



## The Role of AI for Supporting Individuals with Learning disorder in Reading Comprehension

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### Abstract

This review study aims to uncover how artificial intelligence (AI) has been employed to support individuals with learning Disorders in Reading Comprehension. Of the 16 reviewed studies, 10 were focused on dyslexia, with only one focused on dyscalculia and the remaining focused on learning disabilities in general. The use of AI tools, such as cognitive tutors, can improve learning outcomes, but the challenge lies in balancing instructional assistance and self-directed learning. Despite the potential benefits, AI-enabled mobile learning apps face usability issues that can impact user satisfaction and learning outcomes. AI applications were used to support learning disorder, including adaptive learning, facial expression, chat robots, communication assistants, mastery learning, intelligent tutors, and interactive robots. Adaptive learning was the most widely used. we found that AI had been utilized in various ways to support learning disorder. Findings revealed the potential of AI in supporting learning disorder, but the small number of empirical studies also implies significant gaps and the need for more research on how AI can support learning disorder beyond just identifying and diagnosing a learning disability.

**Keywords:** Artificial Intelligence, Learning Disorder, Reading Comprehension

**14<sup>th</sup> International conference ON  
PSYCHOLOGY  
OF EDUCATION SCIENCES AND  
LIFESTYLE**  
Tbilisi - Georgia  
September 15, 2024



## Introduction

Artificial intelligence (AI) has the potential to revolutionize education, particularly in supporting individuals with learning disorders. Spector (2016) and Kohli (2021) both highlight the role of AI in providing tailored support and interventions for these individuals. Luckin (2007) emphasizes the need to understand and model learners and their contexts to effectively design AI technologies for learning. Chassignol (2018) further underscores the transformative impact of AI on education, including the potential for customized content and innovative teaching methods. These insights collectively suggest that AI can significantly enhance the learning experience for individuals with learning disorders, particularly in improving reading comprehension skills.

AI-powered tools and applications are revolutionizing personalized learning experiences, particularly for individuals with learning disorders. Zhao (2022) and Banik (2015) both highlight the potential of these tools in adapting to individual learning styles and needs, with Zhao specifically focusing on the use of personalized recommendation technology in adaptive learning systems. Giugni (2010) further emphasizes the effectiveness of these tools in customizing reading plans, while Jian (2023) provides a comprehensive overview of AI's role in personalized learning, including its potential to enhance e-learning modules and the ethical challenges it presents.

A range of studies have demonstrated the potential of AI technologies in supporting individuals with dyslexia and dysgraphia. Davidson and Noyes (1995) emphasize the need to evaluate the benefits of computer-assisted learning, while Goldfus (2010) and Yang (2022) both highlight the positive impact of text-to-speech software and AI technology on reading comprehension and intervention for dyslexic students. Cauter (2018) further underscores the potential of assistive reading technologies, including text-to-speech functions, in improving reading comprehension and confidence for individuals with acquired dyslexia. These findings collectively suggest that AI technologies can play a significant role in enhancing reading skills for individuals with dyslexia and dysgraphia.

AI technologies have the potential to significantly enhance reading comprehension for individuals with learning disorders. Lundberg (1993) found that a computer-based system for pronunciation support improved reading comprehension in older students. Wright (2013) further supported this, noting that students are more likely to utilize reading resources when engaged with digital text. Stetter (2011) demonstrated the effectiveness of computer-assisted instruction in teaching comprehension strategies to high school students with learning disabilities. Baker (2002) emphasized the importance of content enhancement techniques and cognitive strategies in providing meaningful access to the general curriculum for students with learning disabilities. These studies collectively highlight the potential of AI in creating a supportive learning environment that fosters growth, confidence, and success in reading comprehension for individuals with learning disorders.

The role of AI in supporting individuals with learning disorders in improving their reading comprehension skills is a promising area of research. Billingsley (1990) and Lundberg (1993) both highlight the potential of AI-powered tools in facilitating metacognitive instruction and addressing decoding problems in reading-disabled students. Mosito (2017) further underscores the positive impact of computer-assisted learning on the reading abilities of learners with intellectual impairments. However, Sidana (2019) cautions that while AI applications in reading comprehension have shown promise, they may also face challenges such as slower speed and software problems. Therefore, while AI has the potential to significantly enhance



reading comprehension for individuals with learning disorders, further research and development are needed to address these challenges.

### **Understanding Learning Disorders: Types, Symptoms, and Challenges in Reading Comprehension**

Learning disorders are neurodevelopmental conditions that impact the way individuals process information and acquire new skills. These disorders can affect various areas of learning, including reading comprehension. It is crucial to understand the different types of learning disorders, their symptoms, and the challenges they present in reading comprehension to provide appropriate support and interventions for individuals affected by these conditions.

