


Advancing EdTech for Diverse Learners: Recent Trends in Computer-Assisted Instruction for Students with Learning Disabilities and English Language Learners

John Njikem

Wheelock College of Education and Human Development, Boston University, USA,  0009-0009-5548-4907
Corresponding author: John Njikem (njikemjo@bu.edu)

Article Info

Article History

Received:
5 December 2025

Revised:
28 February 2026

Accepted:
3 April 2026

Published:
18 June 2026

Keywords

Computer-assisted
instruction
Learning disabilities
English language learners
Reading comprehension
Vocabulary development

Abstract

A systematic literature review was conducted to examine the recent trends in the integration of computer-assisted instruction (CAI) to support reading comprehension and vocabulary outcomes for students with learning disabilities (LDs) and English language learners (ELLs) from 2010 to 2022. With approximately 8 million students ages 3–21 receiving special education services under the Individuals with Disabilities Education Act (IDEA), there is a need for educators to incorporate evidence-based computer programs and tools into individualized educational programs (IEPs) to accelerate students' reading progress. As computer programs rapidly advance, there is a pressing need to identify evidence-based computer-assisted tools that K-12 educators can adapt to support supplemental reading instruction for this group of learners. Guided by three research questions, a total of 18 peer-reviewed journal articles were systematically summarized. Findings revealed four main categories of CAI applications: gamified platforms, general language-learning programs, assistive technology tools for reading, and adaptive learning computer software, which were used to enhance reading comprehension and vocabulary acquisition. Quasi-experimental designs dominated the research landscape, with a notable scarcity of randomized controlled trials (RCTs). Overall, most CAI interventions reported statistically significant effects on reading comprehension and vocabulary acquisition among LD and ELL students. Implications for practice and future research are discussed.

Citation: Njikem, J. (2026). Advancing EdTech for diverse learners: Recent trends in computer-assisted instruction for students with learning disabilities and English language learners. *International Journal of Technology in Education (IJTE)*, 9(3), 685-708. <https://doi.org/10.46328/ijte.6400>



ISSN: 2689-2758 / © International Journal of Technology in Education (IJTE).
This is an open access article under the CC BY-NC-SA license
(<http://creativecommons.org/licenses/by-nc-sa/4.0/>).



Introduction

Students with specific learning disabilities (SLDs) and English language learners (ELLs) often face diverse challenges when placed in inclusive classroom settings, including academic, attentional, emotional, and information-processing difficulties. This occurs because traditional instructional strategies for this group of learners often fail to provide the high-quality, individualized support and accessibility they require (Hopcan et al., 2023). Specific learning disabilities (LDs) are neurological disorders that affect the brain's capacity to receive, process, retain, and respond to information (National Joint Committee on Learning Impairments, 1990). SLDs can manifest in different ways, including listening, speaking, writing, reading, and performing mathematical calculations. The challenges faced by children with SLDs often hinder their ability to achieve age-appropriate academic success or meeting state-approved grade-level standards in areas such as oral expression, listening comprehension, written expression, basic reading skills, reading fluency, reading comprehension, and math calculations when provided with grade-level learning experiences (The National Center for Learning Disabilities, 2024; U.S. Department of Education, 2006).

According to the National Center for Learning Disabilities school-aged children with SLDs such as those with dyslexia, dyscalculia and dysgraphia still face learning challenges due to the lack of proper funding, intensive interventions, accommodations, and resources to support their academic success, even though they have the capacity to strive like their peers, yet they do not consistently receive the evidence-based services and support needed to fully support their learning potentials (NCLD, 2026). Furthermore, students categorized as English language learners (ELLs) often struggle to engage with traditional teaching methods because these methods often do not adequately meet their learning needs and preferences. Given the multifaceted challenges learners with SLDs and ELLs face in achieving academic success, integrating educational technologies, such as computer programs, has been pivotal in supplementing instruction for these students.

Research on the integration of computer programs into North American K-12 classrooms began in the 1960s, marking a significant technological revolution in education (Cuba, 2001). Since then, numerous studies have demonstrated that integrating educational technology (Edtech) tools into K-12 education can significantly impact teaching and learning (Tamim et al., 2011; Zheng et al., 2016). For instance, the National Center for Education Statistics survey found that during the 2019-2020 school year, approximately 45% of K-12 public schools reported that every student had access to a computer, while 37% confirmed that every student did. Furthermore, 58% of school leaders reported allowing all or some students to take computers home (National Center for Education Statistics, 2021).

Moreover, computer integration in K-12 settings has particularly benefited students with disabilities who often require specialized instruction and accommodations to succeed academically (Hasselbring & Glaser, 2000; Edyburn, 2013). One of the most significant advancements in special education is the use of computer-assisted instruction (CAI), which has shown promise in improving learning outcomes for students with learning disabilities (Stultz, 2017; Seo & Bryant, 2009).

What is Computer-Assisted Instruction?

Computer-assisted instruction (CAI) is an interactive teaching method in which students engage with a computer or software application to achieve specific learning objectives at their own pace and according to their abilities (Marzban, 2010; Floyd & Judge, 2012). This instructional approach not only delivers educational content but also incorporates ongoing monitoring and assessment of the learning process (Campbell et al., 2022). Over the past 30 years, research on integrating computer programs into classroom instruction has attracted considerable attention. Furthermore, numerous systematic reviews and meta-analyses have highlighted the effectiveness of CAI in improving students' learning outcomes by addressing diverse needs and providing a flexible, adaptive learning environment (Higgins & Raskind, 2005; Okolo & Ferretti, 1998; Sivaram & Ramar, 2014).

Therefore, findings indicate that the use of computer-assisted applications improved student performance, with an overall effect size of +0.15 compared with traditional instructional methods (Cheung & Slavin, 2013). The impact on students' performance varies by the type of technological tool. For example, Supplemental CAI programs, designed to deliver instruction tailored to students' assessed needs, have proven most effective, with an effect size of +0.18. In contrast, comprehensive programs, which address multiple dimensions of student learning, and computer-managed learning (CML) systems, which primarily use technology to oversee the learning process, demonstrate smaller effect sizes of +0.08 and +0.07, respectively (Cheung & Slavin, 2013). Moreover, a meta-analysis by Xie et al. (2020) reported a positive effect size of +0.38, indicating that CAI programs outperform conventional teaching strategies in enhancing mathematical achievement. Among the various types of CAI studied, inquiry-based CAI and Cooperative CAI were found to have a significant impact on students' mathematical performance (Xie et al, 2020).

Furthermore, studies adhering to the What Works Clearinghouse (WWC, 2022) have demonstrated that CAI incorporating features such as practice opportunities, self-correction, immediate corrective feedback, teacher-directed instruction, and motivational contingencies can yield statistically significant improvements in students' reading outcomes, including reading skills and phonemic awareness. For instance, meta-analyses and empirical studies have consistently found that CAI interventions produce small to moderate effect sizes in improving reading compared with control groups, with effect sizes ranging from $d = 0.32$ for reading skills to $d = 0.39$ for phonemic awareness, underscoring the positive impact of CAI on students' learning outcomes (Kim et al., 2017; Kunkel, 2015; Robinson, 2021).

Research Problem

Despite extensive research indicating CAI's effectiveness in enhancing students' outcomes, few recent systematic reviews and meta-analyses have been conducted on this topic (Kim et al., 2017; Kunkel, 2015; Robinson, 2021), and given the rapid evolution in computer programs that support reading instruction, it was necessary to clarify the types of CAI tools used in recent research to meaningfully support vocabulary development and reading comprehension for students with learning disabilities and English language learners. Building on previous reviews (Kim et al., 2017; Kunkel, 2015; Robinson, 2021), the study conducted a systematic literature review to summarize

trends in CAI for reading comprehension and vocabulary development among LDs and ELLs and to provide recommendations for classroom practice and future research.

Research Objective and Questions

The study rigorously mapped the current research landscape of CAI intervention studies, identified trends, and highlighted actionable pathways for classroom practice and future research. By focusing on recent CAI studies targeting reading comprehension and vocabulary development, the study synthesizes the latest evidence and provides a roadmap for instructional improvements. The following questions were formulated to drive the study.

- RQ1. What are the current integration trends in CAI tools designed to enhance reading comprehension and vocabulary skills among students with Learning Disabilities (LDs) and English Language Learners (ELLs)?
- RQ2. What methodological approaches have been employed in CAI research to investigate reading comprehension and vocabulary outcomes for students with LDs and ELLs?
- RQ3. What is the current evidence of CAI on improving the reading comprehension and vocabulary development of students with LDs and ELLs?

