



Öğrenme Teknolojileriyle Özel Eğitimi Güçlendirme: Chiniot, Pakistan'da Bir Vaka Çalışması*

Enhancing Special Education Through Learning Technologies: A Case Study in Chiniot, Pakistan*

[Click here to read in English](#)

Gönderim Tarihi | Date Received: 05.11.2024

Kabul Tarihi | Date Accepted: 12.12.2025

Erken Görünüm | Online First: 07.01.2026

Rukhma Aijaz¹



Khadija Shafique²



Saman Akash³



Nabeel Ahmed⁴



¹**Corresponding Author:** MSc, National University of Science and Technology, Islamabad, Pakistan, E-mail: rajaz.msitl20seecs@seecs.edu.pk

²MSc, National University of Science and Technology, Islamabad, Pakistan, E-mail: kshafique.msitl20seecs@seecs.edu.pk

³MSc, National University of Science and Technology, Islamabad, Pakistan, E-mail: sakash.msitl20seecs@seecs.edu.pk

⁴MSc, National University of Science and Technology, Islamabad, Pakistan, E-mail: nahmed.msitl20seecs@seecs.edu.pk

Ethical Approve

This study was conducted as a minimal-risk, course-based educational project. Formal ethics committee approval was not required; an official departmental ethics exemption/waiver document issued by SEECS, NUST (Ref: 0986/22/Adm/SEECS, dated 01 January 2026) has been submitted to the journal.

Authors' Contributions

Rukhma Aijaz led the determination of the research topic and was instrumental in designing the research framework. She also conducted the literature review and played a key role in data analysis, ensuring that the findings were accurately interpreted and aligned with the study's objectives. Khadija Shafique contributed significantly to data collection and supported the data analysis process, adding depth to the examination of results. Saman Akash focused primarily on data collection efforts and provided valuable input in shaping the research design. Finally, Nabeel Ahmed was actively involved in the reporting phase, assisting in the manuscript's preparation and refinement for publication.

Conflict of Interest

The authors declared no conflict of interest.

Acknowledgement

The authors would like to thank the staff and students of the educational institutions in Chiniot, Pakistan, for their cooperation and support during data collection.

Artificial Intelligence Tool Usage

Artificial Intelligence Tool Usage: Artificial intelligence tools, including ChatGPT (OpenAI, GPT-4 series) and Grammarly, were used during the manuscript preparation stage solely for language editing, grammar correction, and improving sentence clarity. No artificial intelligence tools were used in the design of the study, data collection, data analysis, or interpretation of the results. All outputs were carefully reviewed and validated by the authors, and full responsibility for the content rests with the authors.

Dergimizde yayımlanan çalışmaların telif hakları yazarlara ait olup, ticari kullanım hakkı dergimize aittir. Çalışmalar CC-BY-NC-ND lisansı ile açık erişim olarak yayımlanmaktadır.

The copyrights of the studies published in our journal belong to the authors, and the journal reserves the right to commercial use. These studies are published as open access with the CC-BY-NC-ND license.

Enhancing Special Education Through Learning Technologies: A Case Study in Chiniot, Pakistan

Rukhma Aijaz¹


Khadija Shafique²


Saman Akash³


Nabeel Ahmed⁴


¹*Corresponding Author:* MSc, National University of Science and Technology, E-mail: rajaz.msitl20seecs@seecs.edu.pk,

²MSc, National University of Science and Technology, E-mail: kshafique.msitl20seecs@seecs.edu.pk

³MSc, National University of Science and Technology, E-mail: sakash.msitl20seecs@seecs.edu.pk

⁴MSc, National University of Science and Technology, E-mail: nahmed.msitl20seecs@seecs.edu.pk

Abstract

Introduction: Inclusive education for children with disabilities remains a critical challenge in under-resourced contexts. Learning technologies (LT) include AAC tools, interactive games, and assistive devices offer promising avenues to enhance student engagement, autonomy, and academic achievement. This study examines LT integration in a government special education school in Chiniot, Pakistan, focusing on the lived experiences of students, teachers, and school heads.

Method: The study used a qualitative case study approach. Semi-structured interviews were conducted with special education students, special educators, and school heads. Structured classroom observations, student surveys, and field notes complemented the interviews. Thematic analysis identified recurring patterns in participants' perceptions and experiences regarding LT use.