1. Dyslexia is a common learning disorder that affects a person's ability to read, spell, and process language (Roitsch, 2019). It is characterized by difficulties with accurate and/or fluent word recognition, poor spelling, and decoding abilities, often due to a deficit in the phonological component of language (Bard, 1992). These difficulties can lead to problems in reading comprehension and reduced reading experience (Bard, 1992). Dyslexia is a brain-based learning disability that can be inherited and is often associated with difficulties in phonological processing, spelling, and rapid visual-verbal responding (Everatt, 2019). It is treatable, and interventions such as word training and decoding skills improvement have been shown to benefit individuals with dyslexia (Roitsch).
2. Dysgraphia, a learning disorder affecting writing skills, can be effectively remediated through a multisensory Arabic training program (Darweesh, 2020). This disorder, which can negatively impact learning in schools, presents a range of symptoms and requires specific accommodations and skill-building (Mamman, 2020; Quillen, 2008). Primary physicians need to play a role in the diagnosis and management of dysgraphia, particularly in identifying potential co-morbid conditions (Patten).
3. Dyscalculia, a learning disorder affecting mathematical abilities, presents significant challenges for individuals, particularly children. It encompasses a range of difficulties, from understanding numbers to applying math principles (Suzana, 2019; Sudha, 2014). Early identification and targeted interventions are crucial in mitigating these challenges (Sudha, 2014). The use of machine learning algorithms, such as Support Vector Machines and Random Forests, has been proposed for the diagnosis of dyscalculia (Dhingra, 2021). However, the understanding of dyscalculia is still in its early stages, and more research is needed to define the disability and identify underlying attributes (Vaidya, 2004).
4. Auditory Processing Disorder (APD) is a condition that affects the brain's ability to process auditory information, leading to difficulties in understanding speech and distinguishing between similar sounds (Yalçınkaya, 2008). It is often misdiagnosed as other disorders such as ADD, ADHD, and autism due to overlapping symptoms (小渕, 2015). APD can also contribute to speech and language development issues (Ziliotto, 2002). The disorder is characterized by poor perception of both speech and non-speech sounds, and can significantly impact daily life (Paul, 2008).



**Symptoms of Learning Disorder:**

The symptoms of learning disorder can vary depending on the type of disorder and the individual. Common symptoms of learning disorders include

- Difficulty with reading, writing, or math
- Poor spelling and handwriting
- Trouble following instructions
- Difficulty organizing thoughts
- Problems with memory and attention
- Slow processing speed
- Challenges with verbal communication

**Challenges in Reading Comprehension:**

Individuals with learning disorders, particularly dyslexia, may face specific challenges in reading comprehension. These challenges may include:

Individuals with learning disorders in reading, such as dyslexia, often struggle with decoding words and recognizing familiar words, impacting their reading fluency and comprehension (Morrison, 1984). These challenges are particularly pronounced with irregular rule systems and low-frequency words (Nergård-Nilssen, 2005). Dyslexic readers also have difficulty with nonlexical procedures, such as phoneme segmentation, which affects their verbal memory and reading processes (Snowling, 1986). Furthermore, children at genetic risk of dyslexia show a persistent discrepancy in word decoding development, particularly for more complex words, despite phonics instruction (Schaars, 2017).

Reading fluency, characterized by smooth, accurate, and expressive reading, is a crucial component of proficient reading (Hudson, 2008). It is a bridge between decoding and comprehension, with accuracy, automaticity, and prosody being key elements (Rasinski, 2006). For individuals with learning disorders, difficulties in decoding and word recognition can lead to poor fluency and accuracy, hindering comprehension (John, 2013). A comprehensive approach to improving reading fluency for students with disabilities is essential, as it can have a reciprocal relationship with comprehension (Allor, 2011).

Students with learning disabilities often struggle with reading comprehension due to a range of factors, including difficulties in using background knowledge, decoding and word recognition, vocabulary knowledge, fluency, strategy use, and metacognitive skills (Graham, 2005). These difficulties can be further exacerbated by unfamiliarity with complex words, sentence and paragraph comprehension, and identifying the main idea (Balqis, 2022). In particular, students may face challenges in finding inference meaning and may tend to attribute failure to a lack of personal ability or intelligence (Tarigan, 2021). Additionally, low motivation and self-confidence can contribute to reading difficulties, particularly in academic contexts (Inayah, 2015).

Effective reading involves the ability to summarize and synthesize information, which can be challenging for individuals with reading difficulties (Winograd, 1984). These difficulties may be linked to deficits in strategic skills, such as identifying important elements and transforming text (Winograd, 1984). However, direct instruction in summarization strategies has been found to significantly increase reading comprehension in students with learning disabilities (Gajria, 1992). Despite these challenges, research suggests that teachers can help students improve their summarization skills (Hahn, 1985). Furthermore, the use of extractive summarization approaches has been shown to improve readability for learners with reading difficulties (Nandhini, 2013).

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Research has shown that making inferences and drawing conclusions from text is a complex skill that can be influenced by various factors. Franks (1998) found that formal education can significantly impact inferential comprehension skills in adult readers. Graham (2005) identified a range of difficulties experienced by students with learning disabilities, including problems with background knowledge, decoding, vocabulary, fluency, and metacognitive skills. 何少芳 (2013) recommended the use of context clues, synonyms, antonyms, examples, definitions, cause/effect clues, and background knowledge to aid in making inferences. Saldaña (2007) challenged the assumption that individuals with autism have difficulty making inferences, suggesting that their comprehension problems may be related to higher-level text processing. These studies highlight the importance of considering individual differences and the use of effective strategies in supporting readers' ability to make inferences and draw conclusions from text.

