

Enhancing reading and writing skills of students with learning disabilities through assistive technology: A literature review (2013-2023)



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ABSTRACT

This study explores how assistive technology can help students with learning difficulties improve their reading and writing. It reviews research on the use of assistive technology in primary schools, focusing on reading and writing achievements. We searched six databases with specific criteria and chose studies that matched for further examination. Our findings indicate that students using assistive technology showed notable improvements in reading and writing. Nonetheless, the extent of these improvements varied greatly among the studies. This variation indicates that multiple factors, like the kind of technology used, the amount of support given, and how long the technology is used, can affect how helpful assistive technology is. More research is needed to understand these factors fully and to create and test technologies that are suited to various environments. Despite these variations, the results of our review point towards assistive technology being a beneficial tool for enhancing the reading and writing abilities of students with learning disabilities.

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1. Introduction

Reading and writing skills are essential for active participation in society. However, a significant portion of school students, including approximately 5-8% of the global population with learning disabilities, face challenges in developing these skills (Svensson et al., 2021). Students with learning challenges encounter difficulties that go beyond typical school-related issues, resulting in academic disadvantages and long-term consequences (Clabaugh et al., 2015; Kauffman et al., 2017). The inability to acquire proficient reading and writing skills not only hinders educational progress but also affects students' self-confidence (Duke and Del Nero, 2011).

Research has shown that targeted training can be beneficial, but overcoming these difficulties can still be challenging. Common approaches to addressing reading and writing difficulties include exercises that enhance reading abilities and the use of assistive technology, such as listening to text instead of reading it (Adebisi et al., 2015; Svensson et al.,

2021). Assistive technologies have become valuable resources for enhancing the learning capacity of students with learning difficulties (Wang et al., 2017; Pirani and Sasikumar, 2015). Extensive research has been conducted to investigate the effectiveness of assistive technologies in supporting individuals with learning disabilities.

The Individuals with Disabilities Education Act (IDEA) in the United States mandates inclusive classrooms for students with disabilities and recognizes the role of assistive technology in bridging the gap between desired learning outcomes and students' intellectual potential (Salkind, 2008). Assistive technology refers to interventions where individuals with disabilities utilize technology, such as computerized devices, software, and peripherals, to facilitate functional tasks and enhance access to information technologies (Hartley and Tarvydas, 2023).

Assistive technologies, ranging from simple spellcheckers to complex speech recognition systems, are advocated by schools, parents, and educators to help students with special needs address learning challenges and promote independence (Maor et al., 2011). This review aims to explore the effectiveness of assistive technologies for students with learning disabilities and identify suitable technologies to meet their needs. Accommodations, including assistive technology, provide support for students without compromising

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learning standards or altering the classroom environment.

This paper presents a systematic review of the literature to address the following research questions:

1. Does the use of assistive technology improve the reading and writing abilities of students in intervention groups?
2. Do differences in effect sizes raise concerns about research standards, levels of support, theoretical foundations, and intervention durations in studies evaluating the use of assistive technology for students with learning disabilities?

2. Method

In conducting this systematic review under PRISMA guidelines, our goal was to examine the impact of assistive technology on students with learning disabilities, with a particular focus on reading and writing abilities. We meticulously searched six major databases: ScienceDirect, SAGE, Emerald, Wiley Online Library, Taylor and Francis, and DOAJ, applying specific keywords related to various forms of assistive technology (such as devices, apps, and adaptive equipment) and learning challenges (including learning disabilities, difficulties, and disorders) within the context of reading and writing. Our search was tailored to identify studies published between 2013 and 2023 that were available in English. We looked for

research that either specifically focused on assistive technology or integrated it with other interventions, like behavioral educational therapies, targeting elementary school students.

The inclusion criteria were precise, favoring studies that provided clear evidence of intervention impacts and were accessible in full text online. Conversely, we excluded studies that did not focus on elementary students, as well as review articles, case reports, or those not indexed in the Web of Science or Scopus, two leading citation databases. This exclusion also extended to studies lacking online full-text access. The selection and exclusion criteria, alongside the search process and outcomes, are depicted in Fig. 1, providing a visual summary of our systematic review methodology and the resulting study selection process (Zhu and Liu, 2020). First, studies are screened based on their titles and abstracts using inclusion and exclusion criteria to determine which research can be dropped and which must proceed to the scanning of whole documents. To ensure that no paper is unintentionally excluded as irrelevant, the abstract was read by three people who independently review abstracts. The three reviewers completely agreed about the excluded studies, and their agreement was reported as a sign of the effectiveness of the screening process. The whole article was then scanned to see if it applied to the question and met the requirements.

