

Educational Equity and Bridging Learning Gaps with AI for SWLD

Cong Jia *

School of Education, University of Glasgow, Glasgow, U.K.

* Corresponding Author Email: jiacong0910@163.com

Abstract. AI holds promise for enhancing educational outcomes for students with learning disabilities (SWLD), providing custom-tailored learning experiences to overcome the shortcomings of traditional education modalities. This paper explores one such technological advance, AI, and its potential to bridge the equity gap through an earlier recognition of areas in need of support by tailoring learning environments, providing immediate feedback, and promoting personalized interventions for SWLD. But the journey is not without challenges including insufficient inclusive design, unequal access to technology and inadequate teacher training. Through descriptive analysis, correlation analysis, and linear regression, this paper examines survey and interview data to elucidate the opportunities that AI presents and the challenges that must be faced to fulfill AI's promise for all students.

Keywords: Educational Equity; Bridging Learning Gaps with AI; SWLD.

1. Introduction

Learning disabilities (LDs) are cognitive deficits that hinder the process of reading, writing, mathematical reasoning, and other academic skills, presenting major obstacles in conventional learning environments. Some of these challenges could be addressed using Artificial Intelligence (AI), which can provide individualized support, in the form of personalized learning systems, real-time feedback and adaptive interventions. Although AI is expected to provide SWLD with the opportunity to improve their learning experiences, there are new barriers concerning access, inclusivity and teacher training that must first be addressed. Through an analysis of survey and interview data using descriptive statistics, correlation analysis, and linear regression, this paper presents opportunities and challenges to the role of AI in SWLD education across the total range of educational experiences [1-3].

One of the issues that is faced by thousands of people around the world is learning disabilities. Personalized learning pathways, speech-to-text tools, attention tracking, and other technologies can be adapted to students' individual needs, which are challenges technology like AI can help address. For all these benefits, the incorporation of AI in classrooms has not flourished in every situation, as many students with learning disabilities face juxtaposing obstacles which can stem from the functionalities of the AI tools enabled to them, limited access to technology, lack of adequate teacher training, and so on [4-5].

2. Literature Review

Depriving someone of their rights is only a step toward destroying their humanity — the basis for educational equity, which is how we attempt to provide opportunities for every student, regardless of their socio-emotional status, economic status, cultural background, or struggles they face, to achieve the highest levels of academic and personal success possible in our educational systems. And equity in that it offers all learners the tools, guidance, and support to thrive, based on what life has offered them. Such equity is especially critical for students with learning disabilities (SWLD); these students are often up against a whole slew of gigantic roadblocks in the school environment. Traditional methods of teaching make it hard for students suffering from learning disabilities such as dyslexia,

ADHD, and dyscalculia to relate to the concepts being taught, leading to an imbalance in the learning experience, and eventually, in education [6-7].

In many education systems average child is comfortable in normal pedagogy and very little adaptation and accommodation are available for SWLD. Therefore, rather than reforming the system, we need to think about a reform for the system if we are to meet the urgent obligation of ensuring equitable access to quality education for SWLD. Examples of these solutions and interventions include the use of Artificial Intelligence (AI), which has persistently been viewed as a better way to manipulate education. AI has been promising in how it could transform teaching and learning for learning disabled students — in fact, it has been promising — for more than a decade. AI powered tools and learning material can cater to individual student needs, and create learning scenarios where following the learning styles of SWLD, they can be given the required support.

So they could prime SLD to do well, just like they can for everyone else by applying AI to customize what and how fast, people learn by providing data & content as needed basis. All of these one-on-one experiences can be filled in for what the existing, cookie-cutter approach of education has missed out. With AI, teachers have a range of adaptive technologies and support systems that can guide whole groups of students, allowing them to focus on the other students who would otherwise slip through the net in a busy classroom. The literature review presented here explores how AI is used to promote educational equity for students with learning differences (SWLD). It will examine the possibilities for the tech to make learning accessible; the hurdles that must be cleared for AI to fulfill its promise; and describe the varied experiments that have been undertaken in various educational environments to implement AI tools successfully. The purpose of this review is to examine and discuss how AI can be used to disrupt the educational opportunities of students with learning disabilities [8-10].

