaidat, M. (2019). The effectiveness of graphic organizers in the development of reading comprehension among students with learning difficulties. *Jordanian Journal of Educational Sciences, 17*(1), 39–104. https://doi.org/10.47015/17.1.6

Al-Harithi, S. S. (2019). The effectiveness of a program based on mind maps to improve the reading comprehension and attitudes towards reading with students with reading difficulties. *Journal of Umm Al-Qura University for Educational & Psychological Sciences, 10*(2), 13–57.

Alkhawaldeh, M., Ahmad, M., & Khasawneh, S. (2023). Harnessing the power of artificial intelligence for personalized assistive technology in learning disabilities. *Journal of Southwest Jiaotong University*, *58*(4), 794–805. https://doi.org/10.35741/issn.0258-2724.58.4.60

Almahdawi, A., El-Zeiny, M. E., Aburezeq, I. M., Alqawasmi, A., & Asran, K. M. (2024). Enhancing selective attention of students with learning disabilities through an AI-based strategy. In *Proceedings of the 2024 11th International Conference on Social Networks Analysis, Management and Security (SNAMS)* (pp. 244–250). IEEE. https://doi.org/10.1109/SNAMS64316.2024.10883808

Alqahtani, K. M. (2018). The effectiveness of a training program in improving the reading comprehension among students with reading disabilities in Al-Baha region. *Journal of Educational Sciences, 34*, 151–210.

Al-Zahrani, A. B. (2023). The reality of using the Robinson strategy to improve reading comprehension skills among students with learning difficulties and the barriers to its implementation. *Assiut University College of Education Journal, 39*(3), 127–158. https://doi.org/10.21608/mfes.2023.298553

Al-Saadawi, A. K. (2016). *The effectiveness of a program to improve reading comprehension difficulties among a sample of primary school children with learning disabilities* (using the mind mapping strategy) [Unpublished doctoral dissertation]. Ain Shams University.

Anderson, J. E., Nguyen, C. A., & Moreira, G. (2025). Generative AI-driven personalization of the community of inquiry model: enhancing individualized learning experiences in digital classrooms. *International Journal of Information and Learning Technology*, 42(3), 296–310. https://doi.org/10.1108/ijilt-10-2024-0240

Antonis, T. (2022). Learning difficulties and reading comprehension in the first grades of primary school. *Open Access Journal of Biogeneric Science and Research*, *3*(1), 1-5. https://doi.org/10.46718/jbgsr.2022.10.000255

Avdonina, T. B., & Gurieva, D. X. (2020). Innovative methods for teaching children with special needs. *Archivarius*, *3(48)*, 46–52. https://doi.org/10.31618/2524-0935-2020-48-3-3

Bañados, M. R. L., Sulfelix, J. N. S., Baste, J. D., Gatus, J. T. C., Van P Rafanan, R., & Cagape, W. E. (2024). Innovative teaching approaches of teachers in teaching students with special needs: A case study. *International Journal of Research Publications*, *146*(1), 360–374. https://doi.org/10.47119/ijrp1001461420246284

Bernacki, M. L., & Walkington, C. (2018). The role of situational interest in personalized learning. *Journal of Educational Psychology*, *110*(6), 864–881. https://doi.org/10.1037/edu0000250

Bhutoria, A. (2022). Personalized education and Artificial Intelligence in the United States, China, and India: A systematic review using a Human-In-The-Loop model. *Computers and Education Artificial Intelligence*, *3*, 100068. https://doi.org/10.1016/j.caeai.2022.100068

Bozkurt, A. (2020). Educational technology research patterns in the realm of the digital knowledge age. *Journal of Interactive Media in Education*, *2020*(1), 18. https://doi.org/10.5334/jime.570

Bressane, A., Zwirn, D., Essiptchouk, A., Saraiva, A. C., De Campos Carvalho, F. L., Formiga, J. K., De Castro