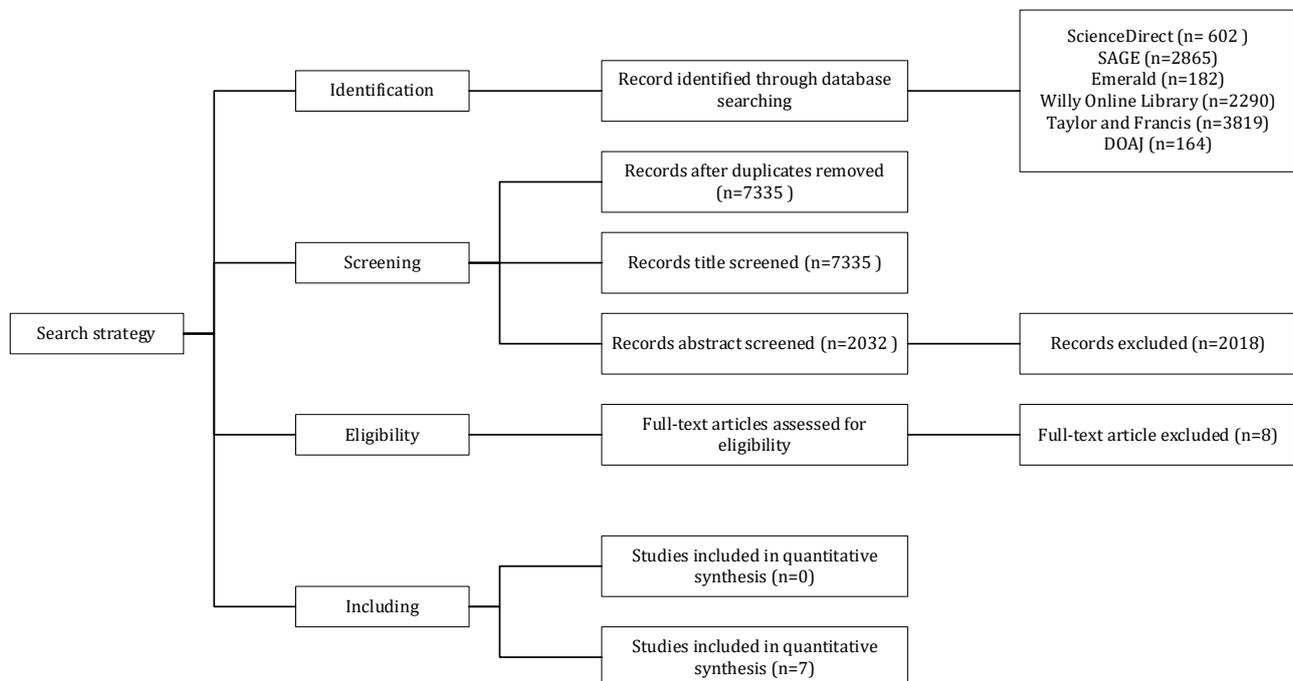


Fig. 1: Study selection flowchart

In this systematic literature review, the researcher focused on selecting studies that examine the effectiveness of assistive technology in teaching students with learning disabilities. To refine the selection of studies, several criteria were applied: (a) Only studies published in peer-reviewed journals

were considered to ensure the reliability and academic credibility of the findings. (b) The researcher limited the selection to studies published within the last ten years, starting from 2013. This time frame was chosen because research in this field evolves rapidly, and earlier studies may no longer

reflect current understanding or best practices. (c) The term "assistive learning technology" was defined broadly to include any digital tools designed to improve reading and writing skills, such as computer software, applications, and devices. (d) The scope of learning disabilities was specifically focused on those affecting reading and writing in classroom settings. This approach was taken to ensure that the findings would be directly applicable to the educational environments in question. (e) Studies involving participants who were not in elementary school—specifically, those in kindergarten, middle, and high school—were excluded to maintain a focus on the primary school context.

Using specific keywords to search through databases yielded a total of 9,922 studies. After applying our inclusion criteria, we initially filtered these results. By removing 4,402 duplicate articles, we were left with 7,335 studies for further examination. These articles underwent a title screening to determine their relevance to our criteria.

Following this process, 1,320 studies were excluded because they were either case reports or review articles, which were not suitable for our analysis. Another 1,050 studies were removed from consideration because, although their titles and abstracts were in English, the full manuscripts were in other languages, making them inaccessible for our review.

This screening process resulted in 2,032 studies progressing to a more detailed evaluation. At this stage, 1,015 articles were excluded because they did not focus on assistive technology programs, and another 1,003 were excluded because they did not involve students as research participants.