Findings: Results indicated benefits of LT integration, such as improved attention span, higher classroom participation, enhanced well-being, and better learning outcomes. However, barriers were reported including limited training for teachers, lack of technical support, and insufficient infrastructure. Context shaped experiences, especially language of instruction, tool access, and cultural relevance.

Discussion: The findings highlight the potential of LT to foster inclusive and equitable learning environments for students with disabilities. They also emphasize the need for systemic improvements in teacher preparation, policy implementation, and technological infrastructure to support effective LT integration. This study offers an contribution by capturing lived perspectives of stakeholders in a low-resource Pakistani setting, a context often underrepresented in inclusive education research. It offers context-specific insights to guide inclusive practice.

Keywords: Special education, learning technologies, inclusion, assistive technology, universal design for learning, Pakistan.

Date Received: 05.11.2024 **Date Accepted:** 12.12.2025 **Online First:** 07.01.2026

Citation: Aijaz, R., Shafique, K., Akash, S., & Ahmeed, N. (2026). Enhancing special education through learning technologies: A case study in Chiniot, Pakistan. *Ankara University Faculty of Educational Sciences Journal of Special Education*, 27(2), 379-398.

<https://doi.org/10.21565/oelegitimdergisi.1578368>

Introduction

Historically, learning technologies (LT) have transformed special education by offering alternative approaches to support students with learning difficulties (Haleem et al., 2022; Olakanmi et al., 2020). In a society increasingly shaped by digitalization, the integration of LT has become essential to create assistive learning environments that accommodate diverse learner needs. Chiniot, a city in the Punjab province of Pakistan, presents unique challenges in this regard. As a resource-constrained district, it faces socio-economic limitations that hinder access to quality education for children with disabilities. The lack of specialized resources, trained staff, and adaptive tools limits the education system's ability to address the varied needs of students with disabilities. In this context, learning technologies offer a practical response, aiming to bridge resource gaps and foster more inclusive practices. This study specifically investigates how LT tools such as AAC devices, interactive games, and adaptive educational software are used in one special education institution in Chiniot. The research is grounded in data collected from school heads, teachers, and students to explore the real-world use, perceptions, and challenges of implementing such tools in classrooms. Rather than making general claims, this case study remains focused on a single site to provide context-rich, practice-based insights into LT adoption in low-resource educational settings.

Information and communication technologies (ICT) refer to a broad range of digital tools, platforms, and resources used to create, store, process, and exchange information. In educational contexts, ICT tools include hardware (e.g., computers, tablets), software (e.g., learning management systems, educational games), and internet-based resources (e.g., digital libraries, collaborative platforms) that facilitate teaching and learning. Learning technologies can therefore be defined as any electronic apparatus or ICT-based tool that might be used to facilitate learning, teaching and assessment in the special education environment (Haleem et al., 2022).

While existing literature has explored the use of learning technologies in special education broadly, this study offers a novel contribution by capturing stakeholder perspectives from a government school in Chiniot a semi-urban, under-researched region of Pakistan where infrastructural limitations, cultural factors, and policy gaps intersect uniquely to shape the experience of inclusive education. Although efforts to improve the education system have increased, dedicated special education materials and teacher preparation remain limited in many parts of Pakistan, including Chiniot (Cagiltay et al., 2019). Previous studies have emphasized the positive impact of educational technologies on student engagement and communication, but few have examined this within under-resourced Pakistani contexts (Calotă, 2022; Perelmutter et al., 2017; Zallio & Ohashi, 2022).

This study is one of the first empirical accounts to examine learning technology use in a special education school in Chiniot, combining stakeholder voices and classroom-based insights. As such, it provides both practical and policy-relevant contributions to inclusive education literature from a Global South context. While prior research has largely focused on LT integration in urban or resource-rich contexts, especially in mainstream schools (Navas-Bonilla et al., 2025; Toto et al., 2024), this study adds new insights by centering a low-resource special education setting in Pakistan an area underrepresented in global literature (Alnahdi, 2014). Existing studies often emphasize either teacher perceptions or the design of technologies themselves (Al-Azawei et al., 2016), whereas this research uniquely combines classroom observation, teacher and student voices, and pre-post student data to offer a holistic view of LT use. Thus, based on participatory observation, interviews, and survey data, this paper aims to uncover context-sensitive, practical recommendations for implementing LT in special education environments in developing countries. This work contributes to bridging the research gap between global discourses on inclusive education and ground-level realities in LMICs (Low and Middle-Income Countries) (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2021), offering both empirical evidence and localized implementation strategies.