Medeiros, L. C., & Negri, R. G. (2023). Understanding the role of study strategies and learning disabilities on student academic performance to enhance educational approaches: A proposal using artificial intelligence. *Computers and Education Artificial Intelligence*, *6*, 100196. https://doi.org/10.1016/j.caeai.2023.100196

Brunow, D. A., & Cullen, T. A. (2021). Effect of Text-to-Speech and Human Reader on Listening Comprehension for Students with Learning Disabilities. *Computers in the Schools*, *38*(3), 214–231. https://doi.org/10.1080/07380569.2021.1953362

Capin, P., Cho, E., Miciak, J., Roberts, G., & Vaughn, S. (2021). Examining the reading and cognitive profiles of students with significant reading comprehension difficulties. *Learning Disability Quarterly*, *44*(3), 183–196. https://doi.org/10.1177/0731948721989973

Capin, P., Gillam, S. L., Fall, A., Roberts, G., Dille, J. T., & Gillam, R. B. (2022). Understanding the nature and severity of reading difficulties among students with language and reading comprehension difficulties. *Annals of Dyslexia*, *72*(2), 249–275. https://doi.org/10.1007/s11881-022-00255-3

Castro, G. P. B., Chiappe, A., Rodriguez, D. F. B., & Sepulveda, F. G. (2024). Harnessing AI for Education 4.0: Drivers of Personalized Learning. *The Electronic Journal of e-Learning*, *22*(5), 01–14. https://doi.org/10.34190/ejel.22.5.3467

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access, 8,* 75264–75278. https://doi.org/10.1109/ACCESS.2020.2988510

Cheng, S., & Lai, C. (2019). Facilitating learning for students with special needs: a review of technology-supported special education studies. *Journal of Computers in Education*, *7*(2), 131–153. https://doi.org/10.1007/s40692-019-00150-8

Cummins, J. (2024). How can emerging technologies advance the creation of language-friendly and literacy-friendly schools? *Language Culture and Curriculum*, *37*(1), 106–119. https://doi.org/10.1080/07908318.2024.2306286

Damyanov, P. K. (2024). Effective Pedagogical Strategies and Support Mechanisms for Enhancing the Learning Outcomes of Students with Special Educational Needs: A Systematic Approach. *International Journal of Scientific Research and Management (IJSRM)*, *12*(10), 3700–3718. https://doi.org/10.18535/ijsrm/v12i10.el03

Daniel, K., Msambwa, M. M., Antony, F., & Wan, X. (2024). Motivate students for better academic achievement: A systematic review of blended innovative teaching and its impact on learning. *Computer Applications in Engineering Education*, *32*(4), e22733. https://doi.org/10.1002/cae.22733

Deckker, N. D., & Sumanasekara, N. S. (2025). Systematic review on AI in special education: enhancing learning for neurodiverse students. *EPRA International Journal of Multidisciplinary Research (IJMR)*, 11(2), 539–545. https://doi.org/10.36713/epra20360

Dibek, M. I., Kursad, M. S., & Erdogan, T. (2024). Influence of artificial intelligence tools on higher order thinking skills: a meta-analysis. *Interactive Learning Environments*, *33*(3), 2216–2238. https://doi.org/10.1080/10494820.2024.2402028

Dodur, H. M. S., & Ceylan, M. (2025). Academic self-concept and reading comprehension among students with learning disabilities: Serial mediating effect of reading anxiety and reading motivation. *British Journal of Educational Psychology*, *95*(3), 836–848. https://doi.org/10.1111/bjep.12763

Du Plooy, E., Casteleijn, D., & Franzsen, D. (2024). Personalized adaptive learning in higher education: a scoping review of key characteristics and impact on academic performance and engagement. *Heliyon*, *10*(21), e39630. https://doi.org/10.1016/j.heliyon.2024.e39630

Elleman, A. M., & Oslund, E. L. (2019). Reading Comprehension Research: Implications for Practice and Policy. *Policy Insights From the Behavioral and Brain Sciences*, *6*(1), 3–11. https://doi.org/10.1177/2372732218816339

