ARTIGO DE REVISÃO

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Technology-based interventions in dyslexia: A review

Intervenções baseadas em tecnologia na dislexia: Uma revisão

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Abstract

With technological advances, research in the area of Education has been investigating teaching tools based on technologies that promote better results in the teaching-learning process. The objective of this article is to present a systematic literature review on the use of technology in the context of dyslexia intervention. The database consists of scientific articles published between 2019 and 2024, from Science Direct/Elsevier, SciELO – Scientific Electronic Library Online, MedLine – Medical Literature Analysis and Retrieval and Portal de Periódicos da CAPES, using the search string dyslexia AND (application OR computer OR software OR technology) AND intervention. Of the 19 articles that make up this review, the majority are articles that aimed to develop interventions in the context of reading (16), with a greater concentration of publications being observed in 2023; the largest number of works (63.2%) had children with dyslexia as their target audience and regarding the language, the majority were developed for the English language (16). The results of the studies reported in this review showed that technological tools positively affect the performance of dyslexics; and their perceptions regarding the use of technology for intervention purposes were generally positive; adaptability and engagement were positive points frequently highlighted by studies; in addition, the role of a multidisciplinary team specialized in the development of technological applications stands out.

Keywords: Dyslexia. Computer-Based Intervention. Learning.

Resumo

Com os avanços tecnológicos, pesquisas na área da Educação vêm investigando ferramentas de ensino baseadas em tecnologias que promovam melhores resultados no processo de ensino-aprendizagem. O objetivo deste artigo é apresentar uma revisão sistemática da literatura sobre o uso da tecnologia no contexto da intervenção na dislexia. A base de dados desta pesquisa é composta por artigos científicos publicados entre 2019 e 2024, provenientes da Science Direct/Elsevier, SciELO – Scientific Electronic Library Online, MedLine – Medical Literature Analysis and Retrieval e Portal de Periódicos da CAPES, utilizando a string de busca dislexia AND (aplicativo OR computador OR software OR tecnologia) AND intervenção. Dos 19 artigos que compõem esta revisão, a maioria teve como objetivo desenvolver intervenções no contexto da leitura (16), sendo observada maior concentração de publicações em 2023; o maior número de trabalhos (63,2%) teve como público-alvo crianças com dislexia e, em relação à língua, a maioria dos trabalhos foi desenvolvida para a língua inglesa (16). Os resultados dos estudos relatados nesta revisão mostraram que as ferramentas tecnológicas afetam positivamente o desempenho dos disléxicos; e as suas percepções sobre a tecnologia implementada foram geralmente positivas; adaptabilidade e engajamento foram pontos positivos frequentemente destacados pelos estudos; além disso, destaca-se o papel de uma equipe multidisciplinar especializada no desenvolvimento de aplicações tecnológicas.

Unitermos: Dislexia. Intervenção Baseada em Computador. Aprendizagem.

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Introduction

Information and Communication Technologies (ICTs) have been used to support intervention in dyslexic students. They are great tools to support the achievement of educational goals (Cidrim & Madeiro, 2017a, Jing & Chen, 2017, Lerga et al., 2021, Hussain et al., 2023, Niklaus et al., 2023). The various types of technology used in education and clinical activity meet the diverse needs of the users, from teachers and clinicians or parents, to students and patients. Technologies may support the learning process, giving more opportunity to practice, providing immediate feedback and an individualized and flexible learning environment (Lorusso et al., 2021; Deepalakshmi et al., 2023). ICTs are technological systems (e.g., hardware devices and software applications) that allow the production, storage, communication, and sharing of information (Lorusso et al., 2021; Cruz et al., 2023). Several studies underlined the effects of technology on students with and without special needs, such as students with learning disorders (Rodríguez-Cano et al., 2022; Cruz et al., 2023; Lim et al., 2023).

The specific learning disorder with impaired reading, also known as dyslexia, is characterized by reading words inaccurately or slowly, requiring effort; difficulty in understanding the meaning of what is read, making it possible to read accurately, but without understanding the sequence, relationships, inferences or deeper meanings of what is read (APA, 2013). It is characterized by individual differences in processing, with difficulties presented at the beginning of literacy, compromising the acquisition of reading, writing and spelling; failures in cognitive, phonological and/or visual processes may also occur (Reid, 2016).

In dyslexia, spelling impairments are often more extensive and persistent than in reading (Cidrim & Madeiro, 2017b). This may occur due to difficulties related to the process of phonographic-orthographic conversion and its use to the correct writing of the words. Acquiring the phoneme-grapheme knowledge is an essential skill for reading and writing skills (Schiff & Levie, 2017; Tilanus et al., 2019).

Early symptoms of this disorder appear in pre-school years, but the official diagnosis of the disorder is done after the official start of the academic process and, if not properly assessed, it has a potential impact on an individual's inconsistent performance and creates weakness in multiple areas of their life (Becker et al., 2017; Romero et al. 2023). The sooner the intervention happens, the better the outcome will be (Cahyana et al., 2021).

Traditional interventions that include only the use of printed materials, handwriting and reading aloud, for example, are not sufficient for students with dyslexia. Extra support and different methods are needed to accommodate their learning disability (Madeira et al., 2015; Jing & Chen, 2017). The multisensory approach is recognized as the most effective teaching method for students with dyslexia to learn to read (Cahyana et al., 2021). Students can learn more easily and successfully when instruction involves multiple senses. The multisensory approach is formerly and occasionally referred to as the Orton-Gillingham (OG) approach. It uses the auditory, visual, and kinesthetic senses in the teaching method (Purkayastha et al., 2012; Cahyana et al., 2021).