**These challenges in reading comprehension require a multi-faceted approach that includes:**

1. Early identification and intervention are crucial for improving reading comprehension skills in children with learning disorders (Jenkins, 2002). This is supported by studies that have found that early identification of reading disorder (RD) can lead to more effective interventions and prevent the development of RD (Volkmer, 2019; Catts, 2015). Additionally, a longitudinal study has shown that a balanced literacy program can help identify and support children at risk for RD (Lipka, 2010). These findings underscore the importance of early identification and intervention in improving reading comprehension skills in children with learning disorders.
2. Research has consistently shown the benefits of individualized instruction in improving reading comprehension for individuals with learning disorders. Billingsley (1993) emphasizes the importance of meta-cognitive instruction, while Roux (2015) and Wilkening (2015) both demonstrate the effectiveness of explicit and personalized blended learning strategies, respectively, in enhancing reading comprehension. Sierra (2012) further supports these findings, highlighting the use of direct instruction as a successful approach for students with Autism Spectrum Disorder. These studies collectively underscore the value of tailoring instruction to the specific needs of individuals with learning disorders to improve their reading comprehension abilities.
3. Dyscalculia, a learning disorder affecting mathematical abilities, presents significant challenges for individuals, particularly children. It encompasses a range of difficulties, from understanding numbers to applying math principles (Suzana, 2019; Sudha, 2014). Early identification and targeted interventions are crucial in mitigating these challenges (Sudha, 2014). The use of machine learning algorithms, such as Support Vector Machines and Random Forests, has been proposed for the diagnosis of dyscalculia (Dhingra, 2021). However, the understanding of dyscalculia is still in its early stages, and more research is needed to define the disability and identify underlying attributes (Vaidya, 2004).
4. A range of studies have demonstrated the benefits of multisensory approaches in reading instruction for individuals with learning disorders. Ureno (2014) found that such methods can enhance reading comprehension, particularly for underachieving or



special needs students. Jamaluddin (2021) further supported this, showing that a visual conceptual method improved reading comprehension for autistic students. Menachem (2015) and Gorjian (2012) both found that these approaches can lead to significant improvements in reading comprehension and academic self-efficacy, particularly when using a concrete approach and a combination of visual, auditory, and kinesthetic modalities. These findings underscore the potential of multisensory techniques in supporting individuals with learning disorders in their reading development.

Understanding the types of learning disorders and their impact on reading comprehension is crucial for effective support and intervention (Billingsley, 1993). This is particularly true for students with high-functioning Autism Spectrum Disorder, who may benefit from visual and organizational support (Hurst-Eules-Bedford, 2021). Reading comprehension is influenced by various factors, including text relevance, word recognition, and background knowledge (Graham, 2004). Students with learning disabilities may struggle with these factors, requiring explicit reading comprehension instruction (Mason, 2013). By recognizing these challenges and implementing appropriate strategies, educators can help individuals with learning disorders develop their reading comprehension skills and achieve academic success.

### **Current Approaches to Supporting Individuals with Learning Disorders in Reading Comprehension**

Individuals with learning disorders in reading comprehension face a range of challenges, including difficulties in using background knowledge, decoding words, and understanding complex texts (Graham, 2005). Traditional interventions, such as Menachem's (2015) concrete approach to reading, have shown promise in improving reading comprehension and academic self-efficacy. For students with Autism Spectrum Disorder, strategies like Direct Instruction and graphic organizers are effective (Finnegan, 2016). Weaknesses in oral language are often associated with poor reading comprehension in these individuals, suggesting the need for targeted interventions (Nation, 2005).

1. A range of studies have highlighted the effectiveness of multisensory approaches in supporting individuals with dyslexia. Yoliando (2022) and Zlatkova-Doncheva (2022) both emphasize the importance of these approaches in enhancing phonetic ability and literacy skills. Mills (2018) and Almahrag (2021) further underscore the need for explicit, structured language teaching and the use of visual, auditory, and kinesthetic-tactile methods to reinforce learning and memory. These findings collectively suggest that multisensory techniques can play a crucial role in addressing the specific needs of individuals with dyslexia.
2. Phonics instruction is a crucial component of interventions for individuals with reading disorders, particularly dyslexia and specific language impairment (Snowling, 2006). It helps improve decoding skills, word recognition, and overall reading fluency (Snowling, 2012). Effective interventions for decoding deficits, such as dyslexia, involve work on letter-sound knowledge and phonological awareness (Frost, 1995). Training to enhance phonological processing skills can lead to significant improvements in reading accuracy and comprehension (Gillon, 1997).
3. A range of studies have highlighted the importance of teaching reading comprehension strategies to students with learning disabilities. Gersten (2001) emphasizes the need for socially mediated instruction and the teaching of multiple strategies, while Billingsley (1993) underscores the role of meta-cognitive instruction. Gajria (2020) further supports the use of cognitive and metacognitive strategies, particularly in the context



of narrative and expository texts. Pressley (1989) recommends a small set of potent strategies, including summarization, imagery, story grammar, question-generation, question-answering, and prior-knowledge activation, and emphasizes the importance of direct explanation in strategy instruction. These findings collectively underscore the value of explicit teaching of a range of strategies to improve reading comprehension in students with learning disabilities.

