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TECHNICAL FACULTY
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ZRENJANIN**



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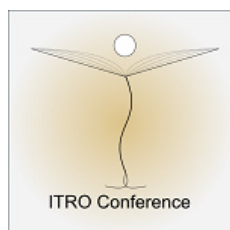
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INTRODUCTION

This Proceedings present the articles delivered at the international conference Information Technology and Education Development (ITRO 2024), held for the jubilee fifteenth time on November 29, 2024. This international event was conducted in a hybrid format, combining in-person and online participation. The conference continues its tradition of bridging science, professional practice, and educational experiences, with this year's focus on the conditions and perspectives of teachers' digital competencies.

The thematic fields of the conference reflect contemporary trends in education, addressing topics such as: the digitalization of education, education in crisis situations, educational challenges, theoretical and methodological issues in contemporary pedagogy, digital didactics and media, modern communication strategies in teaching, curriculum development for contemporary education, advancements in e-learning, education management practices, methodological approaches in teaching natural and technical sciences, and the integration of information and communication technologies in education.

The conference featured three plenary lectures that explored various aspects of the main topic, with the corresponding articles included at the beginning of this volume.

In total, this edition comprises 57 peer-reviewed articles, evaluated through a double-blind review process. These contributions represent the latest research and advancements in the field.

The conference received financial support from the Provincial Secretariat for Higher Education and Scientific Research, Novi Sad. Hosting and technical support were generously provided by the Technical Faculty "Mihajlo Pupin." We extend our sincere gratitude for this invaluable assistance.

The Organizing Committee expresses its heartfelt thanks to the authors, reviewers, and participants for their contributions, which ensure the success and continued tradition of this event.

We look forward to welcoming you to the next ITRO Conference!

On behalf of the ITRO Organizing Committee

Jelena Stojanov

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Review on Software Applications for Children with Dyslexia

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Abstract. Dyslexia is a neurodevelopmental disorder affecting reading, spelling, and writing abilities, quite common among 5% to 17% of the general population. Traditional approaches to education often fail to respond to the special needs of dyslexic learners. That is why this scoping review investigated how ICT tools—web applications, desktop software, and mobile apps—may provide support for children with dyslexia. Key features include TTS, STT, dyslexia-friendly fonts, and adaptive learning paths that provide multisensory environments to address phonological processing and memory challenges. These tools have been shown to improve reading comprehension, writing skills, and engagement by providing flexible and interactive learning experiences. However, access to these technologies is not always equitable, especially in low-resource settings, and there is a need for further research on their long-term effects. Finally, emerging technologies such as virtual reality and artificial intelligence are promising avenues toward the further enhancement of interventions for dyslexia. This review points out the transformative role of ICT in supporting dyslexic learners and calls for continuing innovation to ensure that learning environments become increasingly inclusive.

Keywords and phrases : Dyslexia, Information and Communication Technology (ICT), Assistive technology, Reading interventions, Multisensory learning

1 INTRODUCTION

Dyslexia is a neurodevelopmental learning disorder that primarily affects an individual's ability to read, spell, and write, often despite normal intelligence and adequate educational opportunities. Dyslexia is often described as a condition that leads to surprisingly critical problems in school and everyday life due to deficits in phonological processing and decoding skills. Estimates say that dyslexia might affect up to 5% to 17% of the population (Olivier & Nell, 2020), although the exact prevalence is rather difficult to identify due to the variations in diagnostic criteria, assessment procedures, and awareness across countries (Lerga et al., 2021).

Early diagnosis is critical to the effective management of dyslexia, which may cause major effects on academic achievement and general well-being. Dyslexia can be diagnosed through a complete educational and psychological examination that accounts for reading fluency, phonological awareness, and memory skills. These examinations can usually be carried out by educational psychologists or specialists trained in disorders related to learning. In the absence of intervention, dyslexia may progress to long-term school failure, a decrease in self-esteem, and psychological problems such as anxiety and depression (Wilmot et al., 2023).

Early intervention, especially at the primary level, can greatly change the outcome of the dyslexic child. Dyslexia is best managed through a multisensory approach to learning that integrates visual, auditory, and kinesthetic techniques to strengthen reading skills. One of the most widely applied methods is the Orton-Gillingham approach, which aims to be explicit, direct, and individualized in nature for each student. This multi-sensory approach can be extremely helpful in teaching children with dyslexia and other learning

disabilities using contemporary ICT devices like touch-screens, accelerometers, gyroscopes, voice recognition, sound reproduction, as well as various other software tools.

Moreover, recent developments in AI, particularly in generative AI, are rapidly penetrating various sectors of society, transforming industries with unprecedented efficiency and scalability. Multiple AI tools, are not only revolutionizing content creation in media and entertainment but are also reshaping fields like medicine (Chabra et al., 2013), (Stojanov & Koceski, 2014), (Kotevski et al., 2024), healthcare (Devedžić et al., 2021), (Stojanova et al., 2019), social care (Koceski & Koceska, 2016), (Koceska et al., 2019), robotics (Koceska et al., 2013), (Velinov et al., 2024), finance, business (Kirovska & Koceski, 2015), education (Duh et al., 2017), (Koceski & Koceska, 2022), (Koceska et al., 2024) and customer service.