2.1. The Demand for Equality

A learning disability is a neurologically based difference in how a child learns compared to the other children in a traditional classroom environment. Reading, writing, maths, even socialising in a classroom setting all a struggle; disabilities limit a student's ability to learn and teach like most other students. These consist of dyslexia, tensional deficiency disorder (ADHD), dyscalculia, and various other defined disabilities which disrupt cognitive factors like attention, memory, and also higher-level critical thinking. For example, dyslexia can cause difficulty in reading and understanding words, while dyscalculia can affect understanding maths. Attention deficit hyperactivity disorder Students with ADHD may not be able to pay attention and complete tasks, but other learning deficits may keep a child from playing and interacting socially with peers or following verbal directions.

Yet, research has demonstrated consistently that students with learning disabilities possess the same intellectual potential as anyone else and thus experience little to no impediments or barriers to their potential abilities. This struggle is by NO means a sign of being smart – it shows how a student interacts and internalises the learning content. For example, AADHD student is creative and attempts to focus on typical classes. A dyslexic student may find it difficult to read but may have exceptional skills for solving complex problems. This reinforces the notion that the cognitive skills of special education students diagnosed with LDs are intact and that the deficits are manifestations of the way information is presented or tested (Learning Disabilities, n.d.) [10-12].

SWLD have the right to the same tools, resources, and support as SWNL in order for SWLD to be successful (or equal) in their learning and education; this is what educational equity of students with learning disabilities (SWLD) means. However the differing requirements of SWLD largely remain disregarded in traditional education systems. This approach is completely disconnected with the way these students absorb information, and it results in gigantic gaps in achievement. These mechanics, which are not as developed at this point in life as they will be at a later stage, cause SWLD to feel frustrated, less worth, and even lonely when they cannot stay on track with their other classmates. Their academic performance is affected with such lack of access to educational opportunities and has long-term effects in their social and emotional aspects too.

Such obstacles may cause SWLD to fall behind and therefore more formidable and innovative forms of teaching and learning are required to address the problems highlighted. One-size-fits-all approaches to teaching and learning are terrible for everyone, particularly for students with learning disabilities. That is why designing inclusive learning experiences have been getting a lot more recognition recently. The list is short and really this year is nothing but AI (a little bit of AI), AI in Learning — the addictive way to Learning which offers a tailored and comprehensive form of Learning. It assesses students on their strengths and weaknesses, their learning style, and tailors an interactive learning experience with the help of AI-based technologies. With personalized learning resources and immediate feedback, AI could potentially compensate for gaps in traditional pedagogical approaches that so often limit access to needed support for SWLD to succeed in school. Alan Koenig, an emeritus professor of special education at the University of Northern Colorado, said AI can help level the playing field for the students who have the most difficulty learning with intellectual disabilities, such as dyslexia or dysgraphia, while providing them with equal opportunities for success as their peers and pushing us closer to educational equity [12-14].

2.2. AI and Personalized Learning for Students with Learning Disabilities

In terms of raising educational equity, one of the major benefits of the use of Artificial Intelligence (AI) is its ability to provide hyper-personalized learning experiences. Personalized learning for SWLD is an educational approach in which the pace of learning and the instructional approach are optimized for the needs of each learner — an adjustment to points of difficulty for each individual. Most of us are familiar with the traditional education systems that follow a much rigid and standardized path — everyone makes a journey down the same road adjusting their speed and pace according to their abilities and difficulties. Because this model rarely takes into account the unique ways that SWLD think and process information, it tends to put SWLD at a disadvantage. However, AI is a more flexible and dynamic solution to this problem because it responds to the learner in the moment.

AI-based systems can monitor a student continuously, assess strengths, weaknesses, and troubled areas. Drawing from the students' usage patterns of the studying materials, the AI systems are able to individualize the pace, content and the manner of the material delivery according to the proficiency level of the student. This allows the instructor to always alter their materials to match a student's current ability, preventing them from being overwhelmed by information that is too advanced for them or being bored by information that is not stimulating or difficult enough. Instead, they are given learning materials that are in the sweet spot of their development, creating an invitation to delve into deeper engagement for a more fruitful learning experience. An example of how AI can help bring different groups to a common platform would be a dyslexic student who may not be able to read the conventional text but the same AI system with enlarged fonts, audio support, and highlighting the text when the voice reads them, will enable accessibility to the student [8-9].

