



(REVIEW ARTICLE)



## The use of ICT in the education of students with dyslexia

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### Abstract

In this article, a systematic study of the research literature is carried out regarding the use of Information and Communication Technology (ICT) and its applications as means of supporting and assisting reading for students with dyslexia. The main objective was to examine the use and effectiveness of this type of intervention in serving the learning needs of students with dyslexia. For this purpose, a bibliographic review of relevant research was conducted. The results of the research showed that the different forms of ICT, such as computers, educational platforms, specific software programs, electronic games and various multimedia applications, are able to be used both as a means of early prevention of the risk of dyslexia in children and in enhancing the reading skills of dyslexic children. Probably the positive effect of ICT on students with dyslexia is related to children's familiarity with it, recommending a particularly pleasant learning environment for children. In the future, further research is needed regarding the use of ICT in the diagnosis and management of dyslexia.

**Keywords:** Application of ICT; Dyslexia; Special Education; Education of people with special needs

### 1 Introduction

Dyslexia is one of the most common specific learning disabilities, occurring in approximately 7-10% of the population in most languages and cultures of the world (Peterson & Pennington, 2012) and approximately 6-17% of the school population (Fletcher et al., 2007). Dyslexia is a reading disorder in children and adults and is recognized through the difficulties they face in reading and spelling words (Lyon et al., 2003; Pennington, 2009).

Reading problems experienced by dyslexic individuals are related to factors such as font size and choice (Stein, 2003). Larger font sizes, as well as specific fonts, are likely to help dyslexic children read better (Bachmann & Mengheri, 2018). A biological cause of dyslexia is dysfunction in the brain's magnocellular system. People with dyslexia have on average 30% fewer megaloblastic neurons than people without dyslexia (Stein, 2003).

Various practices and interventions have been developed to support children with dyslexia. Some of them are related to information and communication technologies (ICT). ICT constitutes the material and technical infrastructure and the individual components and features that make possible the modern use of computers (Manola et al., 2023; Vouglanis et al., 2022; Vouglanis & Driga, 2023). In the context of education, Luppicini (2007) has defined ICT as the educational tools and materials that are supported through technological applications and can be used in the educational process. Another definition describes ICT as "skills around information and communication devices, the software to operate them, applications that run on them, and systems built with them" (Mid-Pacific ICT Center, 2014). ICT includes the devices, networking, software applications and operating systems that work together to enable people and organizations to interact through the digital world of computers. Some of the software programs that have been used

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as ICT reading aids for students with dyslexia are Easy Dyslexia Aid (Dysgraphia Spelling & Literacy Helper) and Autism DTT Pro (Professional Discrete Trial Training), and EasyReading (Bachmann & Mengheri, 2018).

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## **2 The use of the computer in dyslexia**

Torgesen et al. (2010) studied the relative effectiveness of two computer-based reading learning support programs for first grade students. They observed that the groups of students who attended the teacher preparation for the use of the computers and used the computers performed significantly better than the students who did not use the computer as a means of supporting reading learning. In particular, the use of ICT significantly helped students with dyslexia in phonemic perception and decoding and in reading accuracy, speed and comprehension.

Thompson et al. (2018) studied a sample of 14 Wednesday through Sixth grade children with dyslexia before and after implementation of a computer-aided reading and writing learning program (HAWK Letters in Motion©). The children showed significant improvement in key problem areas of dyslexia such as word encoding and weaknesses in spelling, syntax and reading comprehension. In addition, they showed improvement in handwriting as well as spelling. Research by Rello & Baeza-Yates (2017) on the reading speed of 46 participants aged 13 to 37 with dyslexia compared to 46 matched participants without dyslexia using a computer showed that large font size as well as longer distances between letters helped participants with and without dyslexia read significantly faster.

Pang & Jen (2018) examined the use of computer-based ICT in online literacy learning for Malaysian students with and without dyslexia. Their results showed that online communication forums are suitable for students with and without dyslexia and that they provide the student with the opportunity to follow his/her own pace of learning.

Recently, Auphan et al. (2018) found that in a sample of 485 French students aged 7 to 14 years, the use of three ICT-based interventions, specifically computer-based, helped the students in reading but also revealed that 76 of the students had difficulties in reading comprehension. Hintikka et al. (2005) concluded that 22 Finnish 6-year-old students at risk of dyslexia benefited from computer-based intervention and showed improvement in reading. Heikkilä et al. (2013) also used a computer-based ICT intervention and found that in a sample of 150 Finnish students there was a significant improvement in reading. Borleffs et al. (2018) piloted a sample of 69 7-year-old students from Indonesia and confirmed that the computer-based preventive ICT program 'GraphoGame' significantly assisted children's developing reading and phonological skills.

In a sample of 30 Greek students of the 5th grade of primary school with the possibility of learning difficulties in reading, Morfidi et al. (2018) studied the use of ICT with multimedia and specifically the application of conceptual mapping (concept mapping) and concluded that it was successful. Lovio et al. (2012) found that 6-year-old children at risk of developing reading learning difficulties benefited from using a computer-based video game designed as an intervention to improve phonological awareness and general reading ability.

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## **3 The use of electronic games in dyslexia**

El Kah & Lakhouaja (2018) created a series of online games to improve reading and writing difficulties in children with dyslexia and dysgraphia in the Arabic language. The researchers tested these electronic games on a sample of 46 students aged 7 to 9, 5 of whom had dyslexia and 20 had learning disabilities. The results showed that the system was effective in improving the learning process (El Kah & Lakhouaja, 2018). Benmarrakchi et al. (2017) examined the benefits of ICT in a sample of 28 Arab students aged 8 to 10 years, eight of whom were dyslexic, by implementing an ICT system for Arabic language based on students' learning styles and concluded that ICT has a significant role in providing opportunities for dyslexic students to have a more active participation in education.