El-Zeiny, M. E., Alwaely, S. A. K., Faqeeh, M. H., Asran, K. M., & Farhat, D. (2024). AI-based working memory training to reduce reading disabilities in primary students. In *Proceedings of the 2024 11th International Conference on Social Networks Analysis, Management and Security (SNAMS)* (pp. 74–80). IEEE. https://doi.org/10.1109/SNAMS64316.2024.10883782

Fernández-Batanero, J. M., Montenegro-Rueda, M., Fernández-Cerero, J., & García-Martínez, I. (2022). Assistive technology for the inclusion of students with disabilities: a systematic review. *Educational Technology Research and Development*, *70*(5), 1911–1930. https://doi.org/10.1007/s11423-022-10127-7

Gerlich, M. (2025). AI Tools in Society: Impacts on cognitive offloading and the future of critical thinking. *Societies*, *15*(1), 6. https://doi.org/10.3390/soc15010006

Giansanti, D., & Pirrera, A. (2025). Integrating AI and Assistive Technologies in Healthcare: Insights from a Narrative Review of Reviews. *Healthcare*, *13*(5), 556. https://doi.org/10.3390/healthcare13050556

Gilmour, A. F., Fuchs, D., & Wehby, J. H. (2018). Are students with disabilities accessing the curriculum? A Meta-Analysis of the reading achievement gap between students with and without Disabilities. *Exceptional Children*, *85*(3), 329–346. https://doi.org/10.1177/0014402918795830

Gligorea, I., Cioca, M., Oancea, R., Gorski, A., Gorski, H., & Tudorache, P. (2023). Adaptive Learning Using Artificial Intelligence in e-Learning: A Literature review. *Education Sciences*, *13*(12), 1216. https://doi.org/10.3390/educsci13121216

Guan, C., Mou, J., & Jiang, Z. (2020). Artificial intelligence innovation in education: A twenty-year data-driven historical analysis. *International Journal of Innovation Studies*, *4*(4), 134–147. https://doi.org/10.1016/j.ijis.2020.09.001

Hassan, N. G. (2023). TECHNOLOGY AND THE TRANSFORMATION OF EDUCATIONAL PRACTICES: a FUTURE PERSPECTIVE. *International Journal of Economic Business Accounting Agriculture Management and Sharia Administration (IJEBAS)*, *3*(1), 1596–1603. https://doi.org/10.54443/ijebas.v3i1.1136

Hopcan, S., Polat, E., Ozturk, M. E., & Ozturk, L. (2022). Artificial intelligence in special education: a systematic review. *Interactive Learning Environments*, *31*(10), 7335–7353. https://doi.org/10.1080/10494820.2022.2067186

Howard-Gosse, A., Bergey, B. W., & Deacon, S. H. (2023). The reading Challenges, Strategies, and Habits of university students with a history of reading difficulties and their relations to academic achievement. *Journal of Learning Disabilities*, *57*(2), 91–105. https://doi.org/10.1177/00222194231190678

Huang, K., Liu, Y., & Dong, M. (2024). Incorporating AIGC into design ideation: A study on self-efficacy and learning experience acceptance under higher-order thinking. *Thinking Skills and Creativity*, *52*, 101508. https://doi.org/10.1016/j.tsc.2024.101508

Hussein, E., Hussein, M., & Al-Hendawi, M. (2025). Investigation into the Applications of Artificial Intelligence (AI) in Special Education: A Literature Review. *Social Sciences*, *14*(5), 288. https://doi.org/10.3390/socsci14050288

Ishartiwi, I., Handoyo, R. R., Prabawati, W., & Suseno, A. (2023). The individualized instruction application for personal-social skills of students with intellectual disabilities. *Jurnal Cakrawala Pendidikan*, *42*(2), 280-294. https://doi.org/10.21831/cp.v42i2.49240

James, E., Thompson, P. A., Bowes, L., & Nation, K. (2024). What are the long-term prospects for children with comprehension weaknesses? A registered report investigating education and employment outcomes. *Journal of Educational Psychology*, *116*(6), 1019–1033. https://doi.org/10.1037/edu0000898