For example, in the context of reading interventions, AI programs can take the form of personalized reading assistants and have been highly effective in implementing these interventions. These platforms may provide students with dyslexia tools for digital books that allow for the adjustment of text sizes, fonts, and color contrasts. These modifications are necessary for students who struggle with the visual or decoding features of standard print. Additionally, real-time pronunciation and comprehension feedback enables students to try and improve in a low stakes way. SM: It also provides such intense personalized support that students with learning disabilities are not learning the exact same material as other students (those without disabilities do not fall under the same level of individualized support). AI plays a major role in narrowing the educational gaps of SWLD and their peers, by providing such personalized learning experiences, and consequently, enhancing educational equity.

In addition to this, certain learning hurdles have been identified using AI tools, which have now been equipped to furnish scaffolding within these confines, ensuring the students receive the assistance they require to excel without experiencing excessive challenges. As an example, Attention

Deficit Hyperactivity Disorder (ADHD) students struggle to stay focused, organized, and manage their time well in most classrooms. The use of AI-driven applications can actually reduce these concerns through the usage of reminders, prompts, or short breaks integrated into the learning experience. This allows to lead the student through his/her assignments, keeping them on task and engaged without losing focus nor getting frustrated. Offering prompt reminders and structure, AI systems enable ADHD students to concentrate on time and focus on their assignment or task. Aside from assistance in maintaining focus, AI systems can also modulate the pace of content delivery [15].

2.3. Intelligent Tutoring Systems (ITS) and Their Impact on Learning Disabilities

TTS systems read aloud written text and thereby allow students to listen to it instead of reading it. For students who have a hard time decoding written words, this auditory form of learning can increase understanding tremendously. For example, students with dyslexia can process the information better when they hear the text read aloud, so even if they would have struggled to understand the ideas when reading on their own, they can learn the concepts with the audio help.

In the same way, speech-to-text (STT) technology provides major benefit for students who have compromised writing skills, like students who have difficulty with spelling or organizing their ideas on a page. For instance, students can use software that converts speech to text such as Dragon NaturallySpeaking, which enables them to dictate their thoughts out loud and have them translated into text. It takes away the stress of getting pen to paper about writing down their thoughts — and helps the students get their ideas out better and clearer. Letting students "speak" their thoughts into the computer allows them to concentrate less on the structure of writing and more on how to express their ideas. This can be especially powerful for students with learning disabilities who may feel anxious or frustrated by more traditional writing assignments. This allows students to overcome barriers to expression so they can engage more completely in writing assignments and class discussion, and ultimately perform better academically, rather than battling penmanship or spelling.

Apart from TTS and STT, AI-powered tools have also found their way into more elaborate assistive tools that cater to other sensory and learning needs. For instance, AI may be implemented in visual technologies that could help the visually impaired and auditory-impaired students. AI tools can offer live captioning, converting speech into textual form on a screen as it is spoken. This can be especially beneficial for students who are deaf or hard of hearing as they can follow along with classroom discussions, lectures, and any multimedia content that would otherwise be inaccessible to them. Aside from captions, AI can also facilitate sign language translation, thus allowing real-time communication between deaf students and their hearing peers and teachers. Through this incorporation of AI, hearing impaired students can take part in the academic experience to the full extent possible, participate in classroom activities and be able to access educational content on equal footing with their peers [1-3].

And AI or technology driven accessibility is not just limited to sound and sight. Artificial intelligence based applications can provide adaptive learning systems and tailor content delivery as per the individual needs of students. Students with motor impairment or other interacting in digital learning environment contexts are enabled by AI-enabled assistive devices performing operations using eye movement, head gestures, or adapted keyboards for classes. AI technologies also remove barriers around various types of disabilities that would inhibit SWLD's classroom participation and academic experience.

Integration of AI into assistive technologies is essential to drive inclusion and equality in educational environments. The ability for AI to personalize interventions to individual-use cases ensures that students receive the type of learning styles necessary to support their learning disabilities—no matter what they are, or how serious they are.

