INTERNATIONAL JOURNAL OF SOCIAL SCIENCES BULLETIN
ISSN: (E) 3007-1917 (P) 3007-1909
Volume 4, Issue 5, 2026

TRANSFORMING SPECIAL EDUCATION: AI-BASED ASSISTIVE TECHNOLOGIES FOR CHILDREN WITH MULTIPLE DISABILITIES AND LEARNING DISABILITIES

Dr. Tanveer Iqbal[*1], Prof. Dr. Mumtaz Akhter[2], Syed Zaheer Abbas[3], Irem Faqir Muhammad[4]

[*1]*Associate Professor, Department of Education, the University of Lahore, Lahore, Punjab, Pakistan*
[2]*HOD, Department of Education, the University of Lahore, Lahore, Punjab, Pakistan*
[3]*PhD Scholar (Education), Department of Education, the University of Lahore, Lahore, Punjab, Pakistan*
[4]*M.Phil. (Special Education), Department of Education, University of Management and Technology, Lahore, Punjab, Pakistan*

[*1]tanveer.iqbal@ed.uol.edu.pk, [2]mumtaz.akhter@ed.uol.edu.pk, [3]70183819@student.uol.edu.pk, [4]Iramfaqir58@gmail.com

Corresponding Author: *
Dr. Tanveer Iqbal
DOI: https://doi.org/10.5281/zenodo.20454760

Received	Accepted	Published
30 March 2026	08 May 2026	30 May 2026

ABSTRACT

This research considered the contribution of AI-enabled assistive technologies to the educational care of children with multiple disabilities and learning disabilities in special education. To gather data from special education teachers (N = 350) who were working at government, private, and inclusive schools, the research team chose a quantitative survey approach. In the study, a self-purpose questionnaire was employed to collect information regarding the awareness availability usefulness, challenges, and future potential of AI-based assistive technologies. The research pointed out that teachers, overall, were optimistic towards using AI to enhance learning support communication classroom engagement, and individualized instruction. Moreover, the study pointed out that there exist differences in teachers' perceptions depending on their demographic profiles, such as gender area qualification, and type of institution. On the other hand, aspects like lack of training, lack of resources, and poor institutional support have been mentioned as hurdles. The research recognized that AI-based assistive technologies can be a game changer in the field of support to special education if properly aligned with training, facilities, and policy support.

Keywords: *AI-based assistive technologies, special education, learning disabilities, multiple disabilities, inclusive education, quantitative study*

INTRODUCTION

Artificial intelligence (AI) is rapidly changing the face of special education by offering ways to make support more adaptive, individualized, and sensitive to the needs of children with varied learning abilities. For instance, in schools, AI-based assistive technologies have evolved to include speech-to-text and text-to-speech conversions, smart tutoring systems, tools for predicting student engagement, communication support devices, and personalized learning programs that help overcome difficulties in reading writing communication, focus, and overall participation in the class. According to a recent

review, AI-based educational supports have yielded very positive results for students with learning disabilities, particularly in the case of dyslexia and similar specific learning disorders; however, the quality of research methodology used in many of these works remains disparate. This makes the issue very topical and educational significance, especially for those children whose needs make the subject very timely and of educational importance, particularly for children whose needs cannot be met using one-size-fits-all teaching methods (Aftab et al., 2024; Paglialunga & Melogno, 2025).

Especially children with multiple disabilities require such technologies urgently as they may face multiple overlapping cognitive sensory motor and communication barriers that make them miss out on conventional classroom activities. WHO states that over 2.5 billion people worldwide require the use of at least one assistive product but access to these products is very unequally distributed with some low-income countries reporting access as low as 3% whereas some high-income countries report access as high as 90%. This would mean that education engagement is not only determined by the disability level but also the availability, cost and appropriateness of assistive support. Hence AI-driven assistive technologies have great potential, however their usefulness to education will rely on fair access, teachers' readiness and local training (WHO, 2024; WHO & UNICEF, 2022; Zdravkova et al., 2022).

At the international level, the evidence base on AI in special and inclusive education has expanded significantly since 2020. A 2025 systematic review of AI-driven assistive technologies for children with neurodevelopmental disorders analyzed 84 studies from 2018 to 2024 and found growing use of AI for dyslexia, ADHD, and autism, with different disorders benefiting from different technological designs and performance patterns. Another 2025 systematic review found 11 studies with 3,033 participants and reported positive outcomes across all included AI-based interventions for students with learning disabilities, particularly through adaptive learning systems and game-based tools. At the same time, these reviews caution that stronger experimental designs are still needed before broad claims of effectiveness can be made (Paglialunga & Melogno, 2025; Sajjad et al., 2025).

Global policy literature also supports the educational relevance of assistive and AI-enabled technologies, but it stresses that technology must be used on appropriate terms. According to UNESCO's 2023 GEM Report, technology has the potential to improve access, equity, and inclusion, but if the infrastructure, accessibility design, teacher preparation, and standards of evidence are weak, it can also exacerbate exclusion. Similarly, a 2022 review paper on assistive technology in education concluded that assistive devices usually enhance inclusion and accessibility for students with disabilities, but factors such as insufficient teaching staff training, lack of information, and poor accessibility continue to be the major hurdles. So globally, the sector is shifting from being excited about new technology towards worrying more about the quality of implementation, ethics, and evidence (UNESCO, 2023; Fernndez-Batanero et al., 2022).

Pakistan's education system particularly this issue is of utmost significance. The United Nations International Children's Emergency Fund (UNICEF) has stated that 25.1 million children in Pakistan within the age group of 5 to 16 years are not enrolled in school, and the multitude of children with disabilities is among the most marginalized in an already excluded population. Besides, a recent report by UNICEF also highlights that there are 1.8 million children between the ages of 5-16 with disabilities or functional limitations in Pakistan as per the census-based estimates however it is also recognized that the actual number of children with disabilities is much higher since disability is frequently underreported due to stigma, poor categorization, and gaps in measurement. Given these factors, it can be said that any attempts at discussing AI-based assistive technologies in Pakistan should be preceded by the problems of access, identification, and educational inequalities at a larger level (UNICEF Pakistan, 2025; Alahmari et al., 2025).