Joseph, L., Ross, K., Xia, Q., Amspaugh, L. A., & Accurso, J. (2021). Reading Comprehension Instruction for Students with Intellectual Disabilities: A Systematic Literature Review. *International Journal of Disability Development and Education*, *70*(3), 314–339. https://doi.org/10.1080/1034912x.2021.1892033

Kamalov, F., Calonge, D. S., & Gurrib, I. (2023). New era of Artificial intelligence in Education: Towards a sustainable Multifaceted Revolution. *Sustainability*, *15*(16), 12451. https://doi.org/10.3390/su151612451

Kampylafka, C., Polychroni, F., & Antoniou, A. (2023). Primary School Students with Reading Comprehension Difficulties and Students with Learning Disabilities: Exploring Their Goal Orientations, Classroom Goal Structures, and Self-Regulated Learning Strategies. *Behavioral Sciences*, *13*(2), 78. https://doi.org/10.3390/bs13020078

Katiyar, P., Awasthi, V., Pratap, R., Mishra, K., Shukla, N., Singh, R., & Tiwari, M. (2024). AI-driven personalized learning systems: enhancing educational effectiveness. *Educational Administration Theory and Practices*, 30(5), 11514-11524. https://doi.org/10.53555/kuey.v30i5.4961

Kendeou, P., McMaster, K. L., & Christ, T. J. (2016). Reading comprehension. *Policy Insights From the Behavioral* *and Brain Sciences*, *3*(1), 62–69. https://doi.org/10.1177/2372732215624707

Kim, S. J., & Lee, E. J. (2025). A study on the application of individualized instruction to improve computational skills of students at risk for mathematics learning disabilities. *Korean Journal of Special Education*, *59*(4), 161–192. https://doi.org/10.15861/kjse.2025.59.4.161

Kocaj, A., Cortina, K. S., Vereb, A. F., & Carlisle, J. F. (2023). Exploring individual changes in disability status and their relations to reading comprehension development. *Remedial and Special Education*, 46(1), 3–17. https://doi.org/10.1177/07419325231217521

Lazarus, K. U., & Anwalimhobor, N. B. I. (2023). Metacognitive Awareness of Reading Strategies as Predictors of Reading Comprehension Achievement among Students with Learning Disabilities in Nigeria. *IJDS Indonesian Journal of Disability Studies*, *10*(1), 83-94. https://doi.org/10.21776/ub.ijds.2023.010.01.07

Lewis, R. B., & Lewis, R. B. (1998). Assistive technology and learning disabilities. *Journal of Learning Disabilities*, *31*(1), 16–26. https://doi.org/10.1177/002221949803100103

Liu, M., Zhang, J., Nyagoga, L. M., & Liu, L. (2023). Student-AI Question Cocreation for Enhancing reading Comprehension. *IEEE Transactions on Learning Technologies*, *17*, 815–826. https://doi.org/10.1109/tlt.2023.3333439

Liu, W., & Wang, Y. (2024). The effects of using AI tools on critical thinking in English literature classes among EFL learners: an intervention study. *European Journal of Education*, *59*(4), e12804. https://doi.org/10.1111/ejed.12804

Lu, J., Zheng, R., Gong, Z., & Xu, H. (2024). Supporting Teachers' professional Development with Generative AI: The Effects on Higher Order Thinking and Self-Efficacy. *IEEE Transactions on Learning Technologies*, *17*, 1279–1289. https://doi.org/10.1109/tlt.2024.3369690

Luckin, R., & Cukurova, M. (2019). Designing educational technologies in the age of AI: A learning sciences-driven approach. *British Journal of Educational Technology*, *50*(6), 2824–2838. https://doi.org/10.1111/bjet.12861

Maghsudi, S., Lan, A., Xu, J., & van der Schaar, M. (2021). Personalized education in the artificial intelligence era: What to expect next. *IEEE Signal Processing Magazine, 38*(3), 37–50. https://doi.org/10.1109/MSP.2021.3055032