Theoretical Framework

Universal Designs for Learning

The Center for Applied Special Technology (CAST, 2017) defines UDL as a framework for improving and optimizing teaching and learning based on what we know about the human brain. CAST also describes UDL as a framework for teaching and learning that focuses on providing students with instructional materials and activities designed to make learning goals achievable for learners who differ in their abilities to receive, process, and express information (Orkwis & McLane, 1998). UDL helps educators address the diversity of learning in three main categories, beginning with Multiple Means of Engagement, which focuses on learner participation by intentionally designing instruction to motivate students based on their interests, strengths, and needs, and by providing choices of participation media (Floyd et al., 2024). For instance, some studies prefer small group work, manipulatives, discussion, interactive websites, or classroom response systems (Floyd et al., 2024).

Furthermore, multiple means of presentation address how learning occurs. Representation involves how content is presented, received, and interpreted. For example, some students benefit from a lecture format with guide notes, whereas others benefit more from text read aloud. Presenting the same information in different formats can benefit many students, and using multiple modalities provides more options for receiving and guiding comprehension (Floyd et al., 2024). Multiple means of action and expression are the third UDL principle, which addresses how to learn. Students are given choices of response modes, including physical, verbal, and visual. Optional modes could include access to tools, choices for demonstrating learning, and scaffolds (Floyd et al., 2024). The UDL lens was used to support our understanding of CAI integration in this study, which is designed to make learning accessible to all students, regardless of their unique learning needs, by emphasizing flexibility in teaching methods and materials (CAST, 2017)

Method

The systematic literature review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines for screening papers (Page et al., 2021). Both inclusion and exclusion criteria were established to identify peer-reviewed journal articles most relevant to the study's purpose. The table below presents the eligibility criteria (i.e., inclusion and exclusion) used in this study.

Table 1. Eligibility Criteria for Selected Studies

Domain	Inclusion Criteria	Exclusion Criteria
Population	LD and ELL students in K-12 through post-secondary college and university levels.	Studies with other student populations, such as students with autism or ADHD, were excluded except for those identified as having LDs or ELLs
Study Design	Study had to adhere to the following criteria's (1) use quasi-experimental designs (pretest-post-test control), randomized controlled trials (RCTs), baseline designs, and mixed-method designs. (2) Studies had to include an intervention group that participated in a CAI intervention. (3) CAI interventions were defined as studies where participants were randomly placed in a control or treatment group with a computer tool used for intervention.	Studies with qualitative designs were excluded
Time Frame	Only peer-reviewed journal articles published from January 2010 to December 2022 were included.	Studies published outside this period were excluded to prevent duplication with earlier reviews.
Study Outcomes	Only studies measuring students' reading outcomes in comprehension or vocabulary were included	Studies that measured other educational outcomes, such as writing, math motivation, cognition, or perceptions, were excluded, unless they also included measures of reading comprehension or vocabulary development
Publication Type	Only peer-reviewed journals were included	Reports, theses, and dissertations were not considered.
Language	Only studies published in English were included	Studies in other languages were excluded
Country of Publication	Europe, Australia, North and South America, Asia, or Africa.	No Exclusion

Search Procedure

A systematic search was conducted in Spring 2023 across six major academic databases: Google Scholar, ERIC, ACM Digital Library, Web of Science, ProQuest, and PsycINFO. This approach aimed to capture a comprehensive range of eligible quantitative studies on computer-assisted instruction (CAI) interventions for English Language Learners (ELLs) and students with learning disabilities (LD), in accordance with the PRISMA guidelines for reporting systematic reviews (Moher et al., 2009). These databases were selected for their broad coverage of psychology, technology, educational research, and special education, thereby ensuring access to high-quality, peer-reviewed literature. The search was conducted in Spring 2023 and identified peer-reviewed journal articles published between 2010 and 2022. The keywords and search terms outlined were combined using Boolean operators to encompass multiple dimensions of the research topic, including computer-assisted instruction (CAI), reading outcomes, and strategies to support children facing learning challenges:

"Reading Comprehension" OR "Vocabulary Development" OR Educational Technology OR Computers OR Software AND Reading Outcomes OR "Learning Disabilities" OR English Language Learners" OR "K-12 Education" OR "College"

The above Boolean search string was adapted and used in all six databases to comprehensively capture studies on computer-assisted instruction (CAI), reading outcomes, and interventions for LD and ELL students. These combined terms and operators were used across multiple databases to ensure a systematic and inclusive literature search.

Selection Process

The screening process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure a thorough, systematic review of eligible studies (PRISMA, 2020). An initial highly filtered search yielded 446 studies: 270 from Google Scholar and the remaining from databases including Web of Science, ACM Digital Library, PubMed, PsycINFO, ERIC, and Scopus. After removing 75 duplicate entries, 371 unique studies were screened for titles and abstracts against predefined inclusion and exclusion criteria, resulting in the exclusion of 43 studies. The next phase involved two independent reviewers who evaluated the remaining 320 articles. Furthermore, 302 participants were excluded for failing to meet the inclusion criteria. In total, 18 studies met all inclusion criteria and were selected for the review. As depicted in the PRISMA flow diagram below, this screening process ensured that only the most relevant and eligible studies were included in the final analysis.

Data Extraction and Analysis Process

To address the three research questions, core data domains were extracted and summarized across all 18 selected studies. First, an inventory of computer-assisted instruction (CAI) tools was compiled with detailed descriptions of each tool's unique functionalities and instructional features. Second, a summary of research methodologies, including research designs and data analysis methods, was compiled alongside specific demographic information about participants. Finally, the empirical findings were extracted and summarized to capture the evidence on CAI's

effectiveness in improving students’ reading outcomes.

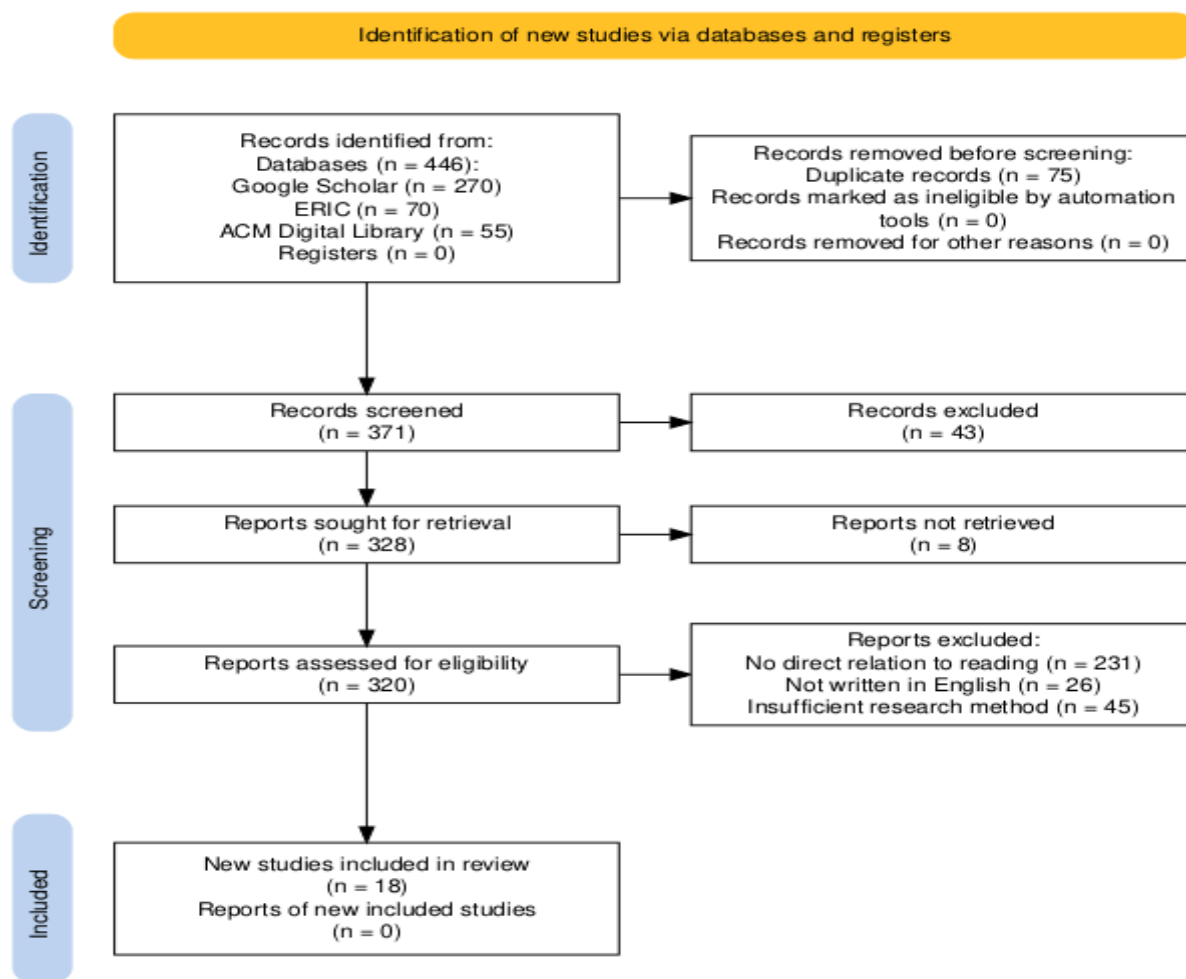


Figure 1. PRISMA Flowchart of Study Selection Process

Table 2 provides a summary analysis of all 18 selected studies relevant to this study, including the year of publication, country of origin, type of CAI tool, participants, design, data analysis technique, and key findings.