Some studies have pointed out that the intervention of dyslexia may require intensive training, explicit instructions for the exercises, and single person or small group implementation (Peterson & Pennington, 2015; Lerga et al., 2021; Lorusso et al., 2021). Technology-based approaches offer several advantages over traditional teaching that prioritizes printed materials. They can personalize the instruction for each individual as well as be accessed at any time and in any location (Cancer et al., 2020; Gharaibeh & Dukmak, 2021). Furthermore, by applying the gamification concept, instruction can become more engaging and increase the adherence of the students to the intervention program (Donnelly et al., 2020; Duarte Filho et al., 2024). Considering the hypothesis that intervention with technology in the context of dyslexia has a positive impact on reading and writing skills, the objective of this article is to present a systematic

literature review on the use of technology in the context of dyslexia intervention.

Research strategies

This is a systematic review study that used the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Page et al., 2021) method, which recommends the use of the following steps: identification; selection; eligibility; and inclusion (Moher et al., 2009). The guiding question was developed based on the research theme and guided by the PICO (Population, Intervention, Comparison, Outcome) strategy, considering: population (P) - child, adolescent and adult with dyslexia; intervention (I) - studies that described strategies using technology in the context of dyslexia; comparison (C) traditional and technology-based interventions in dyslexia; and the outcome (O) - the benefits of the intervention with technology.

Selection criteria

The review presented in this article covers articles written in English and published between 2019 and 2024. The set of scientific articles was obtained from Science Direct/Elsevier, SciELO - Scientific Electronic Library Online, MedLine - Medical Literature Analysis and Retrieval and Portal de Periódicos da CAPES, using the search string dyslexia AND (application OR computer OR software OR technology) AND intervention.

As a result, 257 articles were obtained. Refinements have been made to filter only documents relevant to the purpose of this review. The first strategy adopted was to eliminate duplicate articles, articles that were not written in English or articles in which the search terms did not appear in the title, abstract and keywords, leaving 141 articles. The title, abstract and keywords of the articles were then read to check that they adhered to the pre-defined scope. Review articles, books or chapters and conference abstracts were discarded, leaving 69 articles to be read in full. After applying the following exclusion criteria: studies with students without dyslexia; studies that do not report technology interventions; research using technology to screen or assess dyslexia, and research on the use of imaging technologies and/or examinations of brain function in the condition of dyslexia, 19 articles on intervention in dyslexia with technology were selected (Figure 1).

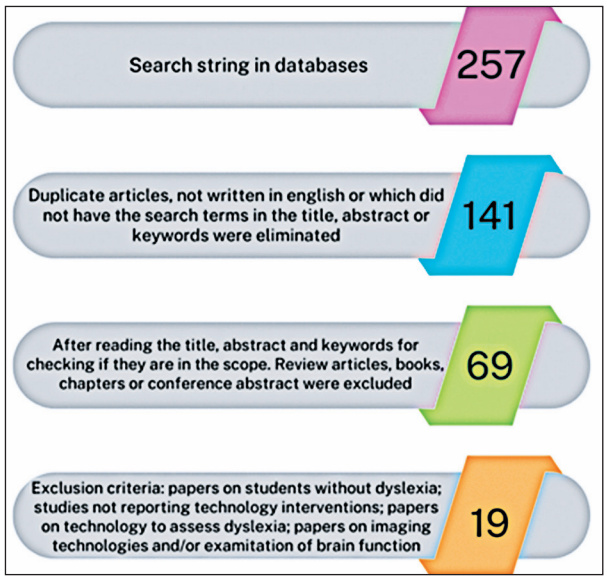
Results

The selected articles are presented in ascending chronological order in Table 1, which presents the author(s), year of publication, objectives and conclusions of the work.

Initially, lexical analyses were performed on the 19 articles included in this review using the Iramuteq software (Ratinaud, 2009). The analyses were based on the frequency of occurrence of the terms in the titles. One of these analyses is the word cloud, which consists of a simplistic visual representation to highlight words with high recurrence, highlighting the most frequent terms in the search for articles related to the previously defined scope (Heimerl et al., 2014). According to Figure 2, the highlighted words are dyslexia and intervention.

Figure 1

Flowchart of the paper selection process for the review considering eligibility criteria



Source: Research data.