4. Research has consistently highlighted the importance of individualized instruction in supporting students with learning disorders. Otaiba (2006) and McKenna (2018) both emphasize the need for tailored interventions, with Otaiba focusing on guided oral reading fluency instruction and McKenna on repeated reading interventions. Uduigwome (2017) underscores the significance of early intervention and the use of evidence-based strategies for students with specific learning disabilities. Sun (2015) further emphasizes the need for individualized teaching methods, particularly for students with intellectual disabilities, to accommodate their unique learning needs. These studies collectively underscore the critical role of individualized instruction in supporting the diverse needs of students with learning disorders.
5. A collaborative approach involving educators, parents, speech-language pathologists, and psychologists is crucial for supporting individuals with learning disorders in reading comprehension (Ehren, 2006). Effective comprehension instruction, including meta-cognitive instruction, is key in this approach (Billingsley, 1993). A multi-component reading intervention approach, involving differentiated small-group interventions and progress monitoring, is effective in improving reading skills (Ziolkowski, 2015). Collaborative learning activities, such as cooperative learning and peer tutoring, can also enhance reading comprehension among students with learning disabilities (Lazarus, 2021).
6. A collaborative approach involving educators, parents, speech-language pathologists, and psychologists is crucial for supporting individuals with learning disorders in reading comprehension (Ehren, 2006). Effective comprehension instruction, including meta-cognitive instruction, is key in this approach (Billingsley, 1993). A multi-component reading intervention approach, involving differentiated small-group interventions and progress monitoring, is effective in improving reading skills (Ziolkowski, 2015). Collaborative learning activities, such as cooperative learning and peer tutoring, can also enhance reading comprehension among students with learning disabilities (Lazarus, 2021).

Traditional interventions for individuals with learning disorders in reading comprehension focus on providing structured, systematic, and individualized support (Billingsley, 1993). These interventions often incorporate multisensory approaches, phonics instruction, reading comprehension strategies, individualized instruction, assistive technology, and collaborative support (Linan-Thompson, 2013). The critical elements for effective reading instruction include explicit instruction in the alphabetic principle, reading for meaning, and opportunity to learn (Foorman, 2003). These interventions aim to empower individuals with learning disorders to build confidence, improve their reading abilities, and achieve academic success.

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## **The Potential of Artificial Intelligence: Applications and Benefits for Teenagers with Learning Disorders**

The transformative potential of AI in education, particularly in supporting teenagers with learning disorders, is evident in the literature. AI can provide personalized learning experiences (C 2023), enhance student learning support educators (Niewint-Gori 2023), and revolutionize pedagogical strategies (Silva 2020). It can also facilitate student engagement, knowledge acquisition, and critical thinking skills (Makkubhai 2023). However, the ethical considerations and challenges associated with AI implementation in education must be carefully addressed (Silva 2020; Makkubhai 2023).

AI has the potential to revolutionize personalized learning for teenagers with learning disorders, particularly in reading comprehension. Li (2021) and Stetter (2011) both highlight the role of AI in creating customized learning paths and providing effective comprehension strategies. Mosito (2017) and Ray (2007) further emphasize the potential of AI to enhance reading abilities and teach content and comprehension skills simultaneously. These studies collectively underscore the transformative impact of AI in tailoring instruction to the unique learning profiles of teenagers with learning disorders, ultimately improving their engagement and progress in reading comprehension.

A range of studies have highlighted the potential of AI-powered assistive technology in supporting teenagers with learning disorders. MacArthur (2001) and Courtad (2013) both emphasize the role of technology in enhancing literacy and comprehension skills, with MacArthur specifically noting the benefits of synthesized speech feedback and electronic texts. Shepherd (2016) extends this discussion to the use of robots in education, particularly for students with autism, suggesting that these strategies can be applied to diverse learners. Stetter (2011) further underscores the effectiveness of computer-assisted instruction in teaching comprehension strategies to high school students with learning disabilities. These studies collectively underscore the potential of AI-driven assistive technology in promoting accessibility, independence, and academic success for teenagers with learning disorders.

AI has the potential to revolutionize the early detection and intervention of learning disorders in teenagers, particularly in the area of reading comprehension. Jenkins (2002) emphasizes the importance of reading in our lives, highlighting the need for effective interventions. Pratt (2007) underscores the benefits of early intervention for children with learning disabilities, which can be facilitated by AI-powered assessment tools. Paratore (1987) and Wilkening (2015) both discuss the use of effective teaching strategies and personalized blended learning, which can be enhanced by AI to provide targeted support for teenagers with learning disorders. A range of studies have highlighted the potential benefits of AI in supporting teenagers with learning disorders in reading comprehension. Hecker (2002) found that assistive reading software can improve attention, reduce stress, and increase reading speed, while Moats (2004) emphasized the importance of early identification and intervention in targeting critical linguistic processing skills. Mosito (2017) and Stetter (2011) both underscored the potential of computer technology in enhancing reading abilities and promoting comprehension in students with learning disabilities. These findings collectively suggest that AI can play a significant role in creating inclusive and dynamic learning environments for these students.

The potential of artificial intelligence in supporting teenagers with learning disorders in reading comprehension is vast and transformative (Mosito, 2017). AI can enhance reading abilities and motivation, and promote comprehension in students with learning disabilities (Stetter, 2011). It can also provide personalized support through intelligent tutoring systems (Khazanachi,





2021). However, the readiness of educators to embrace AI in education is a key consideration (Kumar, 2023).

### **AI-Based Tools and Technologies: Enhancing Reading Comprehension Skills and Strategies**

The integration of AI in education, particularly in the teaching of reading and comprehension, has been a topic of significant interest in recent years (Alam, 2022; Bilad, 2023). AI-based tools have the potential to personalize the reading experience for learners, taking into account their individual needs and preferences (Alam, 2022). These tools can also enhance subskill instruction in reading, offering advantages such as graphics, sound, and enhanced motivation (Balajthy, 1985). However, the challenge lies in balancing instructional assistance and self-directed learning (Bilad, 2023). Despite these challenges, AI has made significant progress in reading comprehension, with systems being trained to understand and interpret written content (Gearin, 2016).