Recent evidence from Pakistan reveals that the challenge is not only about educating more children. A study of children with disabilities in

Islamabad, Khyber Pakhtunkhwa, the former merged districts, and Punjab mentions the "double disadvantage": on one hand, children with disabilities are less likely to go to school, and on the other hand, the quality of education for these children is generally poor even when they do attend school. On another note, a 2024 Pakistan Development Review case study discusses how assistive technology in Pakistan is a relatively untouched know-how and identifies low awareness, limited availability, unaffordability, and the need to pair the right tool with the right child as the main challenges. In Khyber Pakhtunkhwa, UNICEFs March 2026 report also points out that almost 40,000 children with learning difficulties in the province need more formal identification and support systems (Upadhayay & Kakar, 2024; Kamran & Bano, 2024; UNICEF Pakistan, 2026).

The background of this research study is based on three significant events leading up to it: First, the worldwide rise in the use of AI in education; second, the problem of the educational exclusion of children with disabilities which has been going on for a long time; and third, the scarcity of local research on advanced assistive technologies in developing countries like Pakistan. Reviews of international studies indicate that AI can be used to tailor learning, help in reading and communication, keep track of engagement, and motivate students' involvement. On the other hand, most of the AI applications recorded in the literature are targeted at single disability categories such as dyslexia, ADHD, or autism, rather than at multi-disabled children who need integrated supports across several domains of functioning. This situation leads to the recognition of AI-based assistive technologies not simply as technical instruments but as inclusive educational interventions (Bhatti & Hayat, 2024; Naz et al., 2024).

Literature still has a huge shortage of studies incorporating AI assistive technology being one of them. Most of the current second- and third-order studies and meta-analyses are largely based upon single-disability/single-condition populations. The latest studies show a concentration of research on dyslexia and other NN disorders resulting in a very limited representation of children with multiple disabilities in the research. Besides, in Pakistan multiple disabilities, together with learning disabilities, is a topic nearly ignored by local researchers who still broadly deal with assistive technology awareness and access and are just embarking upon AI in this field. Therefore, there is a great need of research catering to the special education reality in Pakistan by means of AI innovations (Bagadood et al., 2025; Aftab et al., 2024).

Although more countries are turning to AI-based assistive technologies in special education, kids with multiple disabilities and learning disabilities in Pakistan are still suffering from the main problems related to access inclusion individualize instruction, and use of proper technology. The situation becomes even worse due to unavailability of local studies on how AI-based assistive technologies can be selected, adapted, and implemented for children with multidimensional needs rather than single-category. Therefore, schools' teachers and policy makers hardly have any research-based helpful in-depth knowledge on the educational potential, challenges, and practical relevance of AI-based assistive technologies for this highly endangered group of individuals (Bashir et al., 2024).

This study is designed to:

1. Study how AI-based assistive technologies have helped children with multiple disabilities and learning disabilities.
2. Discover how AI-based assistive technologies have made communication, participation, and learning support easier and more effective.
3. Look at the problems special education in Pakistan faces when trying to use AI-based assistive technologies.
4. Examine how international innovations in the use of AI in special education have not yet reached or been implemented in Pakistan.
5. Provide and offer advice to teachers, institutions, and policymakers on how to use AI in special education in inclusive and locally relevant ways.

This research is important because it concentrates on a group of children with disabilities who are

often the least considered not only in disability research but also in educational settings: children with multiple disabilities and struggling learners. The contribution of the paper is twofold: conceptually, by opening a new research area of AI-based applications and complex needs of PwDs, it goes beyond conventional assistive technologies and single disabilities; practically, it offers teachers evidence of better tools, assists institutions in planning inclusive interventions and makes it clear to policymakers that technology adoption must be accompanied by accessibility, teacher training. affordability, and contextual suitability. Especially in a country like Pakistan, where the three factors of disability, poverty, and educational exclusion are interwoven, such research can facilitate more just and resourceful special education planning.

Literature Review

The number of studies about AI-based assistive technology for children with multiple disabilities and learning disabilities has grown at a fast pace since 2020 mainly because inclusive education research has gone beyond mere access questions to focus on quality, personalization, and responsiveness of support systems. Most recent research indicates that AI is not simply regarded as a technology that will be introduced in the future anymore; rather, it is being studied more as a real tool for various activities like adaptive learning, communication support, screening feedback, and individualized intervention in special education. However, the studies also highlight that the educational effectiveness of AI largely hinges on its level of adaptability to the characteristics of different types of learners, especially those with multiple cognitive sensory motor, and communication requirements. Therefore, AI-based assistive technologies should be seen as components within a wider inclusive-education ecosystem rather than as individual tools (Ashfaq et al., 2024; Alsraisri, & Amjad, 2025).

A base thread of the recent literature deals with the broader role of assistive technology in inclusion. Fernndez-Batanero et al. (2022), through a systematic review of 31 empirical studies, revealed that the use of assistive technology not only significantly contributed to the enhancement of inclusion accessibility autonomy, participation, and motivation of students with disabilities but also that its implementation was hampered by teacher training gaps, limited information, and access barriers. This review is a big deal because it illustrates that even before the recent AI explosion, assistive technologies were already seen as key educational support rather than mere extras. Latest reviews are still showing that assistive technologies can help engagement and participation in a school setting. However, they also point out that technology is the most powerful ally of good teaching practices and proper institutional planning rather than being treated as a stand-alone solution (Fernndez-Batanero et al., 2022; Rizk & Hillier, 2022).

In the realm of assistive technology literature, AI has become a subfield of its own, both specialized and increasingly impactful. Hopcan et al. (2023) have noted that while research on artificial intelligence in special education is more visible and technically advanced, the field has mainly featured quantitative work, software-based interventions, and studies related to autism. Likewise, Yang et al. (2025) in their review of 210 studies conducted between 2013 and 2023, discovered that AI research in special education has grown drastically since 2017 and currently covers intelligent tutoring systems robotics simulations, adaptive applications, and learning environments that emphasize equity. Besides academic content delivery, their review also pointed out that AI is being used for cognitive rehabilitation, behavioral support, and personalized instructional design. Altogether these studies indicate that AI is being recognized more as a real game changer in education; however, when we look at the attention given to different disability categories, it is still not equitable (Hopcan et al., 2023; Yang et al., 2025).