Table 2. A Summary Analysis of the 18 Included Studies

Authors & Year	Title	Country	CAI Applications	Design	Participants	Data Analysis	Key Findings and Interpretation
Park & Lee (2021)	Effects of E-books and Printed Books on EFL Learners' reading comprehension and grammatical knowledge	South Korea	ReadingGates	Quasi-experiment	97 5th- 6th elementary EFL students.	Descriptive statistics, ANOVA And the Turkey's Honestly Significant Difference (HSD) Test	Large time effect ($\eta^2 = .45$) indicates strong improvement across all groups. A small-to-moderate interaction effect ($\eta^2 = .07$) indicates a difference in improvement between groups. The tablet group achieved the largest gain (Mean difference, (MD) = 14.74), significantly larger than that of the print or

Authors & Year	Title	Country	CAI Applications	Design	Participants	Data Analysis	Key Findings and Interpretation
Meral & Nilgun (2020)	Computer-based reading text to support fourth graders' reading comprehension	Turkey	Multimedia-Based CAI with visuals (animated objects)	Quasi-experiment	60 4th graders	Kolmogorov-Smirnov Test Mann-Whitney U Test Wilcoxon Signed-Rank Test	control group. Presenting students with multimedia-Supported reading activities had a positive effect on their reading comprehension.
Berry (2021)	Level-up Learning: Video Games in an Online Class.	South Korea	SpaceteamESL	Quasi-experiment-mixed method	61 EFL college students	Descriptive statistics. T-tests	An increase in listening comprehension performance from the pretest (M = 13.03, SD = 3.86) to the posttest (M = 15.88, SD = 4.05), with the t-test results showing that this increase was significant (P < .01, $\alpha = 0.05$)
Abba, M. & Ali (2019)	Use of CAI to Improve Student Reading Skills in English Learners.	Nigeria	General CAI for reading skills	Quasi-experiment	40 secondary school students	Descriptive statistics	Extremely large effects favoring the experimental group as reading score increased from M=24.30 to 66.65 (Exp) vs 23.00-30.90 (control). Vocabulary retention also showed a very large effect
Zamora& Pittman (2018)	The Effects of two computer-based reading software programs on student reading performance.	USA	ABC Mouse & Starfall	Quasi-experiment	20 second-grade students		Improved reading levels for the five ABC-mouse participants who were categorized as below average on the pre-test reading benchmark, and for the three Starfall participants who were similarly categorized
Fenty&Washburn (2015)	Effects of Computer-assisted and teacher-led fluency Instruction on students at risk of reading failure.	USA	Quick Reads	Quasi-experiment	50 students	ANCOVA	A significant difference on the vocabulary subtest, $F(2, 49) = 3.76, p = .034$. A post hoc Tukey's HSD analysis revealed significant differences in vocabulary between the text-equivalent and time-equivalent computer groups ($p = .034$), favoring the time-equivalent group.
Sivaram & Ramar (2014)	Effects of CAI on the Achievement of learning disability students in	India	General CAI for English language learning	Quasi-experiment	50 high school students	Descriptive statistics T-test	Computer-assisted instruction was more effective than the traditional lecture method in teaching and learning English

Authors & Year	Title	Country	CAI Applications	Design	Participants	Data Analysis	Key Findings and Interpretation
	English						
Rusmanay anti&Hana ti (2018)	Teaching Reading Comprehension by using computer-based Reading: An experimental study in Indonesian English language teaching.	Indonesia	General computer-based reading methods	Quasi-experiment	60 students	T-test	A reported significant difference of $t=1.47 < 1.86$ ($P > .05$), indicating groups were statistically homogeneous at baseline.
Floyd & Judge (2012)	The Efficacy of Assistive Technology on Reading Comprehension for Post-secondary Students with Learning Disabilities.	USA	ClassMate-Reader	multiple baselines across participants' designs.	6 postsecondary students with LD (Four males and two females)	Improvement Rate Difference (IRD)	Some students performed better with the use of the Classmate-Reader, whereas others demonstrated slight improvements
Stetter & Hughes (2011)	Computer-assisted instruction to promote comprehension in students with learning disabilities.	USA	CAI for reading comprehension strategies	Single-subject multiple baselines	29 students	Pearson's Coefficient	There was a reported descriptive improvement in the intervention group, which increased from $M=10.95$ to 13.20
Marzban (2010)	Improving reading comprehension through computer-assisted language Learning in Iranian Intermediate EFL students.	Iran	Computer-Assisted Language Learning (CALL)	Pre-test/post-test experimental Solomon design	60 students	Two-way ANOVA	ANOVA showed a significant group effect ($F(3,57)=5.14$, $p < .01$), indicating that CALL significantly improved reading comprehension. However, no effect size or descriptive statistics were reported
Marsa & Augustina (2021)	The Effect of Kahoot! Game to Teaching Reading Comprehension Achievement	Indonesia	Kahoot!	Mixed Method	39 students of an English language program	Descriptive statistics Normality, Homogeneity, and an independent t-test	A very large effect size of $d=1.20$ favors the experimental group (Kahoot), which produced substantially higher gains than the conventional instruction
Vahdat &	The Effect of	Iran	Runaway	Quasi-	40 learners	T-test and	There was a reported

Authors & Year	Title	Country	CAI Applications	Design	Participants	Data Analysis	Key Findings and Interpretation
Behbaham (2013)	Video Games on Iranian EFL Learners' Vocabulary Learning.			experiment	(20 males and 20 females, ages 23 to 27)	correlation coefficient	significant difference ($t=3.689, p<.05$) favoring the experimental group. However, no standardized effect size is provided
Gunel & Top (2022)	Effects of Educational video games on English vocabulary learning and Retention.	Turkey	An open-world RPG educational video game.	Mixed Methods	96 students (Middle School)	T-test Mann-Whitney U test Open coding	A very large effect favoring the experimental group. Post-test scores (Exp M=22.27, Control M=16.63 indicate a strong impact of the RPG educational video game.
Katamba (2022)	Vocabulary Enhancement Through Multimedia Learning Among 7th EFL Students.	Indonesia	Educational online Games (OG), educational videos (V)	Pre-test post-test design	93 EFL students (Grade 7)	T-tests ANOVA	All three groups showed extremely large pre- and post-gains, with the OG and V groups improving substantially.
Alhebshi & Gamlo (2022)	The Effects of Mobile Game-Based Learning on Saudi EFL Foundation Year Students' Vocabulary Acquisition.	Saudi Arabia	Quizizz	Mixed Method	56 students	T-test (paired-samples t-test, and independent samples t-test)	A significant difference in scores between the 28 participants who received a mobile game-based learning intervention (MGBL) ($M = 19.50, SD = 4.44$) and the 28 participants in the control group ($M = 15.43, SD = 5.63$), with the intervention group demonstrating better vocabulary learning ($t = 3.00, p = 0.04$)
Toonder & Sawyer (2021)	The impact of adapted computer-assisted instruction on reading comprehension: Identifying the main idea	USA	Adaptive CAI (Digital Comprehension Program)	Randomized Control Trial (RCT)	47 upper elementary struggling readers'	Multiple Regression	A large effect favoring the treatment group (post-test m: Treatment 77%, control=50%. Regression also indicates a significant condition effect ($B=.24, p<.001$))
Campbel et al (2022)	The Efficacy of a computer-adaptive reading program on fifth-grade students' reading achievement scores.	USA	Adaptive CAI (Computer-Adaptive Reading Program)	Quasi-experiment	900 fifth-grade students	Analysis of Covariance (ANCOVA)	The baseline score on the comprehension assessment differed significantly between groups ($t(11,491)=5.7, p<.001$; comprehension: $t(10,869)=1.9, p<.001$).