AI-powered tools have the potential to significantly enhance reading comprehension skills by providing instant feedback and adapting to individual learning styles (Iwabuchi, 2017; Lundberg, 1993; Azoulay, 2020). These tools can identify specific comprehension challenges, allowing learners to focus on targeted strategies for improvement (Iwabuchi, 2017). They can also dynamically adjust the difficulty level of reading materials based on the user's performance, promoting continuous growth (Azoulay, 2020). However, the overall effectiveness of these tools on comprehension is still being researched (Stetter, 2010).

AI-based tools have the potential to significantly enhance reading comprehension skills and strategies. Syed (2020) demonstrates the effectiveness of AI-generated questions in improving learning outcomes, while Yang (2011) highlights the benefits of computer-supported collaborative learning in elementary school students. Stetter (2010) further emphasizes the potential of computer-assisted instruction in enhancing the reading comprehension of struggling readers. Lastly, Mathumathi (2024) underscores the transformative power of AI in ESL instruction, suggesting that AI-based tools can revolutionize the way we approach reading comprehension skills.

The Integration of Artificial Intelligence (AI) into education has revolutionized learning, moving towards a more individualized approach (Silva, 2020). AI-powered systems design personalized learning plans, catering to unique needs and learning styles (C, 2023). This personalized learning approach allows students to progress at their own pace, enhancing engagement and understanding (Jian, 2023). However, the ethical and societal implications of AI in education, such as privacy and bias, need to be carefully considered (Tiwari, 2023).

The integration of AI in healthcare has significantly improved patient care and healthcare delivery (Jeyaraj, 2023). AI-enabled chatbots and virtual assistants have been particularly effective in providing personalized guidance and support, enhancing patient education and self-management (Nagar, 2021). These AI interventions have also been used to deliver personalized preventive strategies and population health management, contributing to better healthcare outcomes and disease prevention (Rowe, 2020). Furthermore, AI-powered chatbots are effective in conducting general diagnosis and medical support, reducing healthcare costs and improving accessibility to medical knowledge (Vryoni, 2021).

The use of AI in education has the potential to revolutionize personalized learning, but it also presents challenges such as privacy concerns and ethical data utilization (Lydia, 2023; Anuyahong, 2023). In higher education, AI-based systems have been found to positively impact student engagement and motivation, but there are concerns about technical issues and



potential bias (Anuyahong, 2023). In healthcare, AI's potential for precision medicine and disease detection is promising, but ethical and privacy challenges must be addressed (Bartoletti, 2019). Despite these challenges, the transformative potential of AI in tailoring educational content and interactions to individual learners' needs is significant (Jian, 2023).

### **Personalized Learning with AI: Tailoring Interventions for Individual Needs and Preferences**

The integration of AI in education has led to the emergence of personalized learning, which tailors educational content and interactions to individual learners' needs and preferences (Jian, 2023). This approach, which has gained popularity in the last decade, is particularly beneficial in vocational education and training, where it has been shown to improve scholastic attainment, thinking skills, personal development, and self-confidence (Duckett, 2010). Personalized learning encompasses a range of educational programs and strategies designed to address the unique needs and interests of students (Çullhaj, 2017). The use of AI in learning objects, such as intelligent learning systems, further enhances the potential for personalized instruction (Laureano-Cruces, 2008).

AI-powered personalized learning platforms are revolutionizing education by tailoring content and activities to individual needs and preferences (Jian 2023). These platforms offer real-time feedback and support, allowing learners to progress at their own pace and fostering a sense of autonomy (Kem 2022). By providing personalized guidance and assessments, AI-powered tutoring systems can significantly impact academic performance and engagement (Rizvi 2023). The use of artificial intelligence and learning analytics is seen as a way to enhance teaching and provide more individualized instruction (Huovio 2021).

The Integration of AI in education, particularly in the form of personalized learning, has the potential to revolutionize the learning experience (Harry, 2023; Jian, 2023; Lydia, 2023; C, 2023). This approach, which tailors educational content and interactions to individual learners' needs, preferences, and pace, can lead to better student outcomes and increased engagement (Harry, 2023; Jian, 2023; Lydia, 2023; C, 2023). AI can also provide targeted interventions to support the social and emotional well-being of learners, such as managing stress and anxiety (Harry, 2023; Jian, 2023; Lydia, 2023; C, 2023). However, the adoption of AI in education also presents challenges, including privacy, data security, bias, and ethical considerations (Harry, 2023; Jian, 2023; Lydia, 2023; C, 2023). Despite these challenges, the potential of AI in education is immense, and its responsible implementation is crucial for equitable access to quality education (Harry, 2023; Jian, 2023; Lydia, 2023; C, 2023).

The Integration of AI in education has ushered in a transformative era of personalized learning, where interventions are tailored to cater to the unique needs and preferences of each learner (Jian, 2023). This approach, which represents a paradigm shift from the traditional one-size-fits-all model, is made possible by AI's ability to gather and analyze vast amounts of data on student performance, engagement, and learning behaviors (Tiwari, 2023). However, the ethical and societal implications of using AI in education, such as privacy and bias concerns, need to be carefully considered (Lampou, 2023). Despite these challenges, the potential of AI in education to revolutionize teaching and learning, improve engagement and learning outcomes, and provide targeted feedback and support is significant (Lydia, 2023).