2.4. Implications for Future Research and Policy

Is AI making it easier or harder for students with learning disabilities (SWLD) to learn along the lines of their peers? As the technology behind Artificial Intelligence (AI) expands at a pace we have

never seen before, we need to take a closer look at its impact on educational equity for SWLD. AI has the promise to improve learning outcomes and promote inclusivity, but a sustained research agenda is needed to understand the effectiveness and the long-term impact of AI on SWLD. Future studies must go beyond the short-term impact of AI tools on academic performance and social inclusion over time. But these studies need to interrogate how AI plays into not just students' cognitive development, but others skills and aspects of their non-academic lives, such as their social interests, emotional feelings, and... Just general engagement in the act of going to school. Because AI tools are intended to deliver customized learning, it is important to determine if these interventions produce larger gains over the long run than conventional forms of teaching.

Future research should explore the other impact on social inclusiveness of the integration with AI technology to SWLD beyond academic performance. While AI systems can provide help to students with disabilities to participate more fully in classroom activities, it remains to be seen whether these technologies will actually help students with disabilities better integrate socially with their peers. If we are to promote emotional and academic performance for our students with learning disabilities, knowing how to implement AI to create a more inclusive classroom is essential. Studies also need to investigate the social hazards of AI, i.e., whether students rely too much on technology or feel isolated when learning experiences become more individualized. Through embedding these dimensions, researchers can offer important perspectives on how AI can be leveraged to enable a more equitable and beneficial academic experience for students.

In addition, researchers should be looking at the use of AI tools in different learning environments. Special education classrooms often have specialized resources and systems to deal with these issues, whereas mainstream classrooms do tend to not be as well prepared to accommodate the needs of SWLD. Identifying how these AI technologies can be appropriately used (and used inappropriately, and when) in classrooms for special education and general education is a critical component to supporting equity. We must address whether AI tools in both settings are equally effective and can be designed to meet the needs of students from a wide variety of educational contexts. Identify best practices regarding the role of AI in different classroom settings and levels of support and resource availability so that all students can participate in the enhanced opportunities offered by AI.

Lastly, researchers, educators or policymakers must also be in the center of an ethically deploying AI in education. Policymakers need to outline new recommendations for the equitable development and deployment of AI tools in classrooms. This means building class-leading AI technologies with equity, access, and inclusion in mind. The design of AI systems should be human-centric with consideration of the different forms of disabilities to accommodate all students who may have unique learning challenges. Also, AI tools should not introduce bias that maintains these types of disparities such as race, gender, geography, economic status, or ability type. Policymakers should regulate the data that is used to develop all these amazing AI practices by ensuring that national data on all the groups the AIs might interact with is equally available, so no group of learners would be unintentionally discriminated against because AIs will not be able to have enough knowledge about them.

Another top priority for policymakers include the equalisation of tech tools and resources. AI has potential to revolutionize education, but it will only deliver if — and only if — schools all have the technological infrastructure that will be required. Policy makers need to think about funding schools, especially the under resourced ones, to support schools with the infrastructure to implement AI Processing. It also means providing schools with dependable internet access, up-to-date computing devices, and trained staff who can properly implement AI tools in the classroom. The digital divide will expand and minority and underprivileged schools and kids will be left behind without proper funding and resources.

3. Methods

This study utilized a mixed-methods approach that included survey data and qualitative interviews and analysis using descriptive analysis, correlation analysis, and linear regression to examine the factors influencing the effectiveness of AI tools tailored to individuals with learning disabilities (SWLD). A survey was administered to 100 educators and 50 parents of SWLD, and in-depth interviews were conducted with 10 teachers and 5 administrators. Survey data were analyzed using SPSS and Excel to describe the responses, explore the relationships between the key factors influencing adoption using correlation analysis, and predict the impact of key factors on the effectiveness of AI tools using linear regression analyses. The survey aimed to capture:

- Perceptions of AI tools in supporting SWLD
- Barriers to implementation, including access to technology, teacher training, and AI design features.

4. Results and Discussions

4.1. Descriptive Analysis

The survey sample consisted of 100 educators and 50 parents of SWLD. Most of the educators were from urban schools (70%), and 30% from rural schools. 60% of these parents indicated that their children had access to AI-based learning tools, while 40% did not as shown in Table 1 and Figure 1.

Table 1. Demographic Information of Survey Respondents.