Table 1

Characteristics of the studies included in the review (n=19)

Author(s)	Year	Objectives of the study	Conclusions
Kariyawasam et al.	2019	To develop a mobile application for screening and intervention of dyslexia, dysgraphia and dyscalculia named "Pubudu".	"Pubudu" is the first app developed for local languages in Sri Lanka to address learning disabilities. Training is carried out through digital activities based on memorizing words through images; handwriting recognition and numerical skills tasks.
Alsobhi & Alyoubi	2019	The purpose of the paper is to describe a dyslexia-adaptive e-learning management system (DAELMS).	DAELMS has been evaluated by university students with dyslexia. The evaluation results show that when the system provides users with learning materials that match their learning style or type of dyslexia, it improves their learning outcomes.
Cancer et al.	2020	To compare the effectiveness of Rhythmic Reading Training (RRT) and that of an intervention resulting from the combination of two yet validated treatments for dyslexia, namely, Bakker's Visual Hemisphere-Specific Stimulation (VHSS) and the Action Video Game Training (AVG).	A computer-assisted intervention method, called Rhythmic Reading Training (RRT), which combines sublexical reading exercises with rhythm processing, was implemented. Each intervention program produced improvements that were most evident in specific reading parameters: RRT was most effective in improving pseudoword reading speed, while VHSS + AVG was most effective in increasing overall reading accuracy.
Donnelly et al.	2020	To develop a reading tool based on the principles of phonics instruction, and determine whether struggling readers could leverage this technology to decode challenging words.	This study demonstrates the potential of a text annotation, grounded in intervention research, to help children decode novel words. These results highlight the opportunity for educational technologies to support and supplement classroom instruction.
Peters et al.	2021	To investigate the efficacy of the action video games (AVG) training in dyslexic children using 'Fruit Ninja', while exploring whether increasing attentional and eye movement demands enhanced AVGs effectiveness.	The findings demonstrate a clear role for visual attention in reading and highlight the clinical applicability of AVGs as a fun, motivational and engaging intervention for dyslexia.
Behnamghader et al.	2021	To develop a game for students with dyslexia and compare its effectiveness with other approaches.	In this research, the Super Mario game platform was used with some elaborate scenarios that included word activities with audio resources, text, missions, scores and competition between players. The application of gamification techniques can increase the individual's motivation, participation and desire to continue the cognitive rehabilitation process.
Cahyana et al.	2021	To present the design and development of a mobile app called Learning Dyslexia (Leady) to help dyslexic students learn to read.	This app has been demonstrated to teachers or parents of children with dyslexia. Through a multisensory approach, this application provides two main activities: recognizing and learning to write the alphabet. Leady uses a simple interface with colors to avoid cognitive overload for the user. All interviewees agree that Leady can help dyslexic students learn to read.
Lorusso et al.	2021	To formulate a series of statements that could form the basis for international "good practices" on the use of technologies in the treatment of dyslexia or specific reading disorders in children and adolescents.	The use of ICT for rehabilitation of reading disorders is, at least in Italy, almost exclusively limited to the more traditional forms of technology, such as computerized games and exercises, while more advanced technologies are still little known and used.
Gharaibeh & Dukmak	2021	The study evaluated the effectiveness of a Multisensory Program (MSP) on English as a second language reading skills of students with reading difficulties and dyslexia in the United Arab Emirates (UAE).	The results reveal a statistically significant difference between the experimental and control groups after the MSP intervention. The study has implications for students who are learning English as a second language and face reading difficulties.

continue...

...Continuation

Table 1

Characteristics of the studies included in the review (n=19)

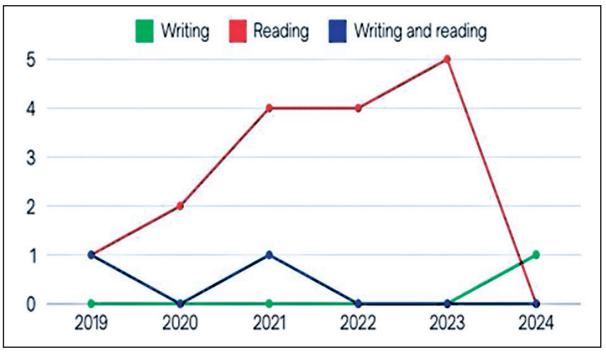
Author(s)	Year	Objectives of the study	Conclusions
Jamshidifarsani et al.	2021	The objective of this research was to propose an intelligent game-based training program focused on the aspect of reading speed in the English language for young dyslexics.	Four mini-games were designed with a focus on promoting reading automaticity at the lexical level explicitly and at the sublexical level implicitly, as well as providing a basis for expanding vocabulary knowledge. Through the use of gamification principles, several elements were incorporated into the game, such as positive/negative reinforcement; goals; progress bars; feedback; scores and levels.
ChePa et al.	2022	To propose a design guideline for intervention games for dyslexics.	A significant contribution of this study is the criteria and guidelines for dyslexic games that will benefit game developers, practitioners, and educators who are directly involved with dyslexic children. The proposed guidelines can serve to assist them in the design and development of game applications for dyslexic children.
Rodríguez-Cano et al.	2022	Contribute to the educational inclusion of students with dyslexia, through the use of technology, specifically Virtual Reality (VR).	The work carried out can contribute to progress in the inclusion and intervention of people with dyslexia through technology and specifically through VR, enabling an immersive and attractive environment to develop the visuospatial skills of students with dyslexia.
Yang	2022	To analyze the effects of visual resources in storytelling and their relationship with reading comprehension by dyslexics.	The learning effect of story-structured instructional materials was consistent with the results of reading comprehension tests.
Romero et al.	2023	To design educational software that would allow an effective intervention to minimize the initial difficulties of children at risk of dyslexia, and that a preschool teacher could apply in the classroom in an inclusive way.	The results showed that multimedia training with the Berni program helped to overcome difficulties in: phonological awareness, rapid automatic naming and verbal memory. Furthermore, teachers and children find Berni software understandable, operable and adequately developed. Teachers consider it to be appropriate to the curriculum, effective and conducive to learning. However, autonomous use, feedback and adaptation possibilities could be improved.
Niklaus et al.	2023	To evaluate different digital reading ruler designs and their effects on the reading performance of participants with dyslexia and without.	The results show that the rulers increased reading speeds for dyslexic readers, although no improvement in comprehension was observed for dyslexic readers. Although non-dyslexic readers showed no increase in reading speeds, they preferred to read with the ruler.
Hussain et al.	2023	To develop an augmented reality-based serious game named ARLexic to train children with dyslexia and dysgraphia.	ARLexic is an entertaining and easy-to-use game for children. Children also engage with the application for a longer time due to augmented reality.
Deepalakshmi et al.	2023	To develop a compact web app called “Dyslexic Duo”.	Three technological tools were developed: a digital document reader; a game to form words using visual and auditory techniques; and a 3D application with a multisensory approach. The results after testing with dyslexics show results that can be used as early as possible to help students overcome learning challenges.
Wannapaschaiyong et al.	2023	To create phonological awareness and letter knowledge materials using the Siriraj Pre-Literacy Enhancement interactive software.	This preliminary study demonstrated that early computer-based intervention may provide additional benefits for Thai children at risk of dyslexia.
Almgren Bäck et al.	2024	To investigate whether a systematic and intensive assistive technology intervention focusing on speech-to-text applications (STT) can improve text production.	This intervention was beneficial in initial teaching of STT and progress monitoring guided future interventions. Removing the spelling barrier with STT provided students with the opportunity to improve their vocabulary and overall text quality. Furthermore, visible progress, such as the ability to produce longer texts, may motivate continued use of STT. However, this evolution may not always be immediate.