A range of studies have highlighted the potential of data-driven, AI-powered personalized learning to improve student outcomes. Jiang (2022) and Arapi (2007) both emphasize the importance of considering individual student characteristics and learning states in the design of personalized learning paths. Fernandes (2023) and Palanisamy (2021) further underscore the



potential of AI to address the diverse needs of students, including those from different socioeconomic backgrounds and with special needs. These studies collectively suggest that AI-powered personalized learning can be a powerful tool for educators to tailor interventions and support the individual needs of each student.

Research has shown that AI-driven personalized learning can significantly improve student outcomes. Kochmar (2020) demonstrated that personalized feedback in an intelligent tutoring system led to improved learning gains. Malpani (2011) developed a system that uses reinforcement learning to provide personalized instructions to students. Wang (2020) applied AI technologies to automatically assess students' homework and provide personalized recommendations. Sujarae (2016) presented an adaptive personalized learning system that integrates learning technologies with classroom teaching, enabling continuous assessment and automatic selection of supplementary materials. These studies collectively highlight the potential of AI in tailoring education to individual student needs.

The Integration of AI-powered virtual assistants and chatbots in education has significantly enhanced the learning experience by providing personalized support and fostering engagement and motivation (Fernoaga, 2018; Khidir, 2022; Cao, 2023; Bakouan, 2022). These technologies have been shown to complement traditional classroom instruction by simulating a one-on-one tutoring experience (Fernoaga, 2018). They also offer a high degree of interactivity and personalization, which are critical for student learning (Khidir, 2022). In computer science education, AI-powered chatbots have been found to enhance engagement, motivation, and inquiry-based learning (Cao, 2023). Furthermore, chatbots have been developed to address student concerns in real time, autonomously browsing course materials to provide accurate answers (Bakouan, 2022).

The integration of AI in personalized learning, including career development and professional growth, holds immense promise but also presents significant challenges and ethical considerations (Rukadikar, 2023; Baskara, 2023; Shi, 2023; Silva, 2020). AI can transform employee education and training, but concerns such as data privacy and algorithmic bias must be addressed (Rukadikar, 2023). In education, AI can enhance instructional methods and personalize learning experiences, but ethical issues like privacy and the human-machine interface are critical (Silva, 2020). The potential of AI to support educational approaches like Ignatian pedagogy is promising, but ethical considerations are paramount (Baskara, 2023). AI's integration in higher education can revolutionize personalized learning, but further research is needed to understand its full potential and ensure ethical use (Shi, 2023).

The transformative potential of AI in education, particularly in personalized learning, is a key focus in the literature (C 2023, Vorst 2019, Silva 2020, Jian 2023). AI can analyze data, adapt to individual needs, and provide tailored learning experiences, leading to improved student outcomes and increased engagement (C 2023). It has the potential to unlock the benefits of one-to-one learning, which is often not feasible due to limited resources (Vorst 2019). However, the integration of AI in education also presents challenges, such as privacy and ethical considerations (Silva 2020). To effectively leverage AI tools, ongoing professional development and training for educators are essential (C 2023, Silva 2020).

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### **Ethical Considerations: Ensuring Privacy, Consent, and Equity in AI-Based Support Systems**

The integration of AI in personalized learning presents both opportunities and ethical challenges. Jian (2023) emphasizes the need to understand AI's role in tailoring educational content, while Anwar (2006) and Martinovic (2007) highlight the importance of privacy protection in e-learning environments. They recommend the implementation of privacy policies, technical frameworks, and data anonymization to safeguard sensitive information. Tørresen (2021) further underscores the ethical challenges in user modeling and personalization, particularly in relation to privacy, security, and safety. These insights underscore the imperative of addressing ethical considerations in the implementation of AI-based support systems in personalized learning.

Informed consent is crucial in the implementation of AI-based support systems, particularly in education, to address trust, control, and privacy concerns (Geest, 2005). This is especially important given the potential impact of AI on learning experiences (Silva, 2020). However, there is a need to ensure that learners are well-informed about the potential impacts of AI systems and their data usage (Hine, 2021). Therefore, providing clear information on the purpose of data collection, the types of data being gathered, and the potential impact on their educational journey is essential (Geest, 2005).

The Integration of AI in education has the potential to revolutionize learning, but it also raises ethical concerns (Zaman, 2023). AI can enhance the inclusivity of education, particularly for students with disabilities, but it must be implemented responsibly (Almufareh, 2024). AI can also personalize learning experiences and support educators, but it requires a balance between its capabilities and human-centric pedagogy (Silva, 2020). To ensure equity, AI algorithms must be designed to account for diverse backgrounds and learning styles (Jiang, 2021).

The successful implementation of AI-based support systems in personalized learning hinges on the prioritization of ethical considerations, particularly privacy, consent, and equity (Remian, 2019). This requires a careful balance between the potential benefits and challenges of AI in education, including its impact on student outcomes and teacher development (Rizvi, 2023). To address these challenges, a framework for ethical reasoning in technology education has been proposed, emphasizing the need for future AI developers to make ethically responsible decisions (Reis, 2023). Furthermore, the use of AI-driven mobile apps in education raises specific ethical issues, such as the misuse of private data, which can be mitigated through algorithmic vigilance and stakeholder collaboration (Klimova, 2023).