AI-driven tools, like speech-to-text and text-to-speech applications, assist students in reading and writing, allowing them to process information at their own pace. Adaptive learning platforms use algorithms to assess each child's specific needs, tailoring lessons and exercises to strengthen literacy skills without overwhelming the learner. This personalized support helps dyslexic students build foundational skills in a structured, manageable way.

AI-powered reading assistants and dyslexia-friendly fonts simplify text comprehension by reducing visual strain and offering real-time feedback, making reading a more positive experience. Additionally, AI tools like predictive text and grammar correction improve writing confidence by addressing frequent spelling or structure-related issues. Virtual classrooms and gamified apps create engaging, multisensory environments that reinforce memory and cognitive skills through interactive, enjoyable exercises. All these ICT and AI advancements are fostering a more inclusive educational environment, empowering dyslexic students to thrive alongside their peers and adapt to a rapidly digitalizing world.

1.1 Role of Technology in Dyslexia Intervention

Therefore, the boom in ICT has given way to new, innovative interventions for children with dyslexia. From simple web-based applications to full-fledged desktop and mobile software, these technologies are aimed at helping children with dyslexia in reading and writing. Several studies have indicated that ICT tools can help traditional educational interventions by providing tailored learning environments that meet the special needs of children with dyslexia (Cidrim & Madeiro, 2017).

- **Text-to-speech** (TTS) software enables children to hear written text, which can improve reading comprehension and fluency. Applications that highlight words as they are spoken allow the child to visually follow the text while hearing it, thus supporting both auditory and visual learning.
- **Speech-to-text tools** (STT) applications convert spoken words to written text, thus allowing dyslexic students to write without the constant embarrassment of spelling and grammatical mistakes.
- **Dyslexia-friendly fonts** like OpenDyslexic, used across many platforms, improve readability by altering the appearance of letters in a way that reduces visual confusion (Lerga et al., 2021).

2 RELATED WORK

Several studies have reviewed the effectiveness of ICT tools in supporting learners with dyslexia. A scoping review by Dean, Pascoe, and le Roux (2023) was conducted on ICT reading interventions; the authors placed much emphasis on text-to-speech and adaptive learning environments. Their results indicated that many digital tools are effective in improving reading comprehension, fluency, and engagement.

Olivier & Nell (2020) conducted a scoping review of ICT-based literacy interventions and found that these technologies significantly improve reading fluency and comprehension. Cidrim and Madeiro (2017) presented a wide-based review of ICT applied to dyslexia, identifying a large range of applications that have been successfully used to enhance learning. They emphasized the importance of customized software, which adapts to the particular needs of the learner, allowing dyslexic children to work at their own pace.

Similarly, Kalyvoti and Mikropoulos (2014) explored the use of virtual environments for dyslexic learners, displaying how immersive experiences can be used to improve phonological awareness and memory retention.

Dean et al. (2023) addressed the role of reading interventions and indicated that, besides providing practical solutions for dyslexic learners, ICT tools also create engagement and motivation.

Furthermore, Lerga, Candrlic, and Jakupovic (2021) examined assistive technologies, noting that mobile apps, desktop software, and web-based tools are integral in improving the literacy skills of students with dyslexia. Exploring virtual environments, as afforded by Kalyvoti and Mikropoulos (2014), it became evident that new opportunities for learners with dyslexia come alive through virtual environments in a manner that offers experiential, hands-on learning to strengthen their cognitive and literacy abilities.

Many of these tools include visual and auditory supports, which are very much in line with the multisensory approach demonstrated to be effective for learners with dyslexia (Di Paolo et al., 2021).

3 TECHNOLOGY AND DYSLEXIA

Technological advancements have significantly expanded the tools available to support children with dyslexia. Technological support tools available fall into three main categories: web applications, desktop software, and mobile applications, each offering distinct features that specifically target certain challenges in literacy.

Table 1 summarizes the categories of software applications used in dyslexia intervention, highlighting their core features and benefits.

Table 1. Categories of Software Applications for Dyslexia Support

<i>Category</i>	<i>Examples</i>	<i>Features</i>	<i>Benefits</i>
Web Applications	Natural Reader, Rewordify	Text-to-speech, Speech-to-text, Dyslexia-friendly fonts	Accessible on multiple devices, improves reading comprehension
Desktop Software	Kurzweil 3000, Grammarly	Advanced text-to-speech, Grammar/spelling checks, Mind-mapping	Comprehensive tools for reading, writing, and organizing thoughts
Mobile Applications	Dyslexia Quest, Reading Eggs, Voice Dream Reader	Phonics training, Spelling games, Audiobook integration	Engaging, portable, provides interactive learning experiences

3.1 Web Applications

In most cases, web applications take the lead as the first line of support because of their accessibility and user-friendliness. Some tools integrate text-to-speech, where a webpage can read written material out loud in order to help children understand its content. A well-known example is Natural Reader, a text-to-speech application used in supporting dyslexic learners through the auditory feature of listening while simultaneously following text visually (Dean, Pascoe, & le Roux, 2023).