Results

Overview of Student Population

The search yielded 18 peer-reviewed journal articles involving 1804 students, most of whom were second- to upper-elementary students (about 71%) who primarily struggled with reading in the early and upper elementary grades. College and post-secondary students accounted for about 29% of the population. Additionally, regarding specific disability types, most studies focused on students with specific learning disabilities, such as struggling readers with dyslexia and English language learners or EFL/ESL students in other settings, while the remaining focused on participants with learning disabilities in general.

The Geographic Distribution of Publications by Country

Regarding the geographical distribution of the 18 studies, 11 studies (61.1%) were conducted in Asian countries such as Indonesia, Iran, South Korea, India, Turkey, and Saudi Arabia, followed by North America with 6 (33.3%) studies conducted exclusively in the United States, and 1 study (5.6%) carried out from Africa in Nigeria.

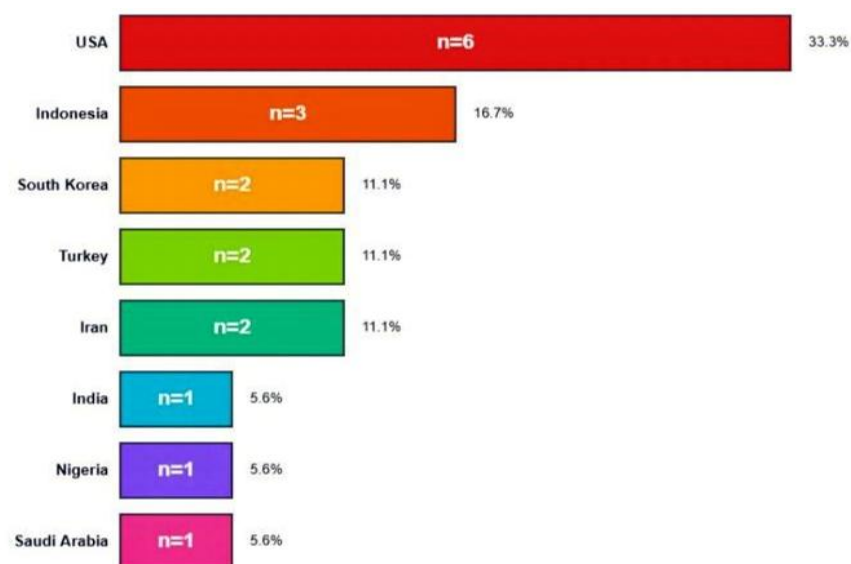


Figure 2. Distribution of Studies by Country

As shown in Figure 2, 18 studies were selected for this review; 11 (61.1%) were conducted in Asian countries, including Indonesia, Iran, South Korea, India, Turkey, and Saudi Arabia. Six (33.3%) studies were conducted exclusively in the United States of America, and 1 (5.6%) was conducted in Nigeria.

RQ1: What are the current integration trends in CAI tools designed to enhance reading comprehension and vocabulary skills among students with Learning Disabilities (LDs) and English Language Learners (ELLs)?

As shown in Figure 3, six of the studies (21.1%) used video games such as Spaceteam, ESL Kahoot, Quizizz, and

Runaway (Vahdat & Behbaham, 2013; Berry, 2021; Marsa & Augustina, 2021; Gunel & Top, 2022; Alhebshi & Gamlo, 2022). Additionally, four studies (15.8%) employed general CAI programs for reading and language learning, such as ABC Mouse, Starfall, Quick Read, and other computer-based reading methods (Zamora & Pitman, 2018; Fenty & Washburn, 2015; Abba & Ali, 2019). Furthermore, two studies (n=2) used multimedia-based CAI tools, visual/animated CAI, and educational videos for reading interventions (Meral & Nilgum, 2020; Katemba, 2022). Furthermore, n=2 studies used assistive technology tools for reading, such as ClassMate-Reader and Tablets (Floyd & Judge, 2012; Park & Lee, 2021). Meanwhile, the remaining studies employed other CAI programs, such as adaptive learning software and computer-assisted language learning (CALL), highlighting the range of CAI tools available in special education, particularly for second-language learning (Toonder & Sawyer, 2021; Campbell & Geo, 2022). This summary trend highlights the types and categories of CAI programs used in research from 2010 to 2022 to enhance students' reading outcomes (see Table 3).

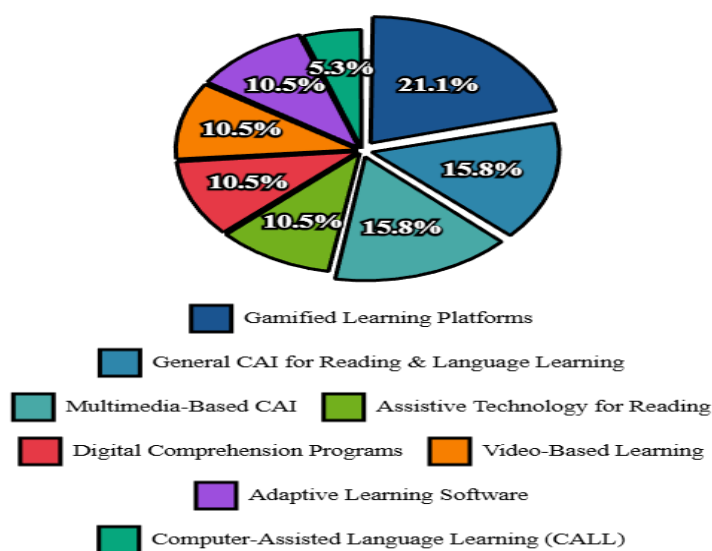


Figure 3. A Summary Analysis of the Types of CAI Tools/applications

Table 3. A Summary of the Categories and Types of CAI Applications/tools used in Intervention Studies

Categories	Types of CAI applications included
Gamified Platforms	SpaceteamESL, Runaway, Kahoot, Quizizz, Educational video games
General CAI for Reading & Language Learning	ABC Mouse, Starfall, Quick-Reads, General computer-based reading methods, and CALL
Assistive Technology for Reading	ClassMate-Reader and ReadingGates
Adaptive Learning computer Programs	Computer-Adaptive Reading Programs (CARP), Digital adaptive systems

Gamified Platforms

Gamified platforms are educational video games that incorporate features such as interactive storytelling, badges,

points, and challenges to enhance students' engagement, enjoyment, and motivation. Six studies (Alhebshi & Gamlo, 2022; Marsa et al., 2021; Berry, 2021; Vahdat & Behbahani, 2013; Gunel & Top, 2022) used different video games in their reading interventions. For instance, Quizizz, a computer learning platform designed to enhance classroom learning by making it more interactive, engaging, and enjoyable, was used with 56 university students learning English as a Foreign Language (EFL). The platform offers numerous features that can enable teachers to efficiently create gamified resources, conduct formative assessments, host live sessions, assign homework, and implement differentiated instruction, all while benefiting from real-time performance reports (Alhebshi & Gamlo, 2022). Marsa et al. (2021) leveraged Kahoot, a video game that enables educators to design, disseminate, and engage students in quiz-based activities, creating a dynamic classroom environment akin to a game show. Kahoot was used in this study to create interesting quizzes, discussions, and surveys to teach reading comprehension.

Additionally, Berry (2021) examined SpaceteamESL, an engaging, enjoyable game designed for English language learning that students can play with their peers on smartphones or tablets. According to Berry, this computer game was selected because it is freely downloadable and compatible with mobile devices (Smith, 2012), making it easily accessible and customizable to match students' skill levels, thereby enhancing their oral and listening fluency. Vahdat and Behbahani (2013) used Runaway, a road-adventure video game, which outperformed other methods of teaching English as a Foreign Language (EFL) vocabulary. Lastly, Gunel and Top (2022) developed and tested an open-world RPG educational video game in which students were exposed, without their awareness, to more than 100 popping name tags and were expected to memorize object names without recognizing them.