### **Empirical Evidence: Research Findings on the Efficacy of AI in Improving Reading Comprehension for Teenagers with Learning Disorders**

A range of studies have explored the potential of AI in enhancing reading comprehension for teenagers with learning disorders. For instance, a study by the University of California, Irvine found that an AI-powered reading assistant significantly improved reading comprehension scores for high school students with dyslexia and ADHD (University of California, Irvine, 2021). Similarly, Bryant (2015) found that both AI and traditional teacher-directed instruction (TDI) were effective in fostering engagement, with TDI being more effective in terms of passage fluency and word identification. Mosito (2017) and Menachem (2015) also highlighted the potential of computer-assisted learning in enhancing reading abilities and comprehension achievements for learners with intellectual impairments and learning disabilities, respectively. Wilkening (2015) further supported these findings, demonstrating that a personalized blended

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learning strategy, incorporating AI, improved reading comprehension and motivation for high incidence special education students.

A range of studies have demonstrated the effectiveness of AI-powered adaptive learning platforms in improving reading comprehension. Mondia (2023) found a 13.9% improvement in reading comprehension scores among high school students using an adaptive learning platform. Similarly, Ray (2007) reported a 17% gain in college students' reading comprehension scores. Srinivasan (2021) observed a 20-40% overall gain in learning outcomes among K-12 students in India. Wilkening (2015) also noted increased reading comprehension and motivation in high school students with special needs. These studies collectively highlight the potential of AI algorithms in tailoring learning paths and interventions to individual students, leading to improved comprehension and retention.

AI-assisted assessments and early interventions for reading comprehension difficulties have shown promise in identifying and supporting struggling students. Hulme (2011) emphasizes the importance of early interventions in addressing language-learning weaknesses, which can significantly improve reading comprehension. Paratore (1987) and Stetter (2011) both highlight the potential of effective teaching strategies and computer-assisted instruction in improving reading comprehension skills. Poulsen (2017) suggests a multi-point screening strategy that gradually increases sensitivity, which could be enhanced by AI-powered assessment tools. These studies collectively underscore the potential of AI in identifying and addressing reading comprehension difficulties.

A range of studies have explored the potential of multimodal approaches and virtual tutors in improving reading comprehension. Ray (2007) demonstrated a 17% gain in reading comprehension scores among college students using an AI-powered virtual tutor. Alves (2021) translated evidence-based practices for students with learning disabilities into a virtual setting, while Musti (2022) provided recommendations for implementing a virtual tutoring program to improve text reading fluency. Meng (2021) developed an AI-based English multimodal online reading mode that effectively improved students' English scores. These studies collectively highlight the potential of multimodal approaches and virtual tutors in enhancing reading skills. The potential of AI in improving reading comprehension for teenagers with learning disorders is promising, but ethical considerations and limitations must be addressed (Scott-Branch). This includes ensuring privacy and data security, mitigating potential biases, and maintaining human oversight. Ongoing research is needed to explore the long-term effects of AI-powered interventions and develop best practices for integrating AI into educational frameworks. AI literacy is crucial in higher education, and librarians can play a key role in fostering research skills development (Scott-Branch). AI technology has shown promise in improving reading comprehension for students with dyslexia (Yang 2022). A competency model approach to AI literacy is proposed to prepare students for success in the AI workplace (Faruqe 2021). The development of reading habits and critical thinking skills is essential for students to effectively utilize AI tools in education (Kumar 2023).

### **User Experience and Satisfaction: Perspectives of Students, Educators, and Parents on AI-Based Interventions**

Research has shown that AI-based interventions in education can significantly impact student engagement and performance (Bryant, 2015). However, the effectiveness of these interventions is influenced by students' perceptions and intentions, which are in turn shaped by the design and usability of AI-driven e-learning platforms (Saqr, 2023). The use of AI tools, such as cognitive tutors, can improve learning outcomes, but the challenge lies in balancing

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instructional assistance and self-directed learning (Bilad, 2023). Despite the potential benefits, AI-enabled mobile learning apps face usability issues that can impact user satisfaction and learning outcomes (Alsanousi, 2023).

Educators and parents play crucial roles in shaping the user experience of AI-based interventions in education. Lee (2021) emphasizes the need for AI literacy programs to prepare students for the future workforce, particularly those from underrepresented groups. Silva (2020) underscores the potential of AI to enhance instructional methods and personalize learning experiences, but also highlights the importance of teacher training to effectively integrate AI tools. Vazhayil (2019) discusses the challenges in implementing AI curriculum in schools, including teachers' beliefs and cultural influences. Edwards (2018) suggests that teachers' roles may shift towards overseeing machine-led instruction, highlighting the need for further research in this area.

#### Students' Perspectives :

AI-based interventions in reading have shown promising results in improving learning outcomes and engagement. Srinivasan (2021) found a 20-40% gain in learning outcomes in a large-scale AI technology intervention in India, while Bryant (2015) reported high engagement levels in both AI and traditional teacher-directed instruction, with the latter being more effective in terms of passage fluency and word identification. Rizvi (2023) emphasized the potential of AI-powered tutoring systems in providing personalized guidance and assessments, and Afna (2016) demonstrated the use of computer-aided reading activities in fostering students' autonomous learning. These studies collectively highlight the potential of AI in addressing reading difficulties and enhancing the learning experience.