Category	Percentage (%)
Educators in Urban Schools	70%
Educators in Rural Schools	30%
Parents with AI Access	60%
Parents without AI Access	40%

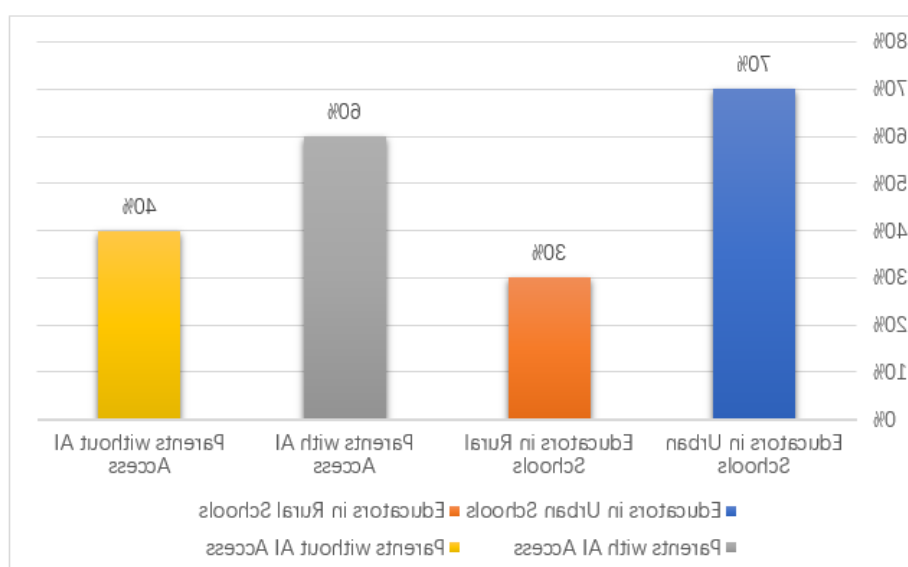


Figure 1. Demographic Information of Survey Respondents.

Survey items on the stated effectiveness of AI in supporting SWLD were summarized using descriptive statistics. Overall, the results support widely positive impressions of AI tools, with 80% of educators and 75% of parents indicating that AI helped lead to positive learning outcomes among students when it comes to reading and writing:

- Enhanced Reading Skills: 80% of teachers and 75% of parents felt that AI tools helped students enhance their reading skills.
- Enhanced Writing: 70% of teachers and 65% of parents believed that AI supported writing-challenged students.

4.2. Correlation Analysis

The relationships among teacher training, availability of technology, perceived effectiveness of AI tools were explored in correlation analysis. Overall, the results indicate a strong positive relationship between teacher training and the effective use of AI tools ($r = 0.72$, $p < 0.01$): specifically, that teachers who received training on how to use AI tools also tended to have positive SWLD outcomes as shown in Table 2 and Figure 2.

Table 2. Correlation between Teacher Training and AI Effectiveness.

Variable	AI Effectiveness (Pearson's r)
Teacher Training	0.72
Access to Technology	0.56