McKenna, J. W., Shin, M., & Ciullo, S. (2015). Evaluating reading and mathematics instruction for students with learning disabilities. *Learning Disability Quarterly*, *38*(4), 195–207. https://doi.org/10.1177/0731948714564576

Murtaza, M., Ahmed, Y., Shamsi, J. A., Sherwani, F., & Usman, M. (2022). AI-based personalized e-learning systems: Issues, challenges, and solutions. *IEEE Access, 10,* 81323–81342. https://doi.org/10.1109/ACCESS.2022.3193938

Murtaza, M., Ahmed, Y., Shamsi, J., Sherwani, F., & Usman, M. (2022). AI-based personalized e-learning systems: Issues, challenges, and solutions. *IEEE Access, 10*, 81323–81342. https://doi.org/10.1109/ACCESS.2022.3193938

Nation, K. (2019). Children's reading difficulties, language, and reflections on the simple view of reading. *Australian Journal of Learning Difficulties*, *24*(1), 47–73. https://doi.org/10.1080/19404158.2019.1609272

Naz, F., & Murad, H. S. (2017). Innovative teaching has a positive impact on the performance of diverse students. *SAGE Open*, *7*(4), 1–8. https://doi.org/10.1177/2158244017734022

Papalexandratou, N. P., Stathopoulou, N. A., & Skanavis, C. (2024). The use of artificial intelligence in the education of students with learning disabilities. *Global Journal of Engineering and Technology Advances*, *21*(3), 033–049. https://doi.org/10.30574/gjeta.2024.21.3.0223

Perelmutter, B., McGregor, K. K., & Gordon, K. R. (2017). Assistive technology interventions for adolescents and adults with learning disabilities: An evidence-based systematic review and meta-analysis. *Computers & Education*, *114*, 139–163. https://doi.org/10.1016/j.compedu.2017.06.005

Pesovski, I., Santos, R., Henriques, R., & Trajkovik, V. (2024). Generative AI for customizable learning experiences. *Sustainability*, *16*(7), 3034. https://doi.org/10.3390/su16073034

Peterson, R. L., McGrath, L. M., Willcutt, E. G., Keenan, J. M., Olson, R. K., & Pennington, B. F. (2021). How specific are learning disabilities? *Journal of Learning Disabilities*, *54*(6), 466–483. https://doi.