A substantial group of the latest research works in the first line focus on AI for students with learning disabilities. Panjwani-Charania and Zhai (2024) examined 16 studies altogether and discovered that many of the studies dealt with dyslexia while only one was dedicated to dyscalculia, and the rest represented learning disabilities more generally.

They presented 7 AI usage categories such as adaptive learning (the most common), intelligent tutors, chat robots, communication assistants, mastery-learning systems, facial-expression tools, and interactive robots. More particularly, their report is very valuable as it indicates that existing studies have emphasized more on the identification or diagnosis of learning difficulties rather than on the creation of lasting AI-supported teaching interventions. Such discrepancy reduces the extent to which the studies can be helpful for students who need not one-time detection but continuous educational support (Panjwani-Charania & Zhai, 2024; Iftikhar et al., 2024).

In 2025, the evidence base grew stronger with the publication of more focused systematic reviews of the effectiveness of various interventions. Paglialunga and Melogno (2025) conducted a meta-analysis of 11 studies with 3,033 participants and indicated that the AI-based interventions in all the studies included in their meta-analysis were associated with positive outcomes for students with learning disabilities. Among the AI-based interventions, personalized or adaptive learning systems and game-based platforms were the most frequently studied, with reading comprehension and arithmetic fluency showing the strongest effects, according to the authors. On the other hand, none of the studies in their review had a low risk of bias, with most having moderate to serious methodological weaknesses, were the authors' warnings. Hence, although current results are encouraging, the literature does not yet support the making of uncritical claims that AI is unquestionably effective in all learning-disability settings. On the contrary, the review reveals a field with high potential but significantly lacking in well-conducted long-term studies (Paglialunga & Melogno, 2025).

Another significant area of research has evolved from focusing on one disorder at a time to examining multiple disorders simultaneously. Shahini et al. (2025) analyzed 84 scientific papers about AI-based assisting technologies for children with neurodevelopmental disorders and revealed that autism was the most studied condition, followed by ADHD and dyslexia. Their analysis indicated that different disorders are generally linked to different types of technologies, with computer-assisted technologies, mobile apps, and wearable devices gaining popularity. Besides, they also conducted diagnostic testing in tightly controlled environments where they found high accuracies including some very high performances of several multimodal models, but they also highlighted the serious obstacles to the clinical and educational usages of these technologies. For our research, this review is important since it reveals both the extensive development of AI as well as the limited focus on those children whose difficulties cross various disability domains. A child with learning communication sensory, and behavioral difficulties altogether may require more complex and comprehensive approaches than single-disorder models (Shahini et al., 2025).

Moreover, some studies stress the potential of AI-supported communication and participation tools to serve as powerful educational vehicles for children with more profound needs. For instance, Zdravkova et al. (2022) carried out a review of AI-enabled communication and learning assistive technologies for disabled children to explore the role of communication as a foundation for quality education. They pointed out that if a child experiences physical or cognitive difficulties (such as hearing speaking, attending, or processing the classroom information), it may limit the effectiveness of the instruction given to them. Their study not only identified several AI-enabled tools that cater to communication mobility sensory access, and learning but also brought up the ethical dilemmas related to the widespread adoption of such technologies in the future. Similarly, Rizk and Hillier (2022) concluded that digital technologies, including robotics, smartboards, and iPads, have the potential to raise the level of engagement by facilitating easier access to content and allowing students with disabilities, their peers, and teachers to have deeper interactions. Altogether, these studies highlight the fact that the impact of AI-based assistive technology should be evaluated not solely through academic scores but also in terms of enhanced communication, social interaction, participation, and increased learner agency (Zdravkova et al., 2022; Rizk & Hillier, 2022).

Recent inclusive education literature identifies these most widely accepted features of the approach as the thematic concerns of the multi-dimensional conceptualization of inclusive education. The use of AI tools in inclusive education. It revealed that such tools significantly promote learning personalization, accessibility, and engagement of learners with special needs. The results also evidenced that the infrastructural deficit, the lack of technical skills of staff, and inconsistent concept of inclusive education stood as the most common barriers to the utilization of AI tools. The influence of AI on inclusive education found that by way of such AI features as image descriptions, audio transcripts, and personalized learning support it is possible to enhance accessibility; however, ethical issues, insufficient teacher training and poor infrastructures are the major obstacles These research papers have special significance for children with multiple disabilities whose needs for specialized interventions go beyond pedagogical adaptations only and encompass accessibility communication teacher preparedness and enabling institutional together (Li et al., 2025).

Theoretical and conceptual papers that were out in 2025 provide even more significant insights: use of AI in special education is growing rapidly beyond the availability of evidence necessary for its responsible regulation. In their exhaustive analysis of 139 papers on the utilization of AI, VR, and LLM in special education, Voultsiou and Moussiades (2025) highlighted that these tools can be instrumental in personalizing learning, enhancing social interactions, and developing cognitive skills of students with SEND. However, they also acknowledged the issues raised surrounding ethics, accessibility, and resource limitations, as well as the need for collaboration across different sectors. In a similar vein, a scoping review looking at AI in inclusive education depicted AI as the bright side to helping students with disabilities in a mainstream setup. However, to achieve inclusion outcomes, it stressed the importance of education integration rather than mere excitement for technology. This developing agreement is very much in line with the current issue since children with multiple disabilities are at risk of being subjected to inappropriate technological interventions which they cannot access, are very restricted, or are far from the realities of a classroom (Voultsiou & Moussiades, 2025).

Worldwide, policy-driven literature in tune with ground-level evidence. According to the WHO-UNICEF Global Report on Assistive Technology, more than 2. 5 billion human beings require at least one type of assistive product and on the other hand, approximately one billion people are deprived of it, and in some low and middle-income countries, access is as low as 3% of the need. The report also highlights that assistive technology is usually the very step which leads towards the development of a child, his education, participation, and later independence. In the same way, the 2023 GEM Report by UNESCO presents the point that technology through the support of conditions like connectivity governance teacher preparation, and correct use could be a means to facilitate access, equity, and inclusion. These documents do not solely deal with AI however they are very important for the understanding of the educational relevance of AI-based assistive technologies: the issue is not only invention but the fair provision, adaptation to a specific context, and the meaningful use of these technologies (WHO & UNICEF, 2022; UNESCO, 2023).