Source: Research data.

Figure 2
Word cloud obtained from the titles of the 19 papers

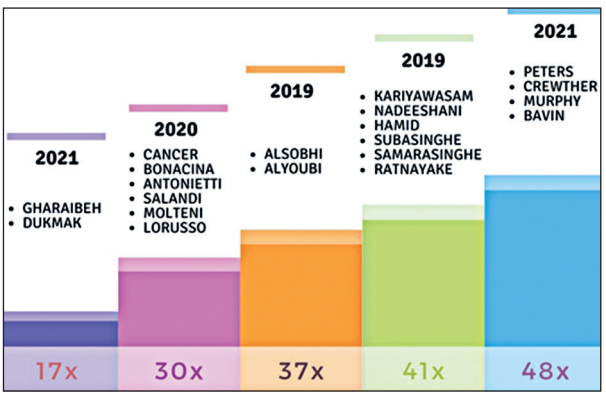
Source: Research data.

Figure 3
Number of articles per year and objective of the intervention



Source: Research data.

Figure 4
The five most cited papers according to the Google Scholar database



Source: Research data.

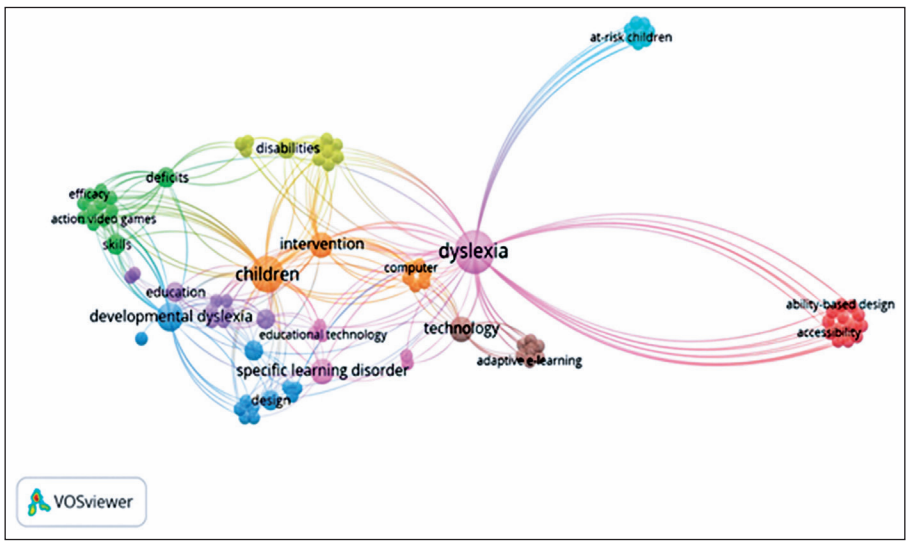
Of the 19 articles that make up this review, the majority are articles that aimed to develop interventions in the context of reading for students with dyslexia (16), with a greater concentration of publications being observed in 2023 (5). Only one article was observed within the scope of intervention in written language, published in 2024; and two articles focused on intervention in writing and reading as can be seen in Figure 3.

In relation to the most frequent target audience in interventions, the largest number of works (63.2%) were developed to intervene in the school difficulties of children with dyslexia; 26.3% of the works developed interventions for children and adolescents and 10.5% are aimed at adults with dyslexia. Regarding the language, of the 19 selected articles, the majority were developed for the English language (16), and the remaining 3 articles were in Spanish, Thai and Sinhala.