org/10.1177/0022219420982981
Quinn, J. M., Wagner, R. K., Petscher, Y., Roberts, G., Menzel, A. J., & Schatschneider, C. (2020). Differential codevelopment of vocabulary knowledge and reading comprehension for students with and without learning disabilities. *Journal of Educational Psychology*, *112*(3), 608–627. https://doi.org/10.1037/edu0000382
Rad, H. S. (2025). Reinforcing L2 reading comprehension through artificial intelligence intervention: refining engagement to foster self-regulated learning. *Smart Learning Environments*, *12*(1), 23. https://doi.org/10.1186/s40561-025-00377-2
Rane, N., Choudhary, S., & Rane, J. (2023). Education 4.0 and 5.0: Integrating Artificial Intelligence (AI) for personalized and adaptive learning. *SSRN Electronic Journal*, 1(1), 29–43. https://doi.org/10.2139/ssrn.4638365
Redhu, V., Singh, A. K., & Saravanan, M. (2024). AI-enhanced learning assistant platform: An advanced system for Q&A generation from provided content, answer evaluation, identification of students' weak areas, recursive testing for strengthening knowledge, integrated query forum, and expert chat support. In *Proceedings of the 2024 2nd International Conference on Artificial Intelligence and Machine Learning Applications (AIMLA): Theme—Healthcare and Internet of Things* (pp. 1–6). IEEE. https://doi.org/10.1109/AIMLA59606.2024.10531533
Rodríguez-Cano, S., Cuesta-Gómez, J. L., Delgado-Benito, V., & De La Fuente-Anuncibay, R. (2022). Educational Technology as a Support Tool for Students with Specific Learning Difficulties—Future Education Professionals' Perspective. *Sustainability*, *14*(10), 6177. https://doi.org/10.3390/su14106177
Sarisahin, S. (2020). Reading Comprehension Strategies for students with learning disabilities who are emergent bilingual. *Intervention in School and Clinic*, *56*(1), 3–12. https://doi.org/10.1177/1053451220910731
Schulte, A. C., Stevens, J. J., Elliott, S. N., Tindal, G., & Nese, J. F. T. (2016). Achievement gaps for students with disabilities: Stable, widening, or narrowing on a state-wide reading comprehension test? *Journal of Educational Psychology*, *108*(7), 925–942. https://doi.org/10.1037/edu0000107
Shanahan, E., Choi, S., An, J., Casey-Wilke, B., Birinci, S., Roberts, C., & Reno, E. (2024). Ongoing teacher Support for Data-Based Individualization: a Meta-Analysis and Synthesis. *Journal of Learning Disabilities*, 58(1), 3-18. https://doi.org/10.1177/00222194241271335
Shemshack, A., & Spector, J. M. (2020). A systematic literature review of personalized learning terms. *Smart Learning Environments*, *7*(1), 33. https://doi.org/10.1186/s40561-020-00140-9
Söğüt, D. A., & Melekoğlu, M. A. (2025). Effect of the Self-Determination Learning Model of instruction on reading comprehension and Self-Determination skills of students with learning disabilities. *Learning Disability Quarterly*, 48(2), 130–142. https://doi.org/10.1177/07319487241301054
Sokpheng, S., & Meng, L. H. (2022). Comparison of Modern and Conventional Learning Methods for Children with Special Needs. *Journal of Asian Multicultural Research for Educational Study*, *3*(1), 14–22. https://doi.org/10.47616/jamres.v3i1.264
Süer, S., Kumaş, Ö. A., & Karagül, A. (2021). Investigating the Teachers' Innovative Pedagogical Practices towards Students with Special Needs. *Academia Eğitim Araştırmaları Dergisi*, 6(2), 363–381. https://doi.org/10.53506/egitim.902289
Sumanth, N. S., Priya, S. V., & KS., K. (2024). AI-enhanced learning assistant platform. In *Proceedings of the 2024 International Conference on Inventive Computation Technologies (ICICT)* (pp. 846–852). IEEE. https://doi.org/10.1109/ICICT60155.2024.10545011
Sumanth, N. S., Priya, S. V., M, S., & K.S., K. (2024). AI-enhanced learning assistant platform. In *Proceedings of the 2024 International Conference on Inventive Computation Technologies (ICICT)* (pp. 846–852). IEEE. https://doi.org/10.1109/ICICT60155.2024.10545011
Svensson, I., Nordström, T., Lindeblad, E., Gustafson, S., Björn, M., Sand, C., Almgren/Bäck, G., & Nilsson, S. (2019). Effects of assistive technology for students with reading and writing disabilities. *Disability and Rehabilitation Assistive Technology*, *16*(2), 196–208. https://doi.org/10.1080/17483107.2019.1646821
Talbott, E., Lloyd, J. W., & Tankersley, M. (1994). Effects of Reading Comprehension Interventions for Students with Learning Disabilities. *Learning Disability Quarterly*, *17*(3), 223–232. https://doi.org/10.2307/1511075

Tapalova, O., & Zhiyenbayeva, N. (2022). Artificial Intelligence in Education: AIED for Personalised Learning Pathways. *The Electronic Journal of e-Learning*, *20*(5), 639–653. https://doi.org/10.34190/ejel.20.5.2597

Taşkın, M. (2025). Artificial Intelligence in Personalized Education: Enhancing learning outcomes through adaptive technologies and Data-Driven Insights. *Human Computer Interaction.*, *8*(1), 173. https://doi.org/10.62802/ygye0506

Torppa, M., Vasalampi, K., Eklund, K., Sulkunen, S., & Niemi, P. (2019). Reading comprehension difficulty is often distinct from difficulty in reading fluency and accompanied with problems in motivation and school well-being. *Educational Psychology*, *40*(1), 62–81. https://doi.org/10.1080/01443410.2019.1670334