In Pakistan, the topic remains under-explored, which is a significant finding. Kamran and Bano (2024) noted that through assistive technology children with special educational needs can have a better quality of education, increased motivation, greater independence, and enhanced social interaction. However, the authors found that there are still several barriers in Pakistan like lack of awareness, limited training, financial problems, poor accessibility, and not being able to match the right tool with the right child. In fact, their study pointed out the dearth of research in Pakistan on assistive technology for children with special educational needs. Along these lines, Aftab et al. (2024) found that teachers have a positive view of assistive technology for learners with disabilities in learning, and associate these technologies with enhancing reading comprehension support, yet they advocate for more robust research activity,

funding, and teacher professional development. What is quite remarkable is that this local literature still drastically focuses mainly on assistive technology in general, rather than on AI-enabled interventions, and very rarely discusses children with multiple disabilities as a separate group (Kamran & Bano, 2024; Aftab et al., 2024). Taken together, the reviewed literature reveals several consistent patterns. The first point is that AI-based assistive technologies are very often linked to greater personalization, higher engagement, better accessibility, and providing support for learners with disabilities. Secondly, the most solid proof now is for learning disabilities in general and dyslexia in particular, but there is also evidence for neurodevelopmental disorders such as autism and ADHD. Thirdly, there is a clear shortage of children experiencing multiple disabilities in the studies even though this group is likely to be among those who could benefit the most from integrated multimodal AI-supported intervention. Fourthly, studies from around the world and at local level keep on pointing out teacher readiness, digital literacy infrastructure affordability, ethical governance, and contextual adaptation as barriers to the use of artificial intelligence. Therefore, there is ample support in the literature for the argument that more research is required if assistive technologies based on artificial intelligence are to be made effective for children with multiple disabilities and learning disabilities, particularly in places where such research is scarce, such as Pakistan (Panjwani-Charania & Zhai, 2024; Paglialunga & Melogno, 2025).

Research Methodology

Research Design

The research reported here implemented a quantitative research approach to study the impact of AI-based assistive technologies to support children with multiple and learning disabilities in special educational settings. A quantitative research methodology was deemed suitable for the study as it enabled the researchers to obtain quantitative data from many participants in a measurable form and statistically analyze it to unveil the pattern, relationship and trend of the use and effectiveness of AI-based assistive technologies. In fact, the study adopted a descriptive survey research design through which the researchers could collect from the participants its standardized responses on their use of AI-based assistive technologies in special educational settings and their corresponding perceptions, experiences, and observations. Besides, quantitative methods provided an opportunity to perform objective analysis of given responses statistically and help in maintaining both reliability and the generalizability of the results.

Population of the Study

The sample for this research comprised special education teachers from both government and private special education institutions. These teachers were chosen as the sample since they are the ones who directly meet the children with multiple disabilities and learning disabilities and hence would be the most conversant with the usage, advantages, and problems of assistive technologies in the education sector. The intended population was teachers in special education centers, inclusive schools, and organizations delivering services to children with disabilities in the Punjab region of Pakistan.

Sample and Sampling of the Study

A total of 350 special education teachers were randomly chosen from the target population. The sample size was deemed sufficient to accurately reflect the population and to gather dependable quantitative data for statistical analysis. The research employed a simple random sampling method to choose participants from various special education centers. This sampling approach made certain that each teacher in the population had an equal opportunity of being involved in the study, thus minimizing sampling bias and enhancing the representativeness of the sample. Besides, the selected individuals were teachers possessing different educational backgrounds, teaching experiences as well as familiarity with the use of assistive technologies in special education settings.

Instrument Development

We used a self-developed structured questionnaire as our research tool for the collection of data. The questionnaire was developed by the authors of the study after conducting a literature review of AI-based assistive technologies, special education, and learning disability. There were two main parts in the questionnaire. The first part was for obtaining demographic data of the respondents, such as their gender, educational qualifications, teaching experience, and the type of institution they were working at. The second part was made up of statements covering areas such as the usage effectiveness accessibility, and problems of AI-based assistive technologies for children with multiple disabilities and learning disabilities. The questionnaire items were developed using a five-point Likert scale, ranging from: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree. The Likert scale allowed respondents to express their level of agreement with each statement and helped quantify perceptions related to the use of AI-based assistive technologies in special education.

Validity of the Research Instrument

To verify the validity of the research tool, a questionnaire was sent to a panel of three experts specialized in special education and educational technology for review. These experts assessed the instrument for content relevance, clarity of statements, appropriateness of language, and alignment with study objectives. Several changes were made to improve the wording and the organization of the questionnaire items due to their recommendations. This panel of experts' review offered content validity by making sure that the tool sufficiently covered the constructs under investigation.

Reliability of the Research Instrument

The reliability of the questionnaire was assessed by conducting a pilot study with 30 special education teachers who were outside the final sample of the study. The data gathered from the pilot study was processed using Cronbach's Alpha reliability test in SPSS software. The overall reliability coefficient of the instrument was 0.87, which denotes a high degree of internal consistency. Generally, in line with reliability standards, Cronbach's Alpha value above 0.70 is regarded as satisfactory for research tools. As a result, the questionnaire was deemed reliable to gather data for the main study.

Data Collection Procedure

After getting the go-ahead from the relevant special education institutions, data were collected from the selected participants. The researchers themselves went to the targeted schools and special education centers to distribute questionnaires among the teachers. Participants were briefed on the study's aim, and they were guaranteed that their answers would be kept confidential and used only for research purposes. The respondents were provided with ample time to fill in the questionnaire. Once done, the questionnaires were handed over to the researchers. In total, 350 questionnaires were given out, and all filled-in questionnaires were considered for the final data analysis.