General CAI tools for Language Learning

General computer-assisted tools for language learning are multimedia resources that provide drill-and-practice and interactive platforms to support vocabulary, grammar, comprehension, and communication skills in early readers. Zamora and Pittman (2018) incorporated two computer-based reading software programs, Starfall and ABC Mouse. In their study, Starfall was used to support language development for preschool through second-grade children, including English Language Learners (ELLs). Through repetition, engaging images, interactive activities, games, music, and stories, the platform offers a diverse range of reading levels to promote the development of reading skills. ABC Mouse is an engaging educational platform for children aged 2-8. The curriculum encompasses a wide range of subjects, including reading, mathematics, science, art, and music. With more than 850 lessons organized into 10 levels, the program provides a fun, interactive learning experience through activities such as games, books, puzzles, and songs. Furthermore, Marzban (2010) used a computer-assisted language learning (CALL) program with 60 Iranian students. CALL provides engaging, communicative support for listening, speaking, reading, and writing with substantial use of the Internet. Because it concerns language learning, CALL is sometimes considered a subfield of computer-assisted instruction.

Assistive Technology Programs for Reading

Assistive technology programs for reading are specialized tools that use computers to support learners with

reading difficulties. For instance, Fenty et al. (2015) used QuickReads as an instructional tool to regulate vocabulary aligned with grade-level expectations, aiming to improve oral reading fluency, as noted by Hiebert (2005). The app is designed to ensure accessibility across print and digital formats, thereby enhancing usability in diverse instructional settings. The app is designed for new readers or students seeking quick, engaging reading experiences. The QuickReads app incorporates vocabulary suitable for third graders and allows repeated exposure to similar words across various passages to improve vocabulary.

Furthermore, Floyd and Judge (2012) used the ClassMate-Reader with six postsecondary students with learning disabilities, a portable text reader designed to promote reading and learning independence. With this device, students can listen to the audio version of the text or other materials while following the highlighted text on the screen. The Classmate-Reader features a touch screen or navigation buttons that allow participants to configure their preferences. Files can be stored on a removable Secure Digital (SD) memory card, allowing students to adjust the reading rate, volume, and highlighting features to meet their needs. The text's color, font, style, and highlighting coloration may also be modified to suit the learner.

Meanwhile, Park and Lee (2021) used ReadingGates with 97 5th- 6th elementary EFL students, a digital English reading platform offering approximately 2,000 online and print English books tailored to various proficiency levels. The ReadingGate software aims to make reading fun and engaging for kids. It provides audiobooks, eBooks, and paperbacks to improve English proficiency. The software also offers worksheets for additional practice, a scoreboard to foster motivation, and regular updates to its book selection to keep the material current. Ultimately, ReadingGates can foster a happy reading habit that opens new possibilities for kids.

Adaptive Learning Computer Programs

Adaptive learning computer platforms leverage artificial intelligence to adapt content to learners. For example, Campbell et al. (2022) used supplemental computer-adaptive reading software (CARP). This individualized reading application uses algorithms to adjust the difficulty of the reading materials and provides real-time evaluation of the student's progress. This offers an adjustable curriculum and a formative tool. As noted by Campbell and colleagues, findings from formative assessments are integrated into interactive digital lessons tailored to students' individual learning needs. This ensures that instruction is responsive and effective, fostering a more personalized educational experience. Meanwhile, Toonder and Sawyer (2021) used a digital comprehension program to enhance the reading abilities of 47 upper elementary students who were struggling readers. Through interactive digital materials, promote critical thinking and knowledge acquisition. The program aims to enhance reading outcomes for a range of students through tailored strategies and engaging materials. This emerging trend shows that researchers have leveraged four main categories of CAI tools to support reading outcomes: video games, general CAI tools for language learning, assistive technology software for reading, and adaptive learning computer programs. Moreover, the growing emphasis on gamification, adaptive learning, and digital comprehension programs suggests that AI-driven, immersive, and intelligent tutoring systems will be crucial for second-language acquisition and reading development.

RQ2: What Methodological Approaches have been used in CAI Research?

All eighteen (n=18) quantitative studies employed four main research designs: quasi-experiments, baseline designs, randomized controlled trials (RCTs), and mixed method designs.

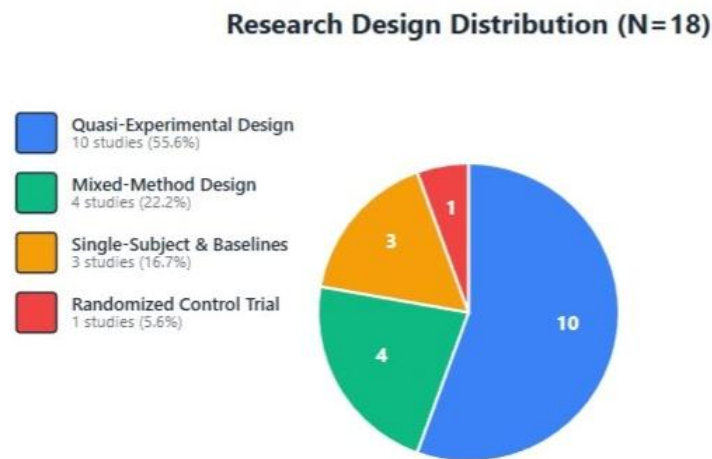


Figure 4. The Research Designs employed in CAI Intervention Studies from 2010 to 2022

As shown in Figure 4, the distribution indicates that most studies used a quasi-experimental design (10, 55.6%). More specifically, the pretest-post design was the standard approach for all quasi-experiments, mainly because it is well-suited to educational settings where random assignment of participants is not possible. Moreover, four (n=4, 22.2%) studies used a mixed-methods design, combining quantitative and qualitative approaches for data collection. The single-subject and baseline designs were the second most common, with three studies (16.7%), including 1 using a multi-baseline and the other a single-subject, multiple-baseline approach. Lastly, it was surprising to see that only 1 study (5.6%) used a randomized controlled trial (RCT) design.

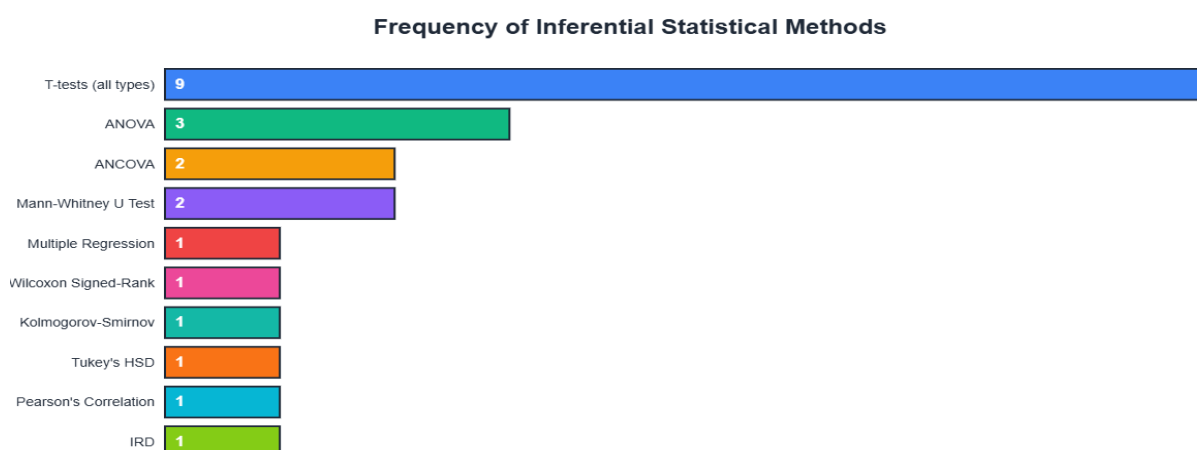


Figure 5. The Distribution of Data Analysis Types used in CAI Interventions from 2010 to 2022

As shown in Figure 5, all 18 (100%) studies employed various inferential statistical methods. For instance, parametric tests such as t-tests, including paired and independent-samples t-tests, were used across 9 studies to

compare groups (Berry, 2021; Sivaram & Ramar, Vahdat, 2014; Behbaham, 2013; Gunel & Top, 2022; Katemba, 2022; Alhebshi & Gamlo, 2022). Furthermore, both analysis of variance (ANOVA), such as two-way and Turkey's HSD post-hoc test, and multivariate analysis of variance (MANOVA) were used in 5 studies to evaluate the effectiveness of CAI interventions (Park & Lee, 2021; Marzban, 2010; Fenty & Washburn, 2015; Campbell & Gao, 2022). Furthermore, nonparametric methods, such as the Mann-Whitney U Test, were used in 2 studies (Meral & Nilgun, 2020; Gunel & Top, 2022) to compare group distributions when the data were not normally distributed. Other inferential statistical methods, such as multiple regression, correlation, the Kolmogorov-Smirnov Test, and the Wilcoxon Signed-Rank Test, were also used in some studies. Only a few studies calculated effect sizes, which can provide a better understanding of the practical significance of the results beyond statistical significance.