Valtonen, T., López-Pernas, S., Saqr, M., Vartiainen, H., Sointu, E. T., & Tedre, M. (2021). The nature and building blocks of educational technology research. *Computers in Human Behavior*, *128*, 107123. https://doi.org/10.1016/j.chb.2021.107123

Walter, Y. (2024). Embracing the future of Artificial Intelligence in the classroom: the relevance of AI literacy, prompt engineering, and critical thinking in modern education. *International Journal of Educational Technology in Higher Education*, *21*(1), 15. https://doi.org/10.1186/s41239-024-00448-3

Wang, C., Chen, X., Yu, T., Liu, Y., & Jing, Y. (2024). Education reform and change driven by digital technology: a bibliometric study from a global perspective. *Humanities and Social Sciences Communications*, *11*(1), 256. https://doi.org/10.1057/s41599-024-02717-y

Wang, S., Sun, Z., & Chen, Y. (2022). Effects of higher education institutes' artificial intelligence capability on students' self-efficacy, creativity and learning performance. *Education and Information Technologies*, *28*(5), 4919–4939. https://doi.org/10.1007/s10639-022-11338-4

Willcutt, E. G., McGrath, L. M., Pennington, B. F., Keenan, J. M., DeFries, J. C., Olson, R. K., & Wadsworth, S. J. (2019). Understanding comorbidity between specific learning disabilities. *New Directions for Child and Adolescent Development*, *2019*(165), 91–109. https://doi.org/10.1002/cad.20291

Wu, X. (2024). Artificial Intelligence in L2 learning: A meta-analysis of contextual, instructional, and social-emotional moderators. *System*, *126*, 103498. https://doi.org/10.1016/j.system.2024.103498

Xu, W., & Ouyang, F. (2021). A systematic review of AI role in the educational system based on a proposed conceptual framework. *Education and Information Technologies*, *27*(3), 4195–4223. https://doi.org/10.1007/s10639-021-10774-y

Yang, H. (2022). Effect of Story Structure Instruction based on Visual Analysis on reading Comprehension intervention for Dyslexic students. *Computational Intelligence and Neuroscience*, *2022*(1), 9479709. https://doi.org/10.1155/2022/9479709

Yang, Y., Chen, L., He, W., Sun, D., & Salas-Pilco, S. Z. (2024). Artificial Intelligence for Enhancing Special Education for K-12: A Decade of Trends, Themes, and Global Insights (2013–2023). *International Journal of Artificial Intelligence in Education*. 1–49. https://doi.org/10.1007/s40593-024-00422-0

Younas, M., El-Dakhs, D. A. S., & Jiang, Y. (2025). A comprehensive systematic review of AI-driven approaches to self-directed learning. *IEEE Access, 13,* 38387–38403. https://doi.org/10.1109/ACCESS.2025.3546319

Yu, H., Miao, C., Leung, C., & White, T. J. (2017). Towards AI-powered personalization in MOOC learning. *Npj Science of Learning*, *2*(1), 17. https://doi.org/10.1038/s41539-017-0016-3

Zdravkova, K., Krasniqi, V., Dalipi, F., & Ferati, M. (2022). Cutting-edge communication and learning assistive technologies for disabled children: An artificial intelligence perspective. *Frontiers in Artificial Intelligence*, *5*, 970430. https://doi.org/10.3389/frai.2022.970430

Zhang, J., Zou, L., Miao, J., Zhang, Y., Hwang, G., & Zhu, Y. (2019). An individualized intervention approach to improving university students' learning performance and interactive behaviors in a blended learning environment. *Interactive Learning Environments*, *28*(2), 231–245. https://doi.org/10.1080/10494820.2019.1636078

Zhang, L., Carter, R. A., Liu, Y., & Peng, P. (2024). Let's CHAT about artificial intelligence for students with disabilities: A systematic literature review and meta-analysis. *Review of Educational Research*, *20*(10), 1–43. https://doi.org/10.3102/00346543241293424