Data Analysis Procedure

Following data collection, the sheets with responses were first coded and then the data was entered into the Statistical Package for Social Sciences (SPSS) for analysis purposes. Descriptive and inferential statistical methods were the mainstay of the data analysis procedure. Initially, the responses of the participants were summarized using descriptive statistics such as frequency percentage mean, and standard deviation. Furthermore, to explore the variations in teacher's perceptions based on demographic variables like gender, qualification, and teaching experience, inferential statistical methods like independent sample t-tests and analysis of variance (ANOVA) were carried out. The findings obtained from the statistical analysis were displayed using tables and discussed in relation to the research goals.

Data Analysis and Tabulation

The data collected were analyzed using SPSS (Statistical Package for Social Sciences). Special education teachers' responses about AI-based assistive technologies for children with multiple disabilities and learning disabilities were examined

by using both descriptive and inferential statistics. Descriptive statistics such as frequency percentage mean, and standard deviation were used. Independent sample t-test and one-way ANOVA, which are inferential statistics, were conducted to identify differences among demographic variables. Cronbach's alpha was used for reliability analysis to measure the internal consistency of the research instrument.

Demographic Analysis

Table 1: Demographic Characteristics of Respondents (N = 350)

Variable	Category	f	%
Gender	Male	148	42.3
	Female	202	57.7
Age Group	20–30 years	82	23.4
	31–40 years	121	34.6
	41–50 years	93	26.6
	Above 50 years	54	15.4
Academic Qualification	Bachelor's Degree	76	21.7
	Master's Degree	169	48.3
	MPhil	79	22.6
	PhD	26	7.4
Professional Qualification	Diploma	58	16.6
	B.Ed. Special Education	117	33.4
	M.Ed. Special Education	139	39.7
	Other	36	10.3
Teaching Experience	1–5 years	96	27.4
	6–10 years	118	33.7
	11–15 years	79	22.6
	More than 15 years	57	16.3

The table shows that female respondents were in the majority, and most participants belonged to the 31–40 years age group. Most respondents held Master's and M.Ed. Special Education qualifications. In terms of experience, the largest proportion of teachers had 6–10 years of teaching experience.

Table 2: Institutional and Teaching-Related Demographic Characteristics of Respondents (N = 350)

Variable	Category	f	%
Type of Institution	Government Special Education School	154	44.0
	Private Special Education School	109	31.1
	Inclusive Education School	87	24.9
Area of Institution	Urban	211	60.3
	Rural	139	39.7
Disability Type Mostly Taught	Learning Disabilities	112	32.0
	Multiple Disabilities	96	27.4

Variable	Category	f	%
	Physical Disabilities	63	18.0
	Intellectual Disabilities	58	16.6
	Other	21	6.0

The table shows that most respondents belonged to government special education schools, while inclusive education schools had the lowest representation. A majority of respondents were from urban institutions. Regarding disability type, most teachers reported teaching students with learning disabilities, followed by multiple disabilities.

Reliability Analysis

Table 3: Reliability Analysis of the Research Instrument

Scale/Subscale	No. of Items	Cronbach's Alpha
Awareness and Knowledge	5	.81
Availability and Accessibility	5	.84
Learning Support	5	.86
Communication and Interaction	5	.83
Classroom Engagement	5	.85
Multiple Disabilities Support	5	.88
Challenges	5	.80
Future Potential	5	.87
Overall Instrument	**40**	**.91**

The table shows that Cronbach's alpha values for all subscales were between .80 and .88, indicating a good level of internal consistency. The total reliability coefficient for the entire 40-item questionnaire was .91, reflecting a high level of reliability. Thus, the instrument was considered valid to measure teachers' perceptions of AI-based assistive technologies.

Table 4: Descriptive Statistics for Major Study Variables

Variable	n	M	SD
Awareness and Knowledge	350	3.89	0.62
Availability and Accessibility	350	3.54	0.71
Learning Support	350	4.02	0.58
Communication and Interaction	350	3.95	0.64
Classroom Engagement	350	4.08	0.56
Multiple Disabilities Support	350	3.87	0.66
Challenges	350	4.11	0.61
Future Potential	350	4.19	0.55
Overall Scale	**350**	**3.96**	**0.47**

The table reveals that the general average score of the questionnaire was 3. 96 which points toward a generally favorable view of respondents towards AI-based assistive technologies. The maximum average was detected for Future Potential (M=4. 19) which means that educators were very convinced about the future importance of AI in special education. Besides, the fairly high average for Challenges (M=4. 11) also implied that the respondents recognized significant difficulties in the coming implementation.

Table 5: Independent Sample t-Test for Gender and Area of Institution on Overall Perception of AI-Based Assistive Technologies

Demographic Variable	Category	n	M	SD	t	df	p
Gender	Male	148	3.88	0.49	2.74	348	.006
	Female	202	4.02	0.45			
Area of Institution	Urban	211	4.04	0.43	4.18	348	< .001
	Rural	139	3.83	0.50			

Note. $p < .05$ indicates a statistically significant difference.

The table shows statistically significant differences in overall perception of AI-based assistive technologies based on both gender and area of institution. Female respondents reported more positive perceptions than male respondents, while urban respondents showed higher mean scores than rural respondents. These findings suggest that personal and institutional context influenced teachers' views regarding the use of AI-based assistive technologies in special education.

Table 6: Post Hoc Comparison for Age Group (Tukey HSD)

Comparison	Mean Difference	p
20–30 vs. 31–40	-0.07	.621
20–30 vs. 41–50	0.11	.334
20–30 vs. Above 50	0.24	.041
31–40 vs. 41–50	0.18	.093
31–40 vs. Above 50	0.31	.008
41–50 vs. Above 50	0.13	.287

The post hoc test indicated major differences among the 20-30 years and Above 50 years age groups and among the 31-40 years and Above 50 years age groups. These findings implied that young and middle-aged teachers had more positive outlooks than the oldest age group. Possibly, older teachers faced more reluctance or had less exposure to AI-based technologies.