Furthermore, eight articles were removed due to the lack of online full-text accessibility.

After thorough review and assessment, only six articles met all the requirements for inclusion, distillation, and detailed review in our systematic study of the literature.

Two tools were employed to assess the overall quality of each article in this study: the Evaluative Tool for Quantitative Research Studies and the Review Form for Qualitative Research (Taylor, 2005; Flemming, 2010).

The study's context, sample size, research treatments, outcome measures, delivery methods, and outcomes were evaluated and extracted.

3. Results

Table 1 provides a summary of six studies that examined the effects of different types of assistive technology on the literacy skills of students with learning difficulties. The studies vary in terms of sample size, sample age, intervention type, intervention duration, intervention mode, outcome measures, and results. The first question asks whether the use of assistive technology improves the reading and writing abilities of students in intervention groups. The answer to this question is generally yes, as most of the studies report positive effects of the interventions on the literacy skills of the students, either immediately or after a period. However, some studies also report challenges or limitations in implementing or evaluating the interventions, such as technical issues, lack of teacher training, low fidelity, or small sample size.

Table 1: The summary of the selected studies

Reference	Sample size	Sample age	Intervention	Group or individual intervention	Outcome	Results
Ndombo et al. (2013)	24	10 -19		Group	Phonological awareness components assessed for literacy skills	A new integrated assistive model is proposed to improve the phonological skills of dyslexic learners
Ven et al. (2017)	60	7-12	9×15 min	Group	Early intervention games have a sustained effect on early text reading	The multi-component reading game may be used to promote early reading development without compromising reading motivation because intervention had no negative effects on reading motivation
Thompson et al. (2017)	26	6 - 14	12 computer lessons	Group	Output, input, and task modes varied in 12 lessons	Computerized writing instruction improves letter production and related skills
Svensson et al. (2021)	149	10 - 14	24 session	Group	Gains were the same for all groups, both immediately and a year later	Assistive technology can improve reading ability and increase motivation, but challenges remain
Whitney and Ackerman (2023)	4	7-12		Single case	Oral reading has been improved	Great Leaps Digital Reading Program increases oral reading fluency
Alqahtani (2023)	3	10-11		Group	Participants improved reading comprehension, with slight differences between RAAC and iPad	Two participants showed improvement in reading comprehension, but the iPad intervention was shorter

Assistive technology is a term that refers to any device or software that can help learners with reading and writing challenges (Ndombo et al., 2013; White and Robertson, 2015). However, the implementation of assistive technology in

educational contexts is not without obstacles. One of the studies that examined the use of assistive technology was conducted by Ven et al. (2017), who developed a multi-component reading game for primary school students with special needs. The

game was found to improve the students' reading skills without affecting their reading motivation. Another study that used technology-supported instruction was done by [Thompson et al. \(2017\)](#), who provided computerized writing training for students with specific learning disabilities in written language. The training consisted of 12 lessons that varied in input modes, output modes, and task types, and the results showed that the training improved the students' writing skills. A different type of technology-supported intervention was investigated by [Whitney and Ackerman \(2023\)](#), who used a digital reading fluency program for four elementary students with reading difficulties. The program, called Great Leaps Digital Reading Program, was based on evidence-based practices and was effective in increasing oral reading fluency using a single-case, multiple probes across participant's designs. Lastly, [Alqahtani \(2023\)](#) compared question creation with two reading interventions (repeated reading and iPad text-to-speech) for six students with reading challenges in grades three and four. The study revealed that the Reread-Adapt and Answer-Comprehend (RAAC) intervention, which took more time than the iPad intervention, was more beneficial for some students.

The second question asks whether the differences in effect sizes among the studies raise concerns about research standards, levels of support, theoretical foundations, and intervention durations. Effect size is a statistical measure that indicates the magnitude and direction of the difference between two groups or the strength of the relationship between two variables. Based on the results reported in [Table 1](#), it can be inferred that some interventions have larger or more consistent effects than others. For example, [Ven et al. \(2017\)](#) found that their reading game had a sustained effect on early text reading after one year, while [Svensson et al. \(2021\)](#) found that their assistive technology had no effect on reading motivation after one year. Similarly, [Whitney and Ackerman \(2023\)](#) found that their digital reading fluency program increased oral reading fluency for all four participants, while [Alqahtani \(2023\)](#) found that his question creation intervention improved reading comprehension for only two out of three participants.