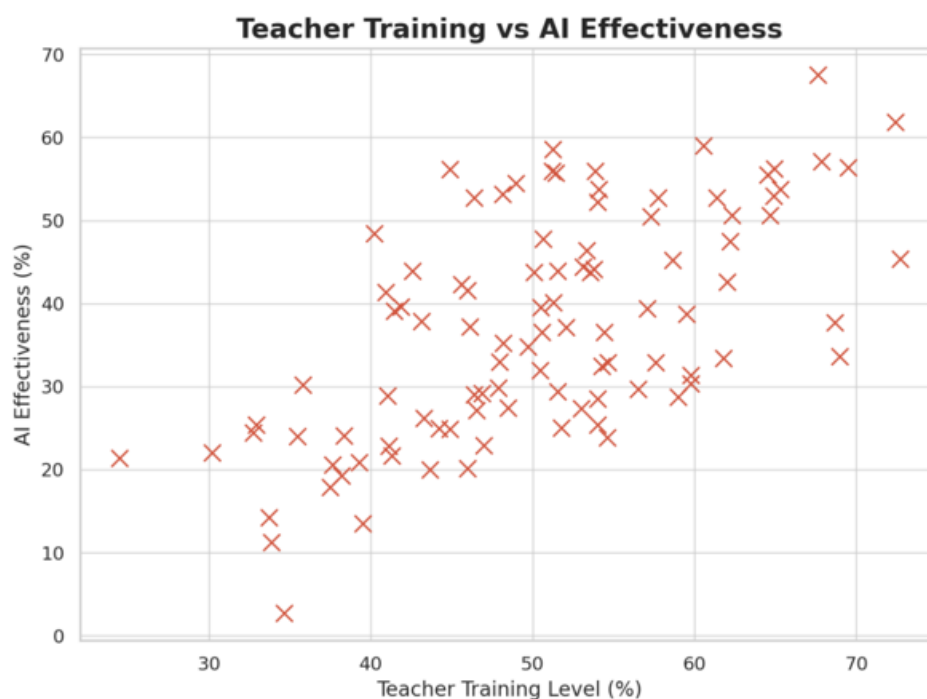


Figure 2. Teacher training level vs. AI Effectiveness.

A significant negative correlation was also observed between access to technology and barriers to implementation ($r = -0.45$, $p < 0.05$), suggesting that schools with higher access to technology have lesser barriers for implementing AI tools effectively.

4.3. Regression Analysis

Modeling was conducted through linear regression predicting the influence of different measures on the performance of AI tools for SWLD. The dependent variable consists of teachers' perception of the effectiveness of AI tools in improving learning outcomes for SWLD; while the independent variables are teacher training, access to technology, and design of AI tools as shown in Table 3 and Figure 3.

Effectiveness= $\beta_0 + \beta_1(\text{Teacher Training}) + \beta_2(\text{Access to Technology}) + \beta_3(\text{AI Tool Complexity}) + \epsilon$
 $\text{Effectiveness} = \beta_0 + \beta_1 (\text{Teacher Training}) + \beta_2 (\text{Access to Technology}) + \beta_3 (\text{AI Tool Complexity}) + \epsilon$

Table 3. Regression Analysis.

Variable	Beta Coefficient	t-Value	p-Value
Teacher Training	0.42	5.32	< 0.01
Access to Technology	0.35	4.21	< 0.01
AI Tool Complexity	-0.18	-2.11	< 0.05

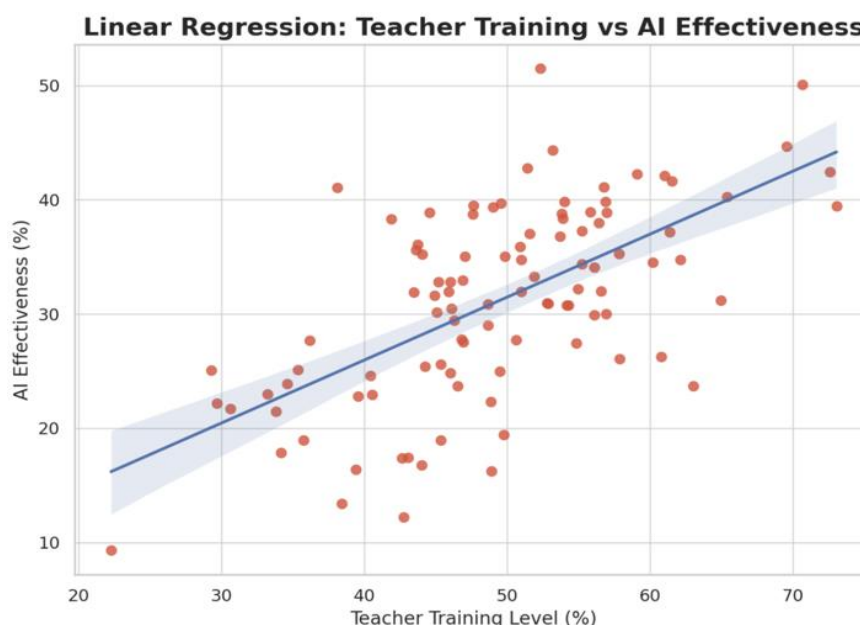


Figure 3. Regression Analysis.

The results of the regression analysis show that teacher training and access to technology have a significant positive impact on the effectiveness of the AI tools, and the complexity of the AI tools had a negative effect on SWLD effectiveness.