Figure 4 shows a bar chart of the number of Google Scholar citations of the five most cited articles. The article by Peters et al. (2021) is the most cited, with 48 citations. Kariyawasam et al. (2019) ranks second, with 41 citations. There are 37 articles that cited the study by Alsobhi & Alyoubi (2019). The fourth most cited paper, by Cancer et al. (2020), has 30 citations. Finally, Gharaibeh & Dukmak (2021) ranks fifth, with 17 citations.

Figure 5 provides a complementary analysis. In this case, the co-occurrence of keywords is evaluated using the VOSviewer software, which is a tool for developing bibliometric networks (Van Eck & Waltman, 2010). This analysis is based on graph theory, in which each vertex (circle) represents a keyword, and the larger the vertex, the more times that term has appeared, and also by edges, which are the connections between the vertices, so whenever a keyword is associated with another, they are connected to each other. In addition, this analysis is segmented by clusters, i.e. the most

Figure 5
Graph analysis considering the co-occurrence of keywords



Source: Research data.

frequently related terms are grouped together with the same coloring. As expected, some of the terms highlighted are dyslexia, children, intervention and technology.

Discussion

Learning to read can be a difficult and laborious task, especially when a child is underperforming, as observed in schoolchildren with dyslexia. Difficulty in learning to read can lead to demotivation and discouragement to engage in reading activities, and this can further widen the gap between successful and unsuccessful readers (Jamshidifarsani et al., 2021). Given the difficulties that readers with dyslexia face, gamification can be a mechanism to increase motivation, engagement and persistence in the process of acquiring and learning to read (Peters et al., 2021; Behnamghader et al., 2021; Jamshidifarsani et al., 2021; ChePa et al., 2022; Hussain et al., 2023).

The most traditional methods of intervention use a classic paper-and-pencil format, but children may find these exercises boring or repetitive (Lorusso et al., 2021). Technology can be a great support for dyslexic children in achieving their educational goals (Drigas & Politi-Georgousi, 2019; Cruz et al., 2023; Lim et al., 2023). Furthermore, the use of technological tools can make learning more engaging and increase students' adherence to intervention programs (Jing & Chen, 2017).

Gamification has been defined as using game design elements in nongaming context (Deterding et al., 2011) and it can be used to improve the learner's engagement (Behnamghader et al., 2021) as well as their autonomy and creativity (Turan et al., 2016; Kariyawasam et al., 2019; Hussain et al., 2023). By applying the concept of gamification, instruction can become more engaging and increase student adherence to the intervention program. However, despite the advantages, building such approaches requires multidisciplinary effort and in-depth knowledge of game design and learning theories (Qian & Clark, 2016).

Dynamic visual attention training using action games (AVGs) has been considered a promising intervention for dyslexia, favoring better performance in reading rate and fluency in children with dyslexia (Peters et al., 2021). The purpose of some research was to use popular gaming platforms, such as Super Mario (Behnamghader et al., 2021) and Fruit Ninja (Peters et al., 2021) to develop gamified activities.

New technologies such as augmented and virtual reality have emerged as alternatives for implementing intervention tools (Hussain et al., 2023). Augmented Reality (AR) is a technology that displays virtual objects or virtual information in our real environment in real time (Bhatti et al., 2020). An augmented reality-based game – ARLexic – has been developed for children with dyslexia and dysgraphia (Hussain et al., 2023) increasing the level of involvement and interest of young dyslexics, as well as improving their learning outcomes.

Virtual reality (VR) is an interactive simulation created with computer hardware and software to generate a fully immersive experience, an environment that appears similar to the real world (Weiss & Katz, 2004). In the technological field, virtual reality can bring important contributions to dyslexia intervention, as it offers more playful environments that can improve student adherence (Rodríguez-Cano et al., 2022), in addition to offering a multisensory approach (Broadhead et al., 2018).

Speech-to-text (STT) applications can help dyslexic students with writing difficulties produce text (Almgren Bäck et al., 2024). In a recent study, the use of STT assistive technology provided opportunities for students to improve their vocabulary skills and overall text quality. In addition, visible progress, such as the ability to produce longer texts, may motivate continued use of STT (Almgren Bäck et al., 2024). Games for learning and remediation of dyslexia were developed with fluency and vocabulary tasks (Jamshidifarsani et al., 2021). Speech recognition technology was used to decide whether the pronunciation was accurate or not. The reading task of the vocabulary module uses the cloze technique, also called accelerated word meaning recognition (AWMR). This task is also designed to improve the user's vocabulary, as well as increase the automaticity in decoding words and reading sentences (Jamshidifarsani et al., 2021).

Artificial intelligence (AI) has been used in the development of e-learning educational systems, allowing students to learn at their own pace and being suitable for distance learning as well as classroom teaching (Alsobhi & Alyoubi, 2019; Yang, 2022; Deepalakshmi et al., 2023).

Improved reading comprehension performance was observed in an intervention study with dyslexics that used story structure (story composition) based on visual analysis instructions (Yang, 2022). The main elements of stories are presented through visual diagrams, including the main character, the situation, the main question, and what happens and the ending of the story.

Researchers used the computer-assisted intervention method to stimulate reading skills in students with dyslexia (Cancer et al., 2020; Gharaibeh & Dukmak, 2021; Romero et al., 2023; Wannapaschaiyong et al., 2023). The Rhythmic Reading Training (RRT) (Cancer et al., 2020) integrates musical and rhythmic elements. RRT is a child-friendly computerized reading program that is designed with an interactive and enjoyable interface to engage and sustain children's attention during intervention sessions. Computer-based learning systems have been shown to increase the efficiency and effectiveness of learning in special education settings, such as for children with dyslexia (Gharaibeh & Dukmak, 2021). However, despite the advantages, building such approaches requires a multidisciplinary effort and knowledge of the needs of the target audience, as well as learning theories and game design (Jing & Chen, 2017; Alsobhi & Alyoubi, 2019).