These differences in effect sizes may reflect differences in research standards, levels of support, theoretical foundations, and intervention durations among the studies. For example, research standards may vary in terms of design quality, validity, reliability, and generalizability. Levels of support may vary in terms of teacher involvement, feedback provision, and scaffolding strategies. Theoretical foundations may vary in terms of alignment with evidence-based practices, cognitive models, and instructional principles. Intervention durations may vary in terms of intensity, frequency, and duration. These factors may influence the effectiveness and efficiency of the interventions and their impact on student outcomes. In summary, these studies provide evidence for the advantages of using

assistive technology and technology-supported instruction in enhancing the reading and writing skills of students with learning difficulties. However, there are still challenges to be addressed in the adoption of such technology, and more research is needed to fully explore its effectiveness and potential in educational settings. Moreover, these studies highlight the importance of teacher-researcher collaboration in implementing and evaluating new technologies to ensure their optimal effectiveness in improving student outcomes.

4. Discussions

Assistive technology can significantly enhance the reading and writing skills of students facing challenges, particularly those with significant difficulties. Proper use and supervision of this technology can lead to improvements in reading fluency, understanding, and interest in reading ([Ndombo et al., 2013](#)). For example, a reading game was found to boost early reading skills without reducing students' motivation. Research has also focused on students with specific learning disabilities (SLDs) in writing, investigating how technology-supported teaching can help ([Thompson et al., 2017](#)). Studies involving post-tests and computerized writing training have shown that such training can improve letter writing and related skills. Furthermore, using different research designs, one study compared the effects of two reading interventions (repeated reading versus using an iPad's text-to-speech feature) on the ability to generate questions, demonstrating the potential benefits of integrating technology into reading exercises ([Alqahtani, 2023](#)).

The Great Leaps Digital Reading Program was found to be a successful method for boosting oral reading fluency. Students with learning challenges who utilized assistive technology experienced greater success in academic writing. Benefits of using assistive technology included better organization, increased social acceptance, and enhancements in academic results across writing, reading, math, and spelling. The research reviewed literature using keywords such as "technology education," "assistive technology," "handheld devices," "effective intervention," "using technology," and "elementary school students" ([Baker, 2017](#)). It was found that audio-assistive technology could assess the impact of assistive technology (AT) on writing clarity, reading coherence, and word recognition. The study also showed that various strategies could lead to improved learning outcomes, such as higher word count, better quality of arguments, and richer content in arguments. Additionally, speech-to-text (STT) technology was identified as providing students with an alternative approach to learning writing skills. The use of tablet computers, known for their user-friendly interfaces, was linked to supporting learning processes ([Whitney and Ackerman, 2023](#)). First-grade students were among the participants in these studies.

Despite this focus, the study highlighted the potential for technology to improve learning outcomes for children facing learning challenges.

To meet our objective, we carried out an extensive review of the literature and identified six studies that met the inclusion criteria outlined in Table 1. A potential limitation of our study may be the small number of studies selected for review and the limited number of participants in some of these studies, especially when comparing them to studies that focus on identifying causes. Consequently, there is a need for future research to assess the effectiveness of a broader range of intervention programs.

5. Conclusions

In this systematic review, we selected seven studies according to our predetermined criteria for inclusion and exclusion. The age range of participants in the studies varied from 6 to 14 years, with an average age of 11.5 years. The number of participants in these studies ranged from 4 to 149 students, with most studies involving groups of students. The evidence gathered from this review generally supports the idea that assistive technology benefits students facing reading and writing difficulties. Assistive technology often includes tools known as accommodation software, which facilitates the learning process. Examples of such software are text magnifiers, digital notetaking tools, and word prediction programs. For students with LDs, early diagnosis and the initiation of suitable interventions by parents can significantly contribute to preventing academic delays when compared to their peers. It is crucial not to delay intervention until the child is significantly behind. Early educational success, which sets the foundation for later achievements, often begins in kindergarten.

5.1. Implications

School principals can utilize assistive technology to unlock the educational abilities of certain students, particularly those identified with specific learning disabilities. Special education aims to support students who face challenges in keeping pace with their classmates, especially during their elementary education years. Educators continually seek the most effective methods for learning and teaching. Many teachers consider employing technology to enhance the academic success of an entire class a valuable effort.

5.2. Limitations

This literature review is limited by several factors, including the small number of studies included and the focus on elementary school settings. Future research should include a larger number of studies and should examine the effectiveness of assistive technology interventions in

other settings, such as middle school and high school.

5.3. Future directions

Future research should focus on the following areas:

- Identifying the most effective types of assistive technology interventions for different types of learning disabilities.
- Examining the role of support in the effectiveness of assistive technology interventions.
- Developing and evaluating assistive technology interventions that are designed to be used in different settings, such as the classroom, home, and community.

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Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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