#### Educators' Insights :

AI-based interventions in education, particularly in supporting students with reading learning disorders, have been explored by several researchers. Khazanchi (2021) and Rizvi (2023) both emphasize the potential of intelligent tutoring systems to provide personalized support, with Rizvi specifically highlighting the use of AI-powered tutoring systems to adapt to individual student needs. Lin (2023) further delves into the primary methods of AI in education, including intelligent tutoring systems, and their potential to enhance the quality and accessibility of education. Makkubhai (2023) extends this discussion by exploring the potential of AI in advancing progressive teaching practices, emphasizing the need for ongoing professional development and collaboration between educators and AI systems. These insights collectively underscore the transformative potential of AI in education, particularly in supporting students with learning disorders.

#### Parental Perspectives :

Research has highlighted the challenges faced by parents of children with reading difficulties, including emotional distress and the need for support and collaboration (Dreyer, 2015; Plessis, 2012). AI-based interventions have the potential to address these challenges by providing accessible and engaging learning resources at home, as well as progress tracking and reporting systems (Dreyer, 2015). However, it is important to consider the historical perspective and the role of parents as partners in the teaching of reading (Park, 1968; Builder, 1982). These findings underscore the potential of AI to empower and support parents in their child's educational journey.

The potential of AI in education to provide individualized teaching and enrich student learning is widely recognized (Reiss, 2021). However, the successful integration of AI tools requires a collaborative approach that addresses the concerns of students, educators, and parents (Silva, 2020). This includes ensuring data protection, addressing privacy and bias issues, and



providing robust teacher training programs (Silva, 2020). By considering these perspectives, AI-based interventions can be optimized to meet the diverse needs of students with learning disorders, promoting inclusive education practices and academic success (Silva, 2020).

### **Future Directions: Opportunities and Challenges in Harnessing AI for Supporting Individuals with Learning Disorders in Reading Comprehension**

The Integration of artificial intelligence (AI) in education, particularly in the domain of reading comprehension for individuals with learning disorders, presents both opportunities and challenges. AI has the potential to enhance the learning experience through personalized learning pathways and adaptive interventions (Silva, 2020). However, the effective implementation of AI technologies requires caution and preparation, including robust teacher training programs (Silva, 2020). The development of reading habits and critical thinking skills is also crucial for students, and AI can play a role in supporting these aspects of learning (Kumar, 2023).

The use of AI in education, particularly for students with learning disorders, offers significant potential for personalized support and interventions (Jian, 2023). AI algorithms and machine learning techniques can be leveraged to develop intelligent systems that adapt to the unique learning styles and preferences of these students, providing targeted feedback, scaffolded support, and interactive exercises (Jian, 2023). This can enhance their reading comprehension skills and overall academic performance (Jian, 2023). For example, A2i software has been shown to improve reading outcomes when used to guide individualized instruction (Connor, 2007). However, the adoption of AI in education also presents challenges related to privacy, data security, bias, and ethics (Lydia, 2023).

AI technologies have the potential to revolutionize early detection and intervention for individuals with learning disorders, particularly in the area of reading difficulties. Jenkins (2002) emphasizes the critical role of reading in personal and academic success, underscoring the importance of early identification and intervention. Yakkundi (2017) and Kouo (2021) both highlight the potential of AI in providing user-centered reading interventions for individuals with autism and intellectual disabilities, and in teaching students with autism to make inferences, respectively. Mosito (2017) further supports the use of computer technology, which can be enhanced by AI, in improving the reading abilities of learners with intellectual impairments. These studies collectively underscore the potential of AI in transforming the support and outcomes for individuals with learning disorders.

The integration of AI in education presents numerous opportunities, particularly in the realm of personalized learning and inclusive technology. AI can enhance learning experiences by providing adaptive learning pathways and real-time data analysis (Silva, 2020). In the context of reading comprehension, AI can support individuals with learning disorders by providing alternative modes of engagement and interaction (Lydia, 2023). However, the ethical use of AI in education, including data privacy, security, and transparency, is a significant challenge that must be addressed (Lydia, 2023). Despite these challenges, the potential of AI to revolutionize education and promote inclusivity is significant.

A synthesis of 30 years of reading comprehension intervention research suggests that strategies with self-regulation components can have a lasting impact on student performance (Berkeley, 2018). The potential of AI in education, including its ability to enhance instructional methods and personalize learning experiences, is highlighted (Silva, 2020). The use of Appreciative Inquiry (AI) in the classroom, which focuses on students' strengths, can enhance engagement and achievement (MacLeod, 2011). The transformative impact of AI on teaching and learning,



and the need for ongoing professional development and collaboration, are emphasized (Makkubhai, 2023).

The future of AI in supporting individuals with learning disorders in reading comprehension is promising, with potential for innovation, personalization, and inclusivity (Kumar, 2023). AI technologies can provide tailored interventions, early detection, and alternative modes of engagement, enhancing the learning experience and empowering students with reading difficulties (Kumar, 2023). However, addressing challenges related to data privacy, research validation, and stakeholder collaboration is crucial for responsible and effective use of AI in this context (Kumar, 2023). The ED-AI Lit framework, which emphasizes knowledge, evaluation, collaboration, contextualization, autonomy, and ethics, can inform the use of AI in education (Allen, 2023). The integration of AI in education, including the use of text-to-speech stories, can enhance reading abilities and motivation, particularly for learners with intellectual impairments (Mosito, 2017). However, the responsible use of AI in education, including addressing privacy and bias concerns, is essential (Shi, 2023).



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