RQ3. What is the evidence of CAI interventions on improving reading comprehension and vocabulary development of students with LDs and ELLs?

Reading Comprehension

Most (n=12) studies that used different CAIs with varying sample sizes to enhance students' reading comprehension reported positive results. For example, Meral and Nilgun (2020) observed a significant post-test improvement in reading comprehension among 60 fourth-grade students randomly assigned to either the experimental group, which used a computer-based reading program, or the control group, which used a traditional paper-based format. However, there was no significant difference in reading comprehension between the pretest and posttest in the control group. Additionally, Spaceteam was played among 61 EFL college students aged 18-21 enrolled in a mandatory 15-week "College English" course, in which EFL communication skills (i.e., speaking and listening) were taught. The pretest-posttest design was used to compare improvements in listening comprehension between the EG and CG groups. The findings indicated an increase in listening comprehension performance from the pretest (M = 13.03, SD = 3.86) to the posttest (M = 15.88, SD = 4.05) with the t-test results showing that this increase was significant ($P < .01$, $\alpha = 0.05$), with students in the Spaceteam ESL experimental group demonstrating higher listening comprehension than those in the control group (Berry, 2021).

Furthermore, Park and Lee (2021) studied 97 students (51 boys, 46 girls; ages 10-12) enrolled in fifth or sixth grade at an elementary school in South Korea. All participants were taught English once or twice a week for 11 weeks, either through extensive reading on tablets (n = 42), printed books (n = 32), or regular textbook-based instruction (n = 23) as a control. They found that tablet users showed the greatest improvements in literal comprehension (the most basic level of understanding a text, such as reading between the lines). Post-hoc HSD analysis revealed that the tablet group had the highest mean gain (MD = 14.74), which was significantly greater than those of the print and control groups. Although the print group (MD = 10.59) scored higher than the control group (MD = 6.87), this difference was not statistically significant. A large time effect ($\eta^2 = .45$) indicates significant improvement across all groups. Meanwhile, a small-to-moderate interaction effect ($\eta^2 = .07$) suggests differences in improvement between groups. The tablet group achieved the largest gain (MD = 14.74), significantly surpassing those of the print and control groups. Overall, the findings suggest that extensive tablet-based reading is the most effective CAI intervention for improving literal reading comprehension among EFL

learners.

Furthermore, Marzban (2010) randomly assigned 60 female students aged 18 to 25 to the treatment and control groups. After teaching reading comprehension to both groups using CALL, the other group was taught traditionally, and a standardized proficiency test was used to measure their listening, reading, and sub-skills, such as grammar and vocabulary. There was a statistically significant difference in reading comprehension scores between the two groups at the $P < 0.05$ level, as the calculated F-ratio of 5.14 exceeded the critical value of 4.79. That is, ANOVA showed a significant group effect ($F(3,57) = 5.14, p < .01$), indicating that CALL significantly improved reading comprehension. However, no effect size or descriptive statistics were reported. The findings suggest that using CALL can improve students' reading comprehension. Campbell et al. (2022) also reported a statistically significant effect on reading comprehension among 900 fifth graders who used a computer-adaptive reading program (CARP). Students in the intervention group received at least 30 minutes per week of supplemental computer-adaptive reading instruction. Reading levels were measured using participants' initial achievement percentiles on their annual formative assessment and were further grouped into level 1 (students scoring below the 20th percentile), level 2 (students scoring between the 21st and 40th percentiles), and level 3 (students scoring above the 40th percentile). Therefore, the baseline score on the comprehension assessment differed significantly between groups ($t(11,491) = 5.7, p < .001$; comprehension: $t(10,869) = 1.9, p < .001$).

However, some studies reported mixed findings in students' reading comprehension. For instance, there was no significant difference among the three groups on the comprehension subtest, $F(2, 49) = 1.06, p = .357$. Among six post-secondary students with learning difficulties, results varied, with some demonstrating improved performance when using the Classmate Reader (Fenty et al., 2015; Floyd & Judge, 2012). The overall comprehension scores improved; however, individual results varied across studies. CAI was used to enhance reading comprehension for some students, irrespective of age or learning environment. Nonetheless, the effectiveness of CAI was influenced by its implementation and the characteristics of the learners involved. (Stetter and Hughes, 2011; Abba et al., 2019; Zamora and Pittman, 2018; Sivaram and Ramar, 2014).

Overall, the summary indicates significant improvements in reading comprehension across age groups or settings; however, the effectiveness of these interventions depends on implementation methods and specific participant characteristics (Stetter & Hughes, 2011; Abba et al., 2019; Zamora & Pittman, 2018; Sivaram & Ramar, 2014). Therefore, CAI indicates a significant potential to improve reading comprehension and related skills, though its effectiveness remains variable.

Vocabulary Development

Seven intervention studies ($n = 7$) reported students' vocabulary outcomes, with findings generally indicating positive, significant effects across diverse educational settings. For instance, 40 intermediate EFL learners who used the "Runaway" video game outperformed those who used traditional vocabulary-learning methods, with males outperforming females (Vahdat & Behbahani, 2013). A significant improvement in vocabulary was observed among 50 third graders using the Quick Reads software, as evidenced by a significant difference in the

vocabulary subtest, $F(2, 49) = 3.76, p = .034$. A post hoc Tukey's HSD analysis revealed significant differences in vocabulary between the text-equivalent and time-equivalent computer groups ($p = .034$), favoring the time-equivalent group (Fenty et al., 2015). Alhebshi and Gamlo (2022) also found a significant difference in scores between the 28 participants who received a mobile game-based learning intervention (MGBL) ($M = 19.50, SD = 4.44$) and the 28 participants in the control group ($M = 15.43, SD = 5.63$), with the intervention group demonstrating better vocabulary learning ($t = 3.00, p = .004$). A large effect size ($d = 0.08$) was observed, indicating strong statistical significance.

Furthermore, in a large-scale study of 900 fifth graders, Campbell et al. (2022) employed a computer-adaptive reading program (CARP) and demonstrated statistically significant gains in vocabulary. Students' reading levels were measured using the Station's Indicators of Progress Advanced Reading (ISIP-AR). Campbell and colleagues found a significant difference in mean vocabulary gains between the treatment and control groups, $F(1, 897) = 4.112, p = .043, \eta^2 = 0.13$, after adjusting for pretest scores. Meanwhile, Zamora and Pittman (2018) observed vocabulary skill development in 20 fourth-grade students who were randomly assigned to two comparison groups. The findings revealed improved reading levels for the five ABC-mouse participants who were categorized as below average on the pre-test reading benchmark, and for the three Starfall participants who were similarly categorized. Lastly, Gunel and Top (2022) reported higher vocabulary learning and retention scores among 48 students who used educational video games than among those who used traditional methods

Discussion

This review examines trends in the integration of computer-assisted instruction (CAI) in improving reading comprehension and vocabulary acquisition among students with learning disabilities (LDs) and English language learners (ELLs). The findings for the first research question indicate that four main categories of CAI tools, including video games, general CAI programs for language learning, assistive technology tools for reading, and adaptive learning software, have been integrated to enhance reading comprehension and vocabulary development for students with LDs and ELLs. These findings align with Universal Design for Learning (UDL) principles, which encourage teachers to use multiple means of engagement, representation, and action and expression to support diverse learners in the classroom (Rose & Meyer, 2002). Applying UDL in classrooms involves removing learning barriers (CAST, 2020; Dinnebeil et al., 2013), using engaging materials, motivating students, and maintaining consistency. Teachers present accessible content and offer diverse activities to assess knowledge and provide tailored support (CAST, 2018; Pisha & Coyne, 2001).

However, some CAI interventions did not explicitly outline criteria for selecting UDL-aligned CAI tools (Rose & Meyer, 2002). According to Floyd et al. (2024), UDL principles enable teachers to incorporate technology in diverse ways to support all learners. Therefore, embedding UDL principles in the selection and implementation of future CAI tools and programs in intervention studies can help educators provide students with multiple formats for engaging with text, thereby enhancing their ability to comprehend complex reading materials. UDL principles can facilitate varied modes of representation by incorporating tools such as speech-to-text applications, customizable digital text, highlighting, annotations, and visual aids. Additionally, UDL can promote multiple

means of engagement through interactive components, such as quizzes, polls, and activities within digital texts, helping to sustain student attention (CAST, 2018).