An intervention program called Berni software was developed to intervene in phonological awareness, naming speed, alphabetic principle, verbal memory and language (Romero et al., 2023). The Berni educational software is based on the integration of three areas of knowledge: pedagogy, psychology and linguistics.

Systematic and sequential instructions with a phonological approach are widely used (Maehler et al., 2019; Tilanus et al., 2019; Silva & Godoy, 2020). In addition, multisensory programs (MSP) show results in students with dyslexia (Medda et al., 2024). MSP interventions have been integrated into computer-based training programs that have the advantages of being both didactic and recreational simultaneously (Gharaibeh & Dukmak, 2021), as well as in applications for dyslexia integrated into the e-learning system (Deepalakshmi et al., 2023).

Researchers have developed a tablet application using digital text with phonic cues to support decoding for readers with reading difficulties and dyslexia (Donnelly et al., 2020). The purpose of this app is to provide tips that help schoolchildren decode difficult words and eventually learn the highly inconsistent grapheme-phoneme correspondences of English vowels. Readers with dyslexia often feel lost in a text, rereading or skipping lines, making the reading experience unmotivating (Bucci, 2019). Digital reading rulers with inclusive designs, such as 'grey bar', 'light box', 'shadow' and 'underline', have been developed to support dyslexics by increasing their reading speed (Niklaus et al., 2023).

The use of technologies for intervention in developmental dyslexia is growing. There is interest among researchers in studies on good practices in the use of technologies and guidelines for intervention games in the context of dyslexia (Lorusso et al., 2021; ChePa et al., 2022). Technological implementations can offer several advantages, but they need to be well designed. A crucial aspect of intervention programs concerns the possibility of adapting the learning material to the specific needs of users (Jamshidifarsani et al., 2021).

Considerations

The literature review revealed an important point in the scientific community about the growth, relevance and application of technologies in teaching-learning, especially in the context of dyslexia. The results of the studies reported in this review showed that technological tools positively affect the performance of dyslexics; and their perceptions regarding the use of technology for intervention purposes were generally positive; adaptability and engagement were positive points frequently highlighted by the studies and the importance of a multidisciplinary team specialized in the development of technological applications. The main intervention targets include phonological awareness, visual skills, lexical skills and multisensory strategies.

References

Alsobhi, A., & Alyoubi, K. (2019). Adaptation algorithms for selecting personalised learning experience based on learning style and dyslexia type. *Data Technologies and Applications*, *53*(2), 189-200. https://doi.org/10.1108/DTA-10-2018-0092

Almgren Bäck, G., Mossige, M., Bundgaard Svendsen, H., Rønneberg, V., Selenius, H., Berg Gøttsche, N., Dolmer, G., Fälth, L., Nilsson, S., & Svensson, I. (2024). Speech-to-text intervention to support text production among students with writing difficulties: A single-case study in Nordic countries. *Disability and Rehabilitation: Assistive Technology*, *19*(8), 3110-3129. https://doi.org/10.1080/17483107.2024.2351488

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington.

Becker, N., Vasconcelos, M., Oliveira, V., Santos, F. C. D., Bizarro, L., Almeida, R. M. M., Salles, J. F., & Carvalho, M. R. S. (2017). Genetic and environmental risk factors for developmental dyslexia in children: Systematic review of the last decade. *Developmental Neuropsychology*, *42*(7/8), 423-445. https://doi.org/10.1080/87565641.2017.1374960

Behnamghader, M., Khaleghi, A., Izadpanah, P., & Rahmani, F. (2021). Using gamification based on mobile platform in therapeutic interventions for children with dyslexia. In M. E. Auer, & T. Tsiatsos (Eds.), *Internet of things, infrastructures and mobile applications* (pp. 814-824). Springer. https://doi.org/10.1007/978-3-030-49932-7_76

Bhatti, Z., Bibi, M., & Shabbir, N. (2020). Augmented reality based multimedia learning for dyslexic children. In *International Conference on Computing, Mathematics and Engineering Technologies (iCoMET)* (pp. 1-7). https://doi.org/10.1109/iCoMET48670.2020.9073879

Broadhead, M., Daylamani-Zad, D., MacKinnon, L. M., & Bacon, L. (2018). *A multisensory 3D environment as intervention to aid reading in dyslexia: A proposed framework. 10th International Conference on Virtual Worlds and Games for Serious Applications, VS-Games* (pp. 1-4). Proceedings. https://doi.org/10.1109/VSGames.2018.8493407

Bucci, M. P. (2019). Visual training could be useful for improving reading capabilities in dyslexia. *Applied Neuropsychology: Child, 10*(3), 199-208. https://doi.org/10.1080/21622965.2019.1646649

Cahyana, C., Hidayati, H., Sanjaya, M., Pangestu, A., Sundawa, A., & Aritakalam, A. (2021). Leady: A multisensory approach in mobile application for dyslexic children. *International Journal of Communication and Information*, *15*(1), 31-39. https://doi.org/10.21512/commit.v15i1.6661