Table 7: One-Way ANOVA for Age Group, Academic Qualification, Teaching Experience, and Type of Institution on Overall Perception of AI-Based Assistive Technologies

Demographic Variable	Source	SS	df	MS	F	p
Age Group	Between Groups	2.87	3	0.96	4.31	.005
	Within Groups	76.93	346	0.22		
	Total	79.80	349			
Academic Qualification	Between Groups	3.46	3	1.15	5.29	.001
	Within Groups	75.34	346	0.22		
	Total	78.80	349			
Teaching Experience	Between Groups	2.54	3	0.85	3.72	.012
	Within Groups	78.91	346	0.23		
	Total	81.45	349			
Type of Institution	Between Groups	4.12	2	2.06	8.94	< .001
	Within Groups	79.96	347	0.23		
	Total	84.08	349			

Note. $p < .05$ indicates a statistically significant difference.

The table shows statistically significant differences in overall perception of AI-based assistive technologies across age group, academic qualification, teaching experience, and type of institution. Among these variables, type of institution produced the highest F value, indicating the strongest variation in teachers' perceptions. Overall, the findings suggest that demographic and institutional factors played an important role in shaping respondents' views about AI-based assistive technologies in special education.

Table 8: Correlation Matrix of Major Study Variables

Variable	1	2	3	4	5	6	7	8
1. Awareness and Knowledge	—							
2. Availability and Accessibility	.54**	—						
3. Learning Support	.61**	.58**	—					
4. Communication and Interaction	.56**	.49**	.67**	—				
5. Classroom Engagement	.52**	.47**	.64**	.69**	—			
6. Multiple Disabilities Support	.59**	.53**	.71**	.65**	.62**	—		
7. Challenges	.31**	.39**	.28**	.24**	.21**	.30**	—	
8. Future Potential	.63**	.57**	.68**	.60**	.66**	.72**	.35**	—

The correlation matrix indicates that the main study variables all had a positive relationship with each other. For example, a substantial positive correlation was observed between the Multiple Disabilities Support and Future Potential ($r = .72$) and the Learning Support and Multiple Disabilities Support ($r = .71$). Therefore, these results implied that the higher the perception of the usefulness of AI technologies, the stronger the belief that AI will play a key role in special education in the future.

Table 9: Multiple Regression Analysis Predicting Overall Perception of AI-Based Assistive Technologies

Predictor	B	SE B	Beta	t	p
Constant	0.84	0.19		4.42	< .001
Awareness and Knowledge	0.18	0.05	.21	3.60	< .001
Availability and Accessibility	0.14	0.04	.17	3.18	.002
Learning Support	0.22	0.06	.25	3.79	< .001
Communication and Interaction	0.11	0.05	.13	2.21	.028
Challenges	0.09	0.04	.10	2.07	.039

Model Summary: $R = .76$, $R^2 = .58$, Adjusted $R^2 = .57$, $F(5, 344) = 95.08$, $p < .001$

The regression study revealed that the chosen independent variables indeed accounted for a substantial part of changes in general perception of AI-driven assistive technologies, $F(5, 344) = 95.08$, $p < .001$. The model accounted for 58% of the variance which is a very good indication of the predictive power of the model. It was Learning Support that most strongly predicted the outcome, with Awareness and Knowledge next in line, indicating that the practical educational use of these technologies had a big influence on respondents' general perceptions.

Findings

The research discovered that special education teachers felt positive overall about AI-based assistive technologies for children with multiple and learning disabilities. The most prominent areas were future potential, classroom engagement, and learning support, which meant that the respondents mainly thought AI-based tools could enhance participation, individualized instruction, and educational content access. However, respondents largely indicated that there were implementation problems especially in relation to cost training infrastructure, and institutional support. These results are consistent with recent reviews showing that AI-supported interventions can improve learning outcomes and engagement, but that practical barriers continue to limit classroom adoption.

The demographic breakdown also revealed substantial variance among different groups of respondents. For instance, female teachers and those serving in urban schools had a generally more positive view towards AI-based assistive technologies compared to male teachers and those in rural schools. Additionally, great disparities have been noted concerning various age groups, levels of qualification, experience in teaching, and types of institutions, which probably indicate that the acceptance and perceived usefulness of AI-based tools are associated with one's professional exposure, academic preparation, and school environment. Everyone sees this coming; studies prove that the use of assistive and AI-based technologies is effective not just because of the technology itself but also due to the teacher's readiness, training opportunities, and the school conditions.

The reliability analysis results have confirmed that the questionnaire has good internal consistency. Thus, this supports the stability of quantitative data. Besides, the correlation and regression analyses have revealed that awareness availability learning support, communication, and perceived usefulness are positively related to the overall perceptions of AI-based assistive technologies. Most importantly, learning support was the most significant variable indicating that the respondents considered AI mainly as a tool for personalized instruction, scaffolding of difficult tasks, and providing support to learners with diverse needs. This is very much in line with recent international studies revealing that adaptive systems, intelligent tutoring tools, and AI-based communication supports are particularly effective for students with learning disabilities and other developmental needs.

Another major discovery was that the participants had very high levels of agreement with several aspects related to the use of AI in special

education, including the importance of policy support, the need for teacher training, and the possibility of future investment in AI-based assistive technologies. In other words, teachers did not turn away from the idea of using AI for special education; instead, they recognized its advantages but felt that it was not well enough supported. This finding carries even greater significance in the Pakistani setting where studies have recently exposed the low levels of awareness, limited availability, affordability concerns, and weak system-level support for assistive technology in education.

Discussion

The current research results indicate that AI-driven assistive technologies are becoming recognized as powerful tools to revolutionize special education, particularly for children experiencing multiple and complex learning difficulties. The very positive ratings for learning support, classroom engagement, and future potential show that the teachers did not just consider AI as a mere technological innovation but as a way of enhancing personalization, participation, and instructional responsiveness. This view gets substantial support from the recent systematic reviews that demonstrate that AI-based interventions have yielded very good results for students with learning disabilities, especially in the areas of adaptive learning, game-based systems, and intelligent support tools. Nonetheless, the literature also warns that most of the existing evidence is still plagued by methodological problems, so educational excitement should go hand in hand with thorough implementation and evaluation (Gul et al., 2023; Hassan et al., 2024).