Methodologically, all 18 reviewed studies used quantitative designs to evaluate the effectiveness of computer-assisted instruction (CAI). The most common design was a quasi-experimental pretest-posttest design, in which CAI was primarily compared with traditional teaching methods. This design allowed researchers to assess CAI's impact across diverse educational settings and student populations (Floyd & Judge, 2012; Fenty et al., 2015). Additionally, most studies met the What Works Clearinghouse standards for rigorous research, employing strong methodologies such as randomized controlled trials (RCTs). However, only one study used a longitudinal design, while the others focused primarily on short-term outcomes. This lack of attention to long-term effects may create a significant gap in the literature, leaving unanswered questions about the sustained impact of CAI on reading skills (Kunker, 2015).

Furthermore, despite noted differences in vocabulary and reading comprehension outcomes, the overall findings provide evidence that CAI effectively enhances vocabulary acquisition and reading comprehension in LD and ELLs. Children in the experimental groups who used CAI tools demonstrated significant improvements in reading comprehension, particularly in literal understanding and primary concept recognition (Meral & Nilgun, 2020; Park & Lee, 2021). Adaptive CAI has also produced promising results, particularly for struggling readers, who have benefited from tailored instruction (Toonder & Sawyer, 2021). Research shows that CAI can improve vocabulary learning, with gamified platforms boosting motivation and reducing cognitive load (Alhebshi & Gamlo, 2022), and video games outperforming traditional methods (Vahdat & Behbahani, 2013). The success of CAI also relies on proper implementation and instructional features (Kim et al., 2017). However, some studies report vocabulary gains but not improvements in reading fluency or comprehension (Fenty et al., 2015), suggesting that outcomes may depend on the type of CAI tool, the setting, and the learner's needs.

Limitations of the Study

Although the study highlights current trends in CAI tools and the effectiveness of CAI in enhancing student reading outcomes, it also notes several limitations relative to previous studies. For example, other studies, such as those by Kim et al. (2017), used larger databases and broader inclusion criteria, thereby supporting a more comprehensive synthesis of the current research. As a result, the limited search strategy employed in this study may have omitted some eligible studies, particularly those published outside the designated timeframe (2010–2022) or in non-peer-reviewed journals. Furthermore, Robinson's (2021) study encompasses a broader range of student populations, yielding more specific results and effect sizes, including those with multiple disabilities and diverse linguistic backgrounds. In contrast, this study's narrower scope limits its generalizability to students with learning disabilities (LDs) and English language learners (ELLs). These limitations suggest that the results may not reflect the experiences and needs of all students. Therefore, although the current literature review covers broad CAI interventions, it does not thoroughly investigate the potential of innovative CAI tools and programs, including those that use artificial intelligence, which limits the relevance of its results to individuals seeking more recent instructional CAI tools.

Conclusions

The study identifies a wide range of evidence-based computer-assisted instructional (CAI) tools and programs used to improve reading outcomes for students with learning disabilities and English language learners, and it summarizes the research methodologies used in recent CAI intervention studies. Most studies report significant gains in reading comprehension and vocabulary. However, some studies yielded mixed results or no significant differences in certain areas, underscoring the importance of thoughtful CAI integration and attention to individual student needs. Furthermore, recent studies have increasingly focused on sophisticated, interactive digital tools such as video games and adaptive learning software. This trend underscores the expanding role of technology in education and the ongoing pursuit of innovative methods to support students with learning disabilities and English language learners.

Overall, this review presents current research trends on the use of CAI to enhance reading outcomes for students with learning disabilities and English language learners. It identifies four main evidence-based CAI tools, such as video games, general language-learning CAI programs, AT tools for reading, and adaptive learning software that have been used in research to enhance achievement, while underscoring the need for ongoing research to address remaining gaps. Ultimately, the findings affirm that when thoughtfully selected and implemented, CAI tools can play a pivotal role in enhancing students' reading outcomes and directly creating a more inclusive, engaging, and supportive classroom environment for students with learning disabilities and English language learners.

Recommendations

Further Research

The findings highlight several implications for future research in the effective integration of computer-assisted tools for students with learning disabilities and English language learners. Future researchers may leverage other experimental designs, such as randomized control trials (RCTs), to compare CAI tools for students at risk of specific learning disabilities, the most prevalent disability category in K-12 settings. Such studies should identify which aspects or modalities of CAI are most effective in improving learning outcomes for this group. Also, to maximize classroom use, future researchers may also investigate how intervention factors, such as duration of use, session frequency, and integration with traditional instructional approaches, affect the overall success of CAI for students with LD. Longitudinal research experiments are needed to examine the impact of CAI on diverse learning outcomes, such as motivation and engagement, over sustained periods among students, to inform the development of more engaging and effective CAI interventions.

Additionally, integrating CAI tools with embedded adaptive AI features can be crucial for meeting the specific learning needs of LD and ELL learners and for providing more personalized, targeted support. Lastly, the What Works Clearing House (WWC) principles provide a standard for evidence-based interventions, and they should continue to serve as a benchmark for future CAI interventions that encompass a diverse and equitable range of participant characteristics over extended longitudinal periods. This will enable the measurement of students' distal reading outcomes beyond proximal outcomes.

Classroom Practice

Integrating computer-assisted instructional tools to supplement reading instruction can significantly enhance reading outcomes for struggling readers with learning disabilities. Some experimental studies have demonstrated CAI's efficacy in improving reading outcomes. Furthermore, K-12 teachers should incorporate specific CAI tools to support reading comprehension and vocabulary development for both LD and ELL students. For instance, gamified platforms such as Kahoot and Quizizz can be integrated for older ELL students to increase classroom engagement and support formative assessment, particularly by motivating students and serving as valuable resources for educators. Meanwhile, SpaceteamESL is suitable for both elementary and secondary ELLs. Furthermore, teachers should integrate general CAI programs for language learning, such as ABC-Mouse, Starfall, QuickReads, and CALL, to support language development for preschoolers through grade 3 who are struggling with reading and beginning English.

Furthermore, assistive technology tools and devices for reading, such as ClassMate-Readers and Reading-Gates, should be used across all grades to accommodate and support independent reading for students with reading disabilities. Meanwhile, Computer-assisted language learning (CALL) should be integrated into college and postsecondary English language learners' classrooms for classroom support, and adaptive learning programs are more suitable for middle and high school struggling readers and intermediate ELLs.

However, it is important for educators to use CAI programs only to supplement reading instruction, not to replace evidence-based strategies. Additionally, when selecting CAI tools, teachers should prioritize those that offer multimodal experiences to maximize student engagement and understanding. Specifically, CAI programs should support reading instruction, particularly in areas where this group of learners often struggles, such as comprehension and vocabulary development. Lastly, teachers and school districts should effectively integrate the UDL framework when selecting and adopting CAI tools for classroom accommodations.

Statements and Declarations

Acknowledgments/Notes: Not applicable.

Use of Generative AI and AI-Assisted Technologies: During the preparation of this work, the author used Grammarly AI/editor to enhance the clarity, grammar, punctuation, and tone. After using this tool/service, the author reviewed and edited the content as needed and takes full responsibility for the content of the publication.

Supplementary Materials: Not applicable.

Author Contributions: Not applicable.

Funding: Not applicable.

Data Availability: Not applicable.

Ethics Approval: Not applicable.

Informed Consent: Not applicable.

Conflicts of Interest: Not applicable.

References

*: *Studies included in the systematic literature review*

Alsamadani, H. (2022). Dictogloss in Saudi EFL Context: Potential Effects on Students' Writing Skill and Attitudes towards Learning English. *Arab World English Journal*, 13(1), 27–37. <https://doi.org/10.24093/awej/vol13no1.2>

*Abdullah Alhebshi, A., & Gamlo, N. (2022). The Effects of Mobile Game-Based Learning on Saudi EFL Foundation Year Students' Vocabulary Acquisition. *Arab World English Journal*, 13(1), 408–425. <https://doi.org/10.24093/awej/vol13no1.27>

*Berry, D. (2021). *Level-up Learning: Video Games in an Online Class*.

Bertoni, S., Franceschini, S., Puccio, G., Mancarella, M., Gori, S., & Facoetti, A. (2021). Action Video Games Enhance Attentional Control and Phonological Decoding in Children with Developmental Dyslexia. *Brain Sciences*, 11(2), 171. <https://doi.org/10.3390/brainsci11020171>

Bertoni, S., Franceschini, S., Puccio, G., Mancarella, M., Gori, S., & Facoetti, A. (2021). Action Video Games Enhance Attentional Control and Phonological Decoding in Children with Developmental Dyslexia. *Brain Sciences*, 11(2), 171. <https://doi.org/10.3390/brainsci11020171>

*Campbell, L. O., Howard, C., Lambie, G. W., & Gao, X. (2022). The efficacy of a computer-adaptive reading program on grade 5 students' reading achievement scores. *Education and Information Technologies*, 27(6), 8147–8163. <https://doi.org/10.1007/s10639-022-10953-5>

Cheung, A. C. K., & Slavin, R. E. (2013). The effectiveness of educational technology applications for enhancing mathematics achievement in K-12 classrooms: A meta-analysis. *Educational Research Review*, 9, 88–113. <https://doi.org/10.1016/j.edurev.2013.01.001>

Cuban, L. (2003). *Oversold and underused: Computers in the classroom* (1st Harvard University Press paperback ed). Harvard University Press.