Cancer, A., Bonacina, S., Antonietti, A., Salandi, A., Molteni, M., & Lorusso, M. (2020). The effectiveness of interventions for developmental dyslexia: Rhythmic reading training compared with hemisphere-specific stimulation and action video games. *Frontiers in Psychology*, *11*, 1158. https://doi.org/10.3389/fpsyg

ChePa, N., Bakar, N., & Sie-Yi, L. (2022). Criteria and guideline for dyslexic intervention games. *International Journal of Advanced Computer Science and Applications*, *13*(9), 162-172. http://dx.doi.org/10.14569/IJACSA.2022.0130919

Cidrim, L., & Madeiro, F. (2017a). Information and Communication Technology (ICT) applied to dyslexia: Literature review. *Revista CEFAC*, *19*(1), 99-108. http://doi.org/10.1590/1982-021620171917916

Cidrim, L., & Madeiro, F. (2017b). Studies on spelling in the context of dyslexia: Literature review. *Revista CEFAC*, *19*(6), 842-854. http://doi.org/10.1590/1982-0216201719610317

Cruz, M. A., Hurtado, O. A., & Madariaga, E. C. (2023). Application of machine learning in learning problems and disorders: A systematic review. *International Journal of Advanced Computer Science and Applications*, *14*(12), 441-445. http://dx.doi.org/10.14569/IJACSA.2023.0141245

Deterding, S., Sicart, M., Nacke, L., O'Hara, K., & Dixon, D. (2011). Gamification using game-design elements in non-gaming contexts. In *CHI '11 Extended Abstracts on Human Factors in Computing Systems* (pp. 2425-2428). https://doi.org/10.1145/1979742.1979575

Deepalakshmi, R., Revathy, J. S., Revathy, S. P., & Kousika, N. (2023). *Design and implementation of a comprehensive intelligent e-learning systems integrated web app solution for dyslexic students. International Conference on Research Methodologies in Knowledge Management, Artificial Intelligence and Telecommunication Engineering (RMKMATE*). https://doi: 10.1109/RMKMATE59243.2023.10368902

Donnelly, P., Larson, K., Matskewich, T., & Yeatman, J. (2020). Annotating digital text with phonemic cues to support decoding in struggling readers. *PLoS ONE*, *15*(12), e243435. https://doi.org/10.1371/journal.pone.0243435

Drigas, A. S., & Politi-Georgousi, S. (2019). ICTs as a distinct detection approach for dyslexia screening: A contemporary view. *International Journal of Online and Biomedical Engineering*, *15*(13), 46-60. https://doi.org/10.3991/ijoe.v15i13.11011

Duarte Filho, C. A., Madeiro, F., & Cidrim, L. (2024). Meu amigo Diggo: A tool to stimulate reading and spelling skills in students with learning disabilities. *Revista CEFAC*, *26*(6), e3024. http://dx.doi.org/10.1590/1982-0216/20242663024

Gharaibeh, M., & Dukmak, S. (2021). Effect of computer-based multisensory program on English reading skills of students with dyslexia and reading difficulties. *Applied Neuropsychology: Child*, *11*(3), 504-517. https://doi.org/10.1080/21622965.2021.1898395

Heimerl, F., Lohmann, S., Lange, S., & Ertl, T. (2014). Word cloud explorer: Text analytics based on word clouds. In *Proceedings of the 2014 47th Hawaii International Conference on System Sciences* (pp. 1833-1842). IEEE. https://doi.org/10.1109/HICSS.2014.229

Hussain, H., Faisal, C. M., Habib, M. A., González-Rodríguez, M., Lanvin, D. F., & Andrés, J. D. (2023). ARLexic game: An augmented reality-based serious game for training of dyslexic and dysgraphic children. *Virtual Reality*, *27*, 3649-3663. https://doi.org/10.1007/s10055-023-00862-4

Jamshidifarsani, H., Garbaya, S., Lim, T., & Blazevic, P. (2021). Intelligent games for learning and the remediation of dyslexia: Using automaticity principles. *IEEE Systems, Man, and Cybernetics Magazine*, *7*(1), 15-24. https://doi.org/10.1109/MSMC.2020.3007131

Jing, C. T., & Chen, C. J. (2017). A research review: How technology helps to improve the learning process of learners with dyslexia. *Journal of Communication and Health Development, 2*(2), 26-43. https://doi.org/10.33736/jcshd.510.2017

Kariyawasam, R., Nadeeshani, M., Hamid, T., & Subasinghe, I. (2019). Pubudu: Deep learning based screening and intervention of dyslexia, dysgraphia and dyscalculia. *In 14th Conference on Industrial and Information Systems (ICIIS)*. (pp. 476-481). IEEE. https://doi.org/10.1109/ICIIS47346.2019.9063301

Lerga, R., Candrlic, S., & Jakupovic, A. (2021). *A review on assistive technologies for students with dyslexia. In Proceedings of the 13th International Conference on Computer Supported Education* (pp. 64-72). CSEDU.