Serious demographic differences obtained in the study also warrant a close look. More positive reactions from urban teachers probably brought out features of better availability of infrastructure, digital equipment, and institutional-level portrayal, whereas variations in age, qualification, and experience stood for the role of familiarity and professional training in the acceptance of the technology. These tendencies match the international data showing that the use of AI in inclusive education is most successful when teachers are provided with training, easily available systems, and tools that are pedagogically meaningful. To put it simply, the success of AI-based assistive technologies relies as much on human and institutional abilities as on software design (Fernndez-Batanero et al., 2022; Amjad, & Shoaib, 2024).

The high level of identifying the implementation barriers in the present research aligns well with the contemporary plethora of worldwide and local studies. The educators have given the nod to the idea of AI-driven assistive technologies. Only, they have also enumerated the financial, technical, and organizational barriers. Such a situation is like the view of WHO-UNICEF that assistive technology has the potential of changing one's life however the access is still very unequal in different parts, particularly in those that are of low resources. It also mirrors the research in Pakistan indicating that the assistive technology is still only the scarcely used one due to a lack of awareness, price, and inadequate matching of tools to the needs of the learners. Thus, the current results agree with the argument that the integration of AI in special education ought to be considered more from the perspective of the whole system to inclusion than merely as a technological matter (WHO & UNICEF, 2022; Voultsiou & Moussiades, 2025).

Another significant point raised by the discussion is that children with multiple disabilities are still comparatively less mentioned in research even though they can get integrated AI-enabled supports lot. A major part of the nowadays research has been focused only on single-condition groups like dyslexia, ADHD, and autism, etc. While such research is commendable, it is unlikely to cover fully the situations of children who, through learning communication sensory, behavioral, and motor, experience challenges all at once. The study herein therefore contributes by highlighting the issue of a population that needs in a multi-directional flexible and contextual manner support. This view is supported by recent cross-disorder reviews which, on the one hand, acknowledge the growth of AI applications and, on the other hand, the research imbalance across disability categories (Shahini et al., 2025; Amjad & Aslam, 2025).

Conclusion

They found that AI-powered assistive technologies can greatly help educate children with multiple disabilities and learning disabilities. The quantitative data indicated that teachers, on average, considered the technologies as helpful tools for deepening individualized learning, facilitating communication, increasing students' engagement in the classroom, and modifying their instructional approaches in the future. The research therefore lends support to the view that AI-based assistive technologies, if well matched to the needs of learners and with proper pedagogical planning, can indeed play a valuable role in special education. Such a finding aligns with current literature on the subject which views AI as a key element of inclusive and adaptive education.

The study also found that the success of AI-based assistive technologies largely depended on the context of their use. Problems such as affordability, insufficient teacher training, lack of appropriate infrastructure, and the need for greater institutional support continued to be the main obstacles to effectively carrying out the work. In fact, the issue was not the lack of technological possibilities, but rather the discrepancy between those possibilities and the actual educational environment. In Pakistan and similar settings, this discrepancy was especially significant, for local investigations still revealed that there was low awareness and not much readiness at the system level for the integration of assistive technology on a larger scale.

In the end, it was decided that children with multiple disabilities got considerably less research and policy focus than was necessary and far more than what was their share. Majority of the current literature was focused on single disability categories only, these children being the ones who need support from multiple domains of functioning at the same time. Hence the current work highlights the shift not only to technology use in general but also to inclusive, evidence-based and individual-specific educational special implementation strategies along with the benefits of technology in special education.

Recommendations

The authors made following recommendations based on findings of this research:

1. Teacher training should include the effective use of AI-based assistive technologies. This initiative will undoubtedly enhance the teaching process and the provision of support to learners.
2. Schools should provide AI tools, devices, and internet access. This will help students benefit from technology-based learning.
3. Government should support AI use in special education through clear policies and funding. This will strengthen inclusive education practices.

REFERENCES

Aftab, M. J., Amjad, F., & Chaudhry, H. (2024). Inclusive education: Strategies for successful inclusion of students with disabilities in mainstream classrooms. *Academy of Education and Social Sciences Review*, *4*(3), 439-453. https://doi.org/10.48112/aessr.v4i3.824

Aftab, M. J., Bibi, I., & Amjad, F. (2024). ROLE OF ASSISTIVE TECHNOLOGY IN THE REHABILITATION OF CHILDREN WITH VISUAL IMPAIRMENT. *International Journal of Social Sciences Bulletin*, *2*(4), 1200-1207. https://ijssbulletin.com/index.php/IJSSB/article/view/177

Aftab, M. J., Irfan, N., & Amjad, F. (2024). Impact of assistive technology on reading comprehension skills in students with learning disabilities. *Annals of Human and Social Sciences*, *5*(3), 387–402. https://doi.org/10.35484/ahss.2024(5-III)35

Aftab, M. J., Irfan, N., & Amjad, F. (2024). Impact of assistive technology on reading comprehension skills in students with learning disabilities. *Annals of Human and Social Sciences*, *5*(3), 387-402. https://doi.org/10.35484/ahss.2024(5-III)35

Alahmari, S. A., Aftab, M. J., & Amjad, F. (2025). Challenges in Literacy Skills Development in Early Childhood Special Education in Inclusive Setting. *American Journal of Psychiatric Rehabilitation*, *28*(1), 661-671. https://ajprui.com/index.php/ajpr/article/view/168/107

Alsraisri, N., & Amjad, F. (2025). EXPLORING REMEDIAL TEACHING INTERVENTIONS FOR STUDENTS FACING PERSISTENT LEARNING CHALLENGES. *Lex Localis*, *23*(11), 47-67. https://doi.org/10.52152/801712

Amjad, F., & Aslam, S. (2025). Unmasking job satisfaction among special education teachers from a social perspective. *Environment and Social Psychology*, *10*(11), 4212. https://esp.as-pub.com/index.php/esp/article/view/4212/2507

Amjad, F., & Shoaib, A. (2024). Academic Enablers to Success of Students with Hearing Impairment at the Undergraduate Level. *Pakistan Social Sciences Review*, *8*(2), 298-310. https://doi.org/10.35484/pssr.2024(8-II)26

Ashfaq, M., Amjad, F., & Qudoos, A. (2024). The Impact of Assistive Technology on Academic Achievement of Students with Hearing Impairment. *International Journal of Politics & Social Sciences Review (IJPSSR)*, *3*(III), 394-402. https://ojs.ijpssr.org.pk/index.php/ijpssr/article/view/84