Similar is the case with other Web applications like Rewordify, which simplify complex texts for easier comprehension by dyslexic readers. These tools increase access in their presentation since they offer alternative routes to understanding. The use of dyslexia-friendly fonts and adjustable layouts enhances readability, thereby reducing the cognitive load on dyslexic students (Cidrim & Madeiro, 2017).

3.2 Desktop Applications

Desktop software provides more comprehensive support for dyslexic students by, in many cases, offering advanced features that are not possible with web-based software. Such applications are particularly useful for tasks that require significant processing power, such as speech recognition or mind mapping.

- **Text-to-speech** with advanced features: Desktop applications like Kurzweil 3000 offer enhanced text-to-speech functionalities, including word highlighting and speech rate control. These tools support dyslexic learners by helping them follow along with the text visually while hearing it read aloud (Dean, Pascoe, & le Roux, 2023).
- **Grammar and spelling correction:** Many desktop tools provide real-time grammar and spelling checks that are especially useful for children struggling with written language. Grammarly and other such tools immediately identify errors related to dyslexia and offer appropriate suggestions for correction so that the student may gradually learn correct writing (Lerga et al., 2021).

- **Mind-mapping tools:** Organizing thoughts and structuring essays can be challenging for dyslexic students. Desktop applications like Inspiration offer mind-mapping features that allow users to visually organize ideas, making the writing process smoother and more intuitive (Kalyvioti & Mikropoulos, 2014).

3.3 Mobile Applications

In a nutshell, mobile apps are probably one of the most user-friendly and portable tools that a dyslexic child could leverage. These applications provide interactive and engaging ways to develop literacy skills through games and exercises, making learning fun and accessible.

- **Phonics training:** Apps such as Reading Eggs use interactive games to teach phonics and improve reading fluency. These apps are designed to be intuitive and adaptive, adjusting to each child's progress and providing real-time feedback (Di Paolo et al., 2021).
- **Spelling and handwriting practice:** Apps such as Dyslexia Quest engage children in puzzles and exercises to strengthen spelling and handwriting skills by reinforcing correct letter formation and spelling patterns (Cidrim & Madeiro, 2017).
- **Audiobooks and reading apps:** Dyslexic learners benefit from audiobooks, which allow them to listen to stories while following the highlighted text on the screen. Voice Dream Reader is a popular app that combines text and audio to help children improve their reading comprehension through a multisensory approach (Wilmot et al., 2023).

Mobile applications offer personalized learning paths, in which the development of each child is tracked, and accordingly, the difficulty levels are changed. This kind of individual learning experience is very important to keep children with dyslexia motivated and involved in their studies.

4 CONCLUSION

Integration of technology in educational interventions for children with dyslexia has been transformational in offering new solutions to a traditionally difficult learning disability. ICT-based tools, including web applications, desktop software, and mobile apps, provide practical, flexible, and personalized approaches that adapt to the individual learning needs of dyslexic students. Technologies can also enable learners to engage with literacy tasks in ways that are often more accessible, interactive, and enjoyable, which can lead to increased motivation and confidence.

One of the key benefits of these tools is their ability to provide multisensory learning environments, combining auditory, visual, and sometimes kinesthetic elements. With their aids, the tools cater to the different learning styles of dyslexic children, and by doing so, they help overcome some of the main difficulties related to dyslexia: phonological processing difficulties, poor working memory, and visual word recognition. For example, TTS applications enhance fluency and comprehension in reading, while STT applications help children express their thoughts without having their creativity handicapped by spelling or writing difficulties.

Moreover, ICT-based interventions can be tailored to specific literacy challenges, offering personalized feedback and adaptive learning paths. This way, the tailoring ensures that learners progress at their own pace without being overwhelmed by difficulties encountered individually. Such adaptive tools are especially useful for young children who may not do well with usual one-size-fits-all teaching methods.

However, there are still some challenges to guaranteeing equitable access to those technologies, especially in low-resource settings or developing countries where the infrastructure of ICTs may not be adequate. Additionally, there is a need for further research on the long-term efficacy of these tools, particularly regarding how they impact dyslexic learners' academic performance and psychological well-being over time. Ensuring that educators are adequately trained in using these tools is also crucial to their successful implementation.

The future should see more complex applications of evolving technology, such as virtual reality and artificial intelligence-driven tools for an even more immersive and responsive experience. To illustrate, virtual environments can simulate real-life reading and writing tasks in controlled, stress-free environments that may help dyslexic learners build up their confidence and practice their skills in new ways. Even better, technology in this area may increasingly incorporate AI, which can instantly provide data-based feedback adjusted to the particular learning profile of the pupil. In conclusion, the potential of ICT to support children with dyslexia is huge.

The current level of technologies, from plain web-based tools to complex desktop and mobile applications, offers a variety of opportunities to improve literacy skills and overcome learning difficulties. They are technologies that will continue to advance and therefore could gradually become of greater importance within dyslexia interventions, giving more power to the student in his or her learning journey and beyond. By ensuring equity of access and continuing to innovate, we can create more inclusive and supportive learning environments for all dyslexic students, regardless of their location or background.

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