5. Conclusion

The faculty that are trained to build educational equality for SWLD through AI like personalized learning, real-time feedback and adaptive support. But accessing, training, and the tools themselves still pose hurdles to fully unlocking AI's promise. This paper explains the importance of inclusive design and equitable access to technology to provide that AI can benefit all students, especially those students with learning disabilities.

References

- [1] Ahuja, N. J., Dutt, S., Choudhary, S. L., & Kumar, M. (2022). Intelligent tutoring system in education for disabled learners using human-computer interaction and augmented reality. *International Journal of Human-Computer Interaction*, 1-13. [DOI:10.1080/10447318.2022.2045431]
- [2] Baglama, B., Yucesoy, Y., & Yikmis, A. (2018). Using animation as a means of enhancing learning of individuals with special needs. *T.E.M. Journal*, 7(3), 670-676.
- [3] Berninger, V. W., & Amtmann, D. (2003). Preventing written expression disabilities through early and continuing assessment and intervention for handwriting and/or spelling problems: Research into practice. *Journal of Learning Disabilities*, 36(3), 148-161.
- [4] Bonneton-Botté, N., Fleury, S., Girard, N., Le Magadou, M., Cherbonnier, A., Renault, M. ... & Jamet, E. (2020). Can tablet apps support the learning of handwriting? An investigation of learning outcomes in kindergarten classroom. *Computers & Education*, 151, 103831. [DOI:10.1016/j.compedu.2020.103831]
- [5] Burstein, J., Chodorow, M., & Leacock, C. (2004). Automated essay evaluation: The Criterion online writing service. *AI magazine*, 25(3), 27-27.

- [6] Flogie, A., Aberšek, B., Kordigel Aberšek, M., Sik Lanyi, C., & Pesek, I. (2020). Development and evaluation of intelligent serious games for children with learning difficulties: Observational study. *JMIR Serious Games*, 8(2), e13190. [DOI:10.2196/13190]
- [7] Gou, M., Liu, D., & Wang, Z. (2020). Examination of Teachers' Technological Pedagogical Content Knowledge: A Western Regional Perspective of China's Compulsory Education System. *Journal of Education and Learning*, 9(4), 28-37. [DOI:10.5539/jel.v9n4p28]
- [8] Holstein, K., & Doroudi, S. (2021). Equity and artificial intelligence in education: Will "AIED" amplify or alleviate inequities in education? *arXiv preprint arXiv:2104.12920*. [DOI:10.48550/arXiv.2104.12920]
- [9] Kazimzade, G., Patzer, Y., & Pinkwart, N. (2019). Artificial intelligence in education meets inclusive educational technology—the technical state-of-the-art and possible directions. *Artificial intelligence and inclusive education: Speculative futures and emerging practices*, 61-73.
- [10] Khan, M. F., Hussain, M. A., Ahsan, K., Saeed, M., Nadeem, A., Ali, S. A., & Rizwan, K. (2017). Augmented reality-based spelling assistance to dysgraphia students. *Journal of Basic & Applied Sciences*, 13, 500-507.
- [11] Kalonde, G. (2017). Rural School Math and Science Teachers' Technology Integration Familiarization. *International Journal of Educational Technology*, 4(1), 17-26. [DOI:10.1016/j.ijet.2017.03.002]
- [12] Nacheva, R., & Czaplewski, M. (2024). Artificial Intelligence in Helping People with Disabilities: Opportunities and Challenges. *HR and Technologies*, (1), 102-124. [DOI:10.33058/hrtech.v1i1.8]
- [13] Podder, D., Sinha, M., & Basu, A. (2021). Sentence learning system for children with dyslexia to learn English as second language. In *2021 IEEE International Conference on Engineering, Technology & Education (TALE)* (pp. 1028-1032). IEEE. [DOI:10.1109/TALE52217.2021.9732616]
- [14] Sahari, S. H., & Johari, A. (2012). Improvising reading classes and classroom environment for children with reading difficulties and dyslexia symptoms. *Procedia-Social and Behavioral Sciences*, 38, 100-107. [DOI:10.1016/j.sbspro.2012.03.073]
- [15] Wang, S., Wang, F., Zhu, Z., Wang, J., Tran, T., & Du, Z. (2024). Artificial intelligence in education: A systematic literature review. *Expert Systems with Applications*, 252, 124167. [DOI:10.1016/j.eswa.2023.124167]