Lyytinen et al. (2007) developed the specialized game 'Literate' designed to prevent failure or delay in the acquisition of reading skills and the pilot test of the game was found to have positive results. In Italy, Franceschini & Bertoni (2019) also found that the use of electronic action games by dyslexic children leads to improvements in reading and more specifically in their phonological working memory and visual attention.

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## **4 Use of specific software**

Horowitz-Kraus & Holland (2015) found that the Reading Acceleration Program software was effective in improving reading, visual attention, and processing speed in students with reading difficulties aged 8 to 12 years. In one of the earliest relevant studies identified, Wise & Olson (1992) tested 'Spello' software designed to improve children's spelling

and phonological skills. In 28 students aged 7 to 14 the researchers concluded that this computer program had benefits for the phonological processing of students aged 10 and older. Elkind et al. (1993) studied the effect of a reading software on the performance of 28 students with dyslexia. The software was deemed successful and helped 70% of the sample improve their reading comprehension.

Olofsson (1992) used an automatic speech recognition and pronunciation software with Scandinavian children and concluded that such interventions can help the decoding problems of students with dyslexia and reading difficulties. Students expressed increased understanding of words while reading. Raskind & Higgins (1999) found that in a sample of 9- to 18-year-old students, intervention with ICT and use of speech recognition software led to significantly more improvement in 19 students than computer use in 20 students. In addition, Athanaselis et al. (2014) examined the use of the automatic speech recognition software "Eglogton" as a means of gradually assisting the reading of Greek students with dyslexia. The pilot study of the software showed that there was an improvement in reading rate and accuracy.

Kast et al. (2011) used an educational software for syllabification, which converts words into multisensory representations that include sound and image. They studied spelling learning in 65 dyslexic children, and compared the performance of 37 dyslexic students compared to 25 non-dyslexic students. Their results showed that children with dyslexia showed improvement in spelling to the same extent as children without dyslexia.

Hook et al. (2001) examined the effectiveness of the Fast ForWord (FFW) training program using computer and software in improving reading and speaking in children with phonemic perception and word recognition difficulties. The researchers concluded that the program is effective both immediately after the session and two years later. The program was similarly effective to another non-ICT program in reading and phonemic awareness, but not in word recognition.

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## 5 Educational platforms

Regarding the learning needs of children with reading difficulties or at future risk of dyslexia, McGuinness et al. (1996) trained a sample of 85 children aged 6 to 16 years who had reading and/or spelling difficulties in the use of the 'Phono-Graphix™' program. The results showed that after the implementation of the ICT program the children improved significantly in word recognition and decoding of nonsense words.

Irausquin et al. (2005) studied the use of automated computer exercises as an instructional tool to improve the reading ability of 14 students with low reading ability. The researchers concluded that computer-based support can be effective in reducing reading problems in the short term. Carvalhais et al. (2018) also found that ICT in the form of the computer-based intervention program 'Graphogame', improved spelling in a sample of 15 7-year-old children with reading difficulties in Portugal. Saine et al. (2010, 2011) applied a longitudinal computer-based ICT intervention program to a sample of 166 Finnish 7-year-old students at risk of developing dyslexia, and concluded that it was highly beneficial. After 28 weeks students' emerging reading ability was highly successful for students' reading fluency (Saine et al., 2011).

Johnson-Glenberg (2005) studied the application of the online educational platform "3D-Readers" to 20 students with low reading comprehension, and concluded that it is effective for those who initially had particularly low comprehension. Furthermore, Wentink, van Bon & Schreuder (1997) investigated the effectiveness of a flashcard computer program designed to increase decoding speed in 55 Dutch 8- to 12-year-old students with low reading ability. Children who participated in the training program showed significant improvements. In England, Lynch et al. (2000) found that in 8 children with an average age of 12 years, who had a significant deficit in language skills in previous years, a computer-based ICT-based educational intervention called 'RITA' was effective in supporting and personalizing their learning after 10 weeks of program implementation.

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## 6 Discussion

Based on the preceding literature review, it is concluded that in general the use of ICT in interventions with students with dyslexia is effective and deserves attention both as a main and as a supplementary means of education. As research has shown, the various forms of ICT, such as computers, educational platforms, specific software programs, electronic games and various multimedia applications, are able to be used both as a means of early prevention of the risk of dyslexia in children and enhancing the reading skills of dyslexic children [42-55]. Also, the implementation of ICT educational interventions as a means of early prevention of the risk of developing dyslexia showed similar effectiveness. Probably the positive effect of ICT on students with dyslexia can be attributed to its widespread use in children's everyday life and their familiarity with it, recommending a particularly pleasant learning environment for children.

Finally, it is important to highlight the productive and effective role that all digital technologies play in the education sector for students with special educational needs. These technologies, such as mobile devices (58-61), a variety of ICT applications (62-81), AI & STEM ROBOTICS (82-86), and games (87-89), facilitate and enhance educational procedures such as assessment, intervention, and learning. Additionally, the use of ICTs in conjunction with theories and models of metacognition, mindfulness, meditation, and the cultivation of emotional intelligence [90-116], accelerates and improves educational practices and outcomes, particularly for students with dyslexia and special educational needs.

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## 7 Conclusions

The possibilities opened up, through ICT, to improve the difficulties faced by dyslexic children, or that they will face in the future as older children, are important and further study of their application is recommended. Further examination of ICT interventions and educational programs is recommended in future research, as this review revealed positive outcomes of ICT, in all studies studied, to a greater or lesser extent, in helping and supporting children with reading disabilities, dyslexia or at risk of developing dyslexia.

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## Compliance with ethical standards

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### *Disclosure of conflict of interest*

The Authors proclaim no conflict of interest.

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