Edyburn, D. L. (2013). Critical Issues in Advancing the Special Education Technology Evidence Base. *Exceptional Children*, 80(1), 7–24. <https://doi.org/10.1177/001440291308000107>

Edwards, B. I., & Cheok, A. D. (2018). Why Not Robot Teachers: Artificial Intelligence for Addressing Teacher Shortage. *Applied Artificial Intelligence*, 32(4), 345–360. <https://doi.org/10.1080/08839514.2018.1464286>

*Fenty, N., Mulcahy, C., & Washburn, E. (2015). Effects of Computer-Assisted and Teacher-Led Fluency Instruction on Students At Risk for Reading Failure. *Learning Disabilities*.

*Floyd, K. K. (2012). The Efficacy of Assistive Technology on Reading Comprehension for Postsecondary

Students with Learning Disabilities. 8(1).

- Franceschini, S., Trevisan, P., Ronconi, L., Bertoni, S., Colmar, S., Double, K., Facoetti, A., & Gori, S. (2017). Action video games improve reading abilities and visual-to-auditory attentional shifting in English-speaking children with dyslexia. *Scientific Reports*, 7(1), 5863. <https://doi.org/10.1038/s41598-017-05826-8>
- *Gözüküçük, M., & Günbaş, N. (2020). Computer-Based Reading Texts to Support Fourth Graders' Reading Comprehension. *GIST – Education and Learning Research Journal*, 21, 47–68. <https://doi.org/10.26817/16925777.820>
- *Park, J., & Lee, J. (2021). Effects of E-Books and Printed Books on EFL Learners' Reading Comprehension and Grammatical Knowledge. *English Teaching*, 76(3), 35–61. <https://doi.org/10.15858/engtea.76.3.202109.35>
- *Gunel, E., & Top, E. (2022). Effects of Educational Video Games on English Vocabulary Learning and Retention. *International Journal of Technology in Education*, 5(2), 333–350. <https://doi.org/10.46328/ijte.225>
- *Habib, M. A., Muhammad, A. M., Hajjakaltum, A. (2019). Use OF Computer-Assisted Instruction to Improve Students' Reading Skills in the English Language. *I-Manager's Journal on English Language Teaching*, 9(1), 32. <https://doi.org/10.26634/jelt.9.1.15294>
- Hasselbring, T. S., & Glaser, C. H. W. (n.d.). *Use of Computer Technology to Help Students with Special Needs*.
- Higgins, E. L., & Raskind, M. H. (2004). The Compensatory Effectiveness of the Quicktionary Reading Pen II on the Reading Comprehension of Students with Learning Disabilities. *Journal of Special Education Technology*, 20(1), 31–40. <https://doi.org/10.1177/016264340502000103>
- Inc, C. (n.d.). *The UDL Guidelines*. Retrieved October 18, 2025, from <https://udlguidelines.cast.org>
- Irwin, V., Zhang, J., Wang, X., Hein, S., Wang, K., Roberts, A., York, C., Barmer, A., Mann, F. B., Dilig, R., Parker, S., Nachazel, T., Barnett, M., & Purcell, S. (n.d.). *Report on the Condition of Education 2021*.
- Kelly, O., Buckley, K., Lieberman, L. J., & Arndt, K. (2022). Universal Design for Learning—A framework for inclusion in Outdoor Learning. *Journal of Outdoor and Environmental Education*, 25(1), 75–89. <https://doi.org/10.1007/s42322-022-00096-z>
- Linan-Thompson, S., Vaughn, S., Prater, K., & Cirino, P. T. (2006). The Response to Intervention of English Language Learners at Risk for Reading Problems. *Journal of Learning Disabilities*, 39(5), 390–398. <https://doi.org/10.1177/00222194060390050201>
- *Marsa, S. S., Kuspiyah, H. R., & Agustina, E. (2021). The Effect of Kahoot! Game in Teaching Reading Comprehension Achievement. *JET (Journal of English Teaching)*, 7(2), 133–149. <https://doi.org/10.33541/jet.v7i2.2738>
- *Marzban, A. (2011). Improvement of reading comprehension through computer-assisted language learning in Iranian intermediate EFL students. *Procedia Computer Science*, 3, 3–10. <https://doi.org/10.1016/j.procs.2010.12.003>
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & The PRISMA Group. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Medicine*, 6(7), e1000097. <https://doi.org/10.1371/journal.pmed.1000097>
- Moore, S. L. (2007). David H. Rose, Anne Meyer, *Teaching Every Student in the Digital Age: Universal Design*

- for Learning: Association for Supervision and Curriculum Development, 1703 N. Beauregard St., Alexandria, VA 22311-1714, Product no. 101042, \$22.95 ASCD members, \$26.95 nonmembers, ISBN-0-87120-599-8. *Educational Technology Research and Development*, 55(5), 521–525. <https://doi.org/10.1007/s11423-007-9056-3>
- National Joint Committee on Learning Disabilities. (1991). *Learning Disabilities: Issues on Definition* (Nos. RP1991-00209; pp. RP1991-00209). American Speech-Language-Hearing Association. <https://doi.org/10.1044/policy.RP1991-00209>
- Okolo, C. M., & Ferretti, R. P. (1998). Multimedia Design Projects in an Inclusive Social Studies Classroom: “Sometimes People Argue with Words Instead of Fists.” *TEACHING Exceptional Children*, 31(1), 50–57. <https://doi.org/10.1177/004005999803100107>
- *Sivaram, R. T., Ramar, R. (2014). Effect Of CAI On Achievement of LD Students In English. *I-Manager's Journal on English Language Teaching*, 4(1), 12–17. <https://doi.org/10.26634/jelt.4.1.2638>
- *Rusmanayanti, A., & Hanafi, L. (2018). Teaching Reading Comprehension by Using Computer-Based Reading: An Experimental Study in Indonesian English Language Teaching. *Arab World English Journal*, 4(4), 202–213. <https://doi.org/10.24093/awej/call4.16>
- *Stetter, M. E., & Hughes, M. T. (2011). *Computer-assisted instruction to promote comprehension in students with learning disabilities*. 26.
- Stultz, S. L. (2017). Computer-Assisted Mathematics Instruction for Students with Specific Learning Disability: A Review of the Literature. *Journal of Special Education Technology*, 32(4), 210–219. <https://doi.org/10.1177/0162643417725881>
- Svensson, I., Nordström, T., Lindeblad, E., Gustafson, S., Björn, M., Sand, C., Almgren/Bäck, G., & Nilsson, S. (2021). 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>
- Tamim, R. M., Bernard, R. M., Borokhovski, E., Abrami, P. C., & Schmid, R. F. (2011). What Forty Years of Research Says About the Impact of Technology on Learning: A Second-Order Meta-Analysis and Validation Study. *Review of Educational Research*, 81(1), 4–28. <https://doi.org/10.3102/0034654310393361>
- *Toonder, S., & Sawyer, L. B. (2021). The impact of adaptive computer-assisted instruction on reading comprehension: Identifying the main idea. *Journal of Computer Assisted Learning*, 37(5), 1336–1347. <https://doi.org/10.1111/jcal.12573>
- *Vahdat, S., & Behbahani, A. R. (2013). *The Effect of Video Games on Iranian EFL Learners' Vocabulary Learning*.
- *Universitas Advent Indonesia, & Katemba, C. V. (2022). Vocabulary Enhancement Through Multimedia Learning Among Grade 7th EFL Students. *Mextesol Journal*, 46(1), 1–13. <https://doi.org/10.61871/mj.v46n1-8>
- Xie, H., Chu, H.-C., Hwang, G.-J., & Wang, C.-C. (2019). Trends and development in technology-enhanced adaptive/personalized learning: A systematic review of journal publications from 2007 to 2017. *Computers & Education*, 140, 103599. <https://doi.org/10.1016/j.compedu.2019.103599>
- *Zamora, V., & Pittman, R. T. (n.d.). *The Effects of Two Computer-Based Reading Software Programs on Student Reading Performance*. 5.