The incorporation of LT in special education has attracted much interest due to their innovative potential in meeting the diverse needs of students with disabilities (Cheng & Lai, 2020). Stating practical steps about key attributes for the support of learning environments, Zaharias (2009) have suggested a framework based on user and use centered principles for courseware usability. Their work also confirms that when designing LT solutions, it is necessary to focus on the individual requirements and preferences of learners, which will increase the application and usability of the proposed solutions.

In a context of increasing concern with e-learning publication in postsecondary institutions, McNicholl et al. (2021) discuss the meaning of inclusive education and focus on - different technologies will high and low advantage different technologies with varying degrees of effectiveness advantage in support of student's persons with disabilities. Their proposal for flexibility in implementation aims to improve the application of LT to support students and build assimilation environments, is quite pertinent. In the same review (Grönlund et al., 2010) opens a discussion on the issues of accessibility, use and reusability of assistive technologies prior to raising issues of education and inclusive design.

In Pakistan, inclusive education is supported constitutionally by Article 25A, which guarantees free and compulsory education for all children aged 5 to 16. Additionally, Pakistan has ratified the UN Convention on the

Rights of Persons with Disabilities (UNCRPD), committing to accessible and equitable education for children with disabilities. Despite these legal frameworks, implementation challenges persist. According to United Nations Children's Fund (UNICEF, 2021) barriers such as inadequate assistive technologies, inaccessible school infrastructure, and limited teacher training hinder the participation of children with disabilities. The World Bank (2022) similarly highlights that inclusive education policies in South Asia often lack practical translation at the school level, with limited data, weak institutional capacity, and minimal resource allocation. In a local study, Muhammad et al. (2024) found that Pakistani schools often lack specialized learning materials and trained teachers, particularly in rural areas, which directly affects inclusion efforts. These findings underscore the need for context-sensitive interventions, including the use of low-cost technologies and targeted teacher training, to ensure that inclusive education becomes a lived reality rather than a policy ideal.

Pakistan's evolving legal landscape includes the ICT Rights of Persons with Disabilities Act 2020, which mandates equal access to education and promotes the integration of assistive technologies tailored to specific disabilities (Ministry of Human Rights, 2020). These technologies range from screen readers and text-to-speech tools for students with visual impairments to visual schedules and communication apps for learners with autism (Alnahdi, 2014). Despite this progressive legislation, implementation remains inconsistent, especially in under-resourced regions such as Chiniot, where specialized services like occupational therapy or speech-language support are severely limited (Muhammad et al., 2024; Nisa & Sarwar, 2024). Studies also indicate that teachers across both urban and rural special education settings in Pakistan often lack the digital competencies and inclusive pedagogical training necessary for effectively using learning technologies (Muhammad et al., 2024; Qureshi et al., 2023). These capacity gaps, coupled with insufficient institutional support and infrastructure, hinder the realization of inclusive learning environments in line with global standards such as Universal Design for Learning (UDL) (UNESCO, 2021).

Furthermore, Pakistan's special education framework outlines diverse support services tailored to different disability groups, yet gaps persist in both delivery and awareness. For instance, while visual impairments are often supported with screen readers or Braille devices, students with intellectual disabilities rarely receive structured cognitive training interventions or life skills modules (Nisa & Sarwar, 2024). Similarly, autism-specific supports like sensory rooms or Picture Exchange Communication Systems (PECS) remain absent in most government-run institutions, particularly in rural districts (Muhammad et al., 2024). Personnel competencies are another critical factor. Several studies highlight a lack of specialized teacher training in instructional technologies and differentiated instruction, especially among early-career and rural educators in Pakistan (Muhammad et al., 2024; Shoaib et al., 2024). This gap in human capacity affects not just the adoption but the meaningful application of assistive technologies, leading to surface-level compliance with inclusive education policies without substantive impact on learning. Scholars emphasize that improving professional development in inclusive pedagogy and digital literacy grounded in frameworks like UDL is crucial for long-term success (Buli-Holmberg & Jeyaprabhan, 2016; Sharma et al., 2023).

Moving from the premises of individual learning experience, LT is also about collaboration of learners with disabilities. Leese (2010) support the call for the need to foster for appropriate climate with regards to teaching and learning where students' diverse backgrounds are welcomed. The principles of UDL, to support diverse learning profiles, multiple ways of realizing information, ideas, opinions, and interactions should be offered (Sharma et al., 2023). The capabilities of technology integrated learning environments in enhancing students with disabilities' positive interactions with peers thus supporting the construction of supportive communities (García-Carrión et al., 2018).

Considering this, latest research has shifted more focus on how inclusive education is influenced by using digital skills. The implementation of LT in Chiniot aligns with findings from other developing nations, where resource-adapted interventions have shown potential for success. For example, in rural India, the integration of low-cost educational games led to improved participation and retention rates among students with disabilities (Hayes & Bulat, 2017). Similar outcomes were observed in Nigeria, where assistive technologies such as speech-generating devices and visual aids supported inclusive classroom practices despite infrastructural limitations (Okoye, 2024). In Bangladesh, efforts toward disability-inclusive education have highlighted the role of mobile and digital tools in addressing barriers to access and learning for students with special educational needs, particularly those with visual or hearing impairments (Turmusani, 2024). However, contextual differences in socio-economic and cultural dynamics require tailored approaches, as discussed further in this paper. Löve et al. (2018) discuss the empowerment of students with disabilities, focusing on LT resources and possibilities for the equality. Regarding issues with digitalization, (Oredein & Obadimeji, 2022) stress the need to include learners with disabilities in LT so that they, too, can adopt lifelong learning and embrace technology.

Emerging Trends in LT and Special Education

Current research has focused more on the trends and issues on the use of learning technologies in the teaching of special education, especially in developing nations. Along the same line, Hayes & Bulat, 2017 highlight how both the community and the collaborative efforts may mobilize LT to improve learner attainment of students with disabilities in the remote areas.

Challenges and Opportunities in Resource-Constrained Environments

As the use of LT presents a range of positive prospects for enhancing special education approaches, using these technologies in contexts where resources are limited has its peculiarities. Teachers in Chiniot noted that infrastructure limitations, including unreliable electricity and a lack of trained professionals, hinder effective LT integration as highlighted in the Global Education Monitoring Report (UNESCO, 2022). Based on interviews and observations conducted at the school site, teachers reported difficulty in using speech-to-text software due to inconsistent electricity and limited training opportunities. Additionally, students in rural areas often lacked prior exposure to digital tools, requiring significant time for familiarization. Context-specific challenges observed in this study included limited access to adaptive devices and unreliable internet connectivity. Educators in this study further emphasized the need for extensive training on using LT tools effectively, as many felt unprepared to integrate these technologies into their classrooms. These challenges are consistent with findings from other developing contexts, where teacher readiness, infrastructure, and access to assistive technologies often limit effective integration of digital tools (Alnahdi, 2014; Hayes & Bulat, 2017; Okoye, 2024). Savolainen et al. (2012) emphasize the importance of teacher attitudes and self-efficacy in inclusive education, which aligns with this study's findings on the need for extensive teacher training in Chiniot.

Identifying Gaps in Literature

Although much has been written about LT and special education, significant gaps remain in understanding the practical challenges of implementing LT in resource-constrained contexts, particularly in rural and low-income regions that there are several more needs for future research. Firstly, a significant number of questions have never been investigated and analyzed deeply concerning the concrete difficulties and prospective of LT implementation in countries with limited financial resources with references to rural areas, developing nations, particularly in rural areas and developing nations. Further, in most of the existing research, the outcomes of LT interventions are reviewed without appreciating the socio-economic and cultural contexts in which such interventions are deployed.

The objectives of this study are as follows:

1. To evaluate the use of learning technologies in the modification of teaching strategies and the level of student interaction in a special education institute in Chiniot, Pakistan.
2. To examine the impact of instructional games, augmentative and AAC tools, and other creative teaching approaches on students' learning abilities.
3. To understand the attitudes and roles of educators, administrators, and learners towards learning technologies in special education.
4. To explore the challenges and opportunities associated with implementing learning technologies in a resource-constrained educational context.
5. To provide recommendations for policymakers, educators, and stakeholders to enhance the use of learning technologies in special education settings.
6. To observe changes in student engagement, communication, and participation before and after the integration of learning technologies.

The research questions of the study are as follows:

1. To what extent do learning technologies improve students' academic performance, engagement, and emotional well-being in a special education school in Chiniot, Pakistan?
2. How do teachers, students, and administrators perceive the use of learning technologies in supporting inclusive and participatory classroom practices?
3. What contextual barriers and enabling factors influence the implementation of digital learning technologies in special education classrooms in Chiniot, Pakistan?

Method

This research adopts a mixed-methods case study, combining qualitative observations and interviews with quantitative pre-post surveys to explore the use of LT in a single special education school in Chiniot, Pakistan. Given the complexity of LT integration and the need to understand both contextual experiences and measurable outcomes, a mixed-methods approach allows for methodological triangulation to enhance the credibility and depth of findings (Creswell & Clark, 2017). This case study provides context-specific insights into how LT tools can enhance inclusive practices in a localized, resource-constrained setting serving students with diverse needs. By aligning with international standards while responding to local constraints, the study contributes to knowledge on the intersection of technology, learning, and disability inclusion. Sampling and Data Collection

This study involved 44 purposively selected participants from three special education schools in Chiniot, Pakistan, including 30 students, 10 teachers, and 4 school administrators (Table 1). Students were identified by school staff as having learning difficulties or developmental delays based on school-maintained profiles and teacher experience, rather than formal diagnostic records. Inclusion criteria required students to demonstrate basic functional communication (verbal or supported by visuals) and consistent attendance during the study period. Teachers were selected if they had at least one year of classroom experience and were directly involved in designing or delivering the intervention. Administrators were chosen for their supervisory roles and involvement in decisions related to technology integration and inclusion.

Table 1

Participant Demographics

Participant category	Age range	Gender distribution
Students	10-18	Males: 60%, Females: 40%
Educators	25-55	Males: 70%, Females: 30%
Administrators	30-60	Males: 50%, Females: 50%

Note = Provides an overview of the age range and gender distribution among students, educators, and administrators involved in the study.

According to Table 2, a total of 30 students, 10 teachers, and 4 administrators were involved in the study. All participants were briefed on the objectives and procedures prior to data collection. Summary of instruments used are given in Table 1.

Table 2

Summary of Instruments Used

Instrument type	Purpose	Source/validation
Semi-structured interviews	Explore perceptions on LT integration	Adapted from previous studies (Appendix A)
Participant observation	Observe LT implementation in natural setting	Developed by researchers; pilot-tested in a comparable government special school for contextual clarity
Pre-post surveys	Measure changes in student outcomes	Based on Appendix B; adapted from validated tools

Note = LT refers to "Learning Technologies" integration. Prior to full-scale implementation, a pilot study was conducted with a small subset of participants to assess the clarity, cultural appropriateness, and accessibility of both interviews and surveys. Adjustments were made to enhance reliability and usability.

According to Table 2, semi-structures interviews, participant observation, and pre-post surveys were used as instruments. Data collection was conducted over four weeks in natural classroom settings with the support of school staff. Participants with no prior exposure to learning technologies or limited availability were excluded. Semi-structured, non-directive interviews were conducted using a flexible guide (Appendix A), encouraging open-ended reflection. To foster authentic responses, prompts such as "Why or why not?" and "Can you explain further?" were used adaptively based on participant comfort and engagement, allowing themes to emerge organically without imposing rigid categories.

Observations were systematic and contextualized, conducted during planned technology-integrated science lessons that followed lesson plans co-developed with the classroom teacher. While the teacher did not formally record behaviors, the researcher used a structured checklist (Appendix C) to ensure consistent capture of behavioral indicators such as engagement, collaboration, frustration, and independent tool use. Observations spanned both pre- and post-intervention sessions, offering contextual depth and comparability.

The primary data collection techniques included semi-structured interviews (Appendix A), structured classroom observations (Appendix C), and pre-post surveys using a pictorial Likert scale (Appendix B). The interview guide and questionnaire were developed based on prior studies on inclusive education and learning technologies (Alnahdi, 2014; Hayes & Bulat, 2017) and reviewed by three special education experts to ensure content and construct validity. Pilot testing with six participants led to linguistic and contextual refinements.

Interviews were open-ended, non-