Lim, W. W., Yeo, K. J., & Handayani, L. (2023). A systematic review on interventions for children with dyslexia. *International Journal of Research in Education*, *12*(3), 1674-1682. http://doi.org/10.11591/ijere.v12i3.25099

Lorusso, M. L., Borasio, F., Da Rold, M., & Martinuzzi, A. (2021). Towards consensus on good practices for the use of new technologies for intervention and support in developmental dyslexia: A Delphi study conducted among Italian specialized professionals. *Children*, *8*(12), 1126. https://doi.org/10.3390/children8121126

Maehler, C., Joerns, C., & Schuchardt, K. (2019). Training working memory of children with and without dyslexia. *Children*, *6*(3), 47. http://doi.org/10.3390/children6030047

Madeira, J., Silva, C., Marcelino, L., & Ferreira, P. (2015). Assistive mobile applications for dyslexia. *Procedia Computer Science*, *64,* 417-424. https://doi.org/10.1016/j.procs.2015.08.535

Medda, M. G., Barbosa, T., Rocco, I. S., & Berlim de Mello, C. (2024). Response to intervention as an identification strategy of the risk for dyslexia. *CoDAS*, *36*(4), e20230031. http://doi.org/10.1590/2317-1782/20242023031

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *BMJ (Clinical Research Ed.)*, *339*, b2535. https://doi.org/10.1136/bmj.b2535

Niklaus, A. G., Cai, T., Bylinskii, Z., & Wallace, S. (2023). Digital reading rulers: Evaluating inclusively designed rulers for readers with dyslexia and without. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems* (Article 47., pp. 1-17). https://doi.org/10.1145/3544548.3581367

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S.,

McGuinness, L. A., ... Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ (Clinical research ed.)*, *372*, n71. http://doi.org/10.1136/bmj.n71

Peters, J., Crewther, S., Murphy, M., & Bavin, E. (2021). Action video game training improves text reading accuracy, rate, and comprehension in children with dyslexia: A randomized controlled trial. *Scientific Reports*, *11*(1), 18584. https://doi.org/10.1038/s41598-021-98146-x

Peterson, R. L., & Pennington, B. F. (2015). Developmental dyslexia. *Annual Review of Clinical Psychology*, *11*, 283-307. https://doi.org/10.1146/annurev-clinpsy-032814-112842

Purkayastha, S., Nehete, N., & Purkayastha, J. (2012). Dyscover-An Orton-Gillingham approach inspired a multi-sensory learning application for dyslexic children. In *2012 World Congress on Information and Communication Technologies* (pp. 685-690). IEEE.

Qian, M., & Clark, K. (2016). Game-based learning and 21st century skills: A review of recent research. *Computers in Human Behavior*, *63*, 50-58. https://doi.org/10.1016/j.chb.2016.05.023

Ratinaud, P. (2009). *Iramuteq: Interface de R pour les analyses multidimensionnelles de textes et de questionnaires*. Téléchargeable à l'adresse. http://www.iramuteq.org

Reid, G. (2016). *Dyslexia: A practitioner's handbook* (5th ed.). John Wiley & Sons Ltd.

Rodríguez-Cano, S., Delgado-Benito, V., & Ausín-Villaverde, V. (2022). Áreas de desarrollo para intervención en dislexia: Una propuesta de realidad virtual. Ocnos. Revista de *Estudios Sobre Lectura*, *21*(1). https://doi.org/10.18239/ocnos_2022.21.1.2701

Romero, A., Garay, U., Tejada, E., & López de la Serna, A. (2023). Efficacy of Berni: A software for preschoolers at risk of dyslexia. *International Journal of Child-Computer Interaction*, *38*, 100411. https://doi.org/10.1016/j.ijcci.2021.100411

Schiff, R., & Levie, R. (2017). Spelling and morphology in dyslexia: A developmental study across the school years. *Dyslexia*, *23*(2), 1-21. https://doi.org/10.1002/dys.1549

Silva, G. F., & Godoy, D. M. (2020). Intervention studies in phonological awareness and dyslexia: Systematic literature review. *Revista de Educação PUC-Camp (Online)*, *25*, 1-17. https://doi.org/10.24220/2318-0870v25e2020a4921

Tilanus, A. T., Segers, E., & Verhoeven, L. (2019). Predicting responsiveness to a sustained reading and spelling intervention in children with dyslexia. *Dyslexia (Chichester, England)*, *25*(2), 190-206. https://doi.org/10.1002/dys.1614

Turan, Z., Avinc, Z., Kara, K., & Goktas, Y. (2016). Gamification and education: Achievements, cognitive loads, and views of students. *International Journal of Emerging Technologies in Learning*, *11*(7), 64-69. https://doi.org/10.3991/ijet.v11i07.5455

Van Eck, N., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, *84*(2), 523-538. https://doi.org/10.1007/s11192-009-0146-3

Weiss, P. L., & Katz, N. (2004). The potential of virtual reality for rehabilitation. *Journal of Rehabilitation Research and Development*, *41*(5), 7-10.

Wannapaschaiyong, P., Vajrabhaya, P., Rojmahamongkol, P., & Sutchritpongsa, S. (2023). Computer-based early intervention for Thai preschool children at risk of dyslexia: A pre and post intervention study. *Journal of Child Science*, *13*(1), e28-e34. https://doi.org/10.1055/s-0043-1767809

Yang, H. (2022). Effect of story structure instruction based on visual analysis on reading comprehension intervention for dyslexic students. *Computational Intelligence and Neuroscience*, 9479709. https://doi.org/10.1155/2022/9479709

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