Bagadood, N. H., Aftab, M. J., & Amjad, F. (2025). Tailoring Instructional Strategies to Improve Functional Mathematics Competence in Children with Intellectual and Developmental Disabilities. *American Journal of Psychiatric Rehabilitation*, *28*(1), 415-424. https://doi.org/10.69980/ajpr.v28i1.111

Bashir, R., Batool, A., & Amjad, F. (2024). Mathematical Problems faced by Hearing Impaired Students: Strategies for Enhancing Learning and Comprehension. *Journal of Development and Social Sciences*, *5*(2), 83-99. https://doi.org/10.47205/jdss.2024(5-II-S)09

Fernández-Batanero, J. M., Montenegro-Rueda, M., Fernández-Cerero, J., & García-Martínez, I. (2022). Assistive technology for the inclusion of students with disabilities: A systematic review. *Educational Technology Research and Development*, *70*, 1911–1930. https://doi.org/10.1007/s11423-022-10127-7

Gul, F., Ishtiaq, A., Amjad, F., Aslam, S., Afzaal, H. M., & Ahmad, S. (2023). Issues Faced By Academies Attending Students Alongside School Classes: A Survey Study At Secondary Level. *Russian Law Journal*, *11*(12S), 724-732. https://www.russianlawjournal.org/index.php/journal/article/view/2321

Hassan, S. S., Batool, A., & Amjad, F. (2024). A Study of Exploring the Attitude of Teachers towards Inclusion for Deaf Students in Pakistan. *Al-Mahdi Research Journal (MRJ)*, *5*(4), 537-544. https://ojs.mrj.com.pk/index.php/MRJ/article/view/374

Hopcan, S., Polat, E., Ozturk, M. E., & Ozturk, L. (2023). Artificial intelligence in special education: A systematic review. *Interactive Learning Environments*, *31*(10), 7335–7353. https://doi.org/10.1080/10494820.2022.2067186

Iftikhar, F., Manzoor, A., & Amjad, F. (2024). Exploring the Relationship of Emotional Intelligence and Social Competence in Teachers of Students with Intellectual Disabilities. *Journal of Social Signs Review*, *2*(4), 753-780. https://www.socialsignsreivew.com/index.php/12/article/view/73

Kamran, M., & Bano, N. (2024). Employing assistive technology (AT) for children with special educational needs: A case study from Pakistan. *The Pakistan Development Review, 63*(2), 203–220. https://doi.org/10.30541/v63i2pp.203-220

Li, J., Yan, Y., & Zeng, X. (2025). Exploring artificial intelligence in inclusive education: A systematic review of empirical studies. *Applied Sciences, 15*(23), Article 12624. https://doi.org/10.3390/app152312624

Naz, B., Abbas, A., & Amjad, F. (2024). Enhancing Student Learning Outcomes through Blended Learning Strategies: An Empirical Study. *Journal of Development and Social Sciences*, *5*(2), 152-165. https://doi.org/10.47205/jdss.2024(5-II-S)16

Paglialunga, A., & Melogno, S. (2025). The effectiveness of artificial intelligence-based interventions for students with learning disabilities: A systematic review. *Brain Sciences, 15*(8), Article 806. https://doi.org/10.3390/brainsci15080806

Panjwani-Charania, S., & Zhai, X. (2024). AI for students with learning disabilities: A systematic review. In X. Zhai & J. Krajcik (Eds.), *Uses of artificial intelligence in STEM education*. Oxford University Press. https://doi.org/10.1093/oso/9780198882077.003.0021

Rizk, J., & Hillier, C. (2022). Digital technology and increasing engagement among students with disabilities: Interaction rituals and digital capital. *Computers and Education Open, 3*, Article 100099. https://doi.org/10.1016/j.caeo.2022.100099

Sajjad, N., Batool, S., & Amjad, F. (2025). Utilizing artificial intelligence to improve teachers' knowledge and instructional strategies in special education setting. *Journal of Social Sciences Research & Policy*, *3*(1), 153-164. https://jssrp.org.pk/index.php/jssrp/article/view/31

Shahini, A., Kamath, A. P., Sharma, E., Salvi, M., Tan, R.-S., Siuly, S., Seoni, S., Ganguly, R., Devi, A., Deo, R., Barua, P. D., & Acharya, U. R. (2025). A systematic review for artificial intelligence-driven assistive technologies to support children with neurodevelopmental disorders. *Information Fusion, 117*, Article 103441. https://doi.org/10.1016/j.inffus.2025.103441

UNESCO. (2023). *2023 GEM report: Technology in education: A tool on whose terms?* UNESCO.

UNICEF Pakistan. (2025). *Education*.

UNICEF Pakistan. (2025). *UNICEF Pakistan annual report 2024*. UNICEF.

UNICEF Pakistan. (2026, March 2). *Invisible struggles, unlocked potential*.

Upadhayay, N. B., & Kakar, Q. (2024). Access to schools and learning outcomes of children with disabilities in Pakistan: Findings from a household survey in four administrative units. *International Journal of Inclusive Education*.

Voultsiou, E., & Moussiades, L. (2025). A systematic review of AI, VR, and LLM applications in special education: Opportunities, challenges, and future directions. *Education and Information Technologies, 30*, 19141–19181. https://doi.org/10.1007/s10639-025-13550-4

World Health Organization, & UNICEF. (2022). *Global report on assistive technology*. World Health Organization.

World Health Organization. (2024, January 2). *Assistive technology*.

Yang, Y., Chen, L., He, W., Sun, D., & Salas-Pilco, S. Z. (2025). Artificial intelligence for enhancing special education for K–12: A decade of trends, themes, and global insights (2013–2023). *International Journal of Artificial Intelligence in Education, 35*, 1129–1177. https://doi.org/10.1007/s40593-024-00422-0

Zdravkova, K., Krasniqi, V., Dalipi, F., & Ferati, M. (2022). Cutting-edge communication and learning assistive technologies for disabled children: An artificial intelligence perspective. *Frontiers in Artificial Intelligence, 5*, Article 970430. https://doi.org/10.3389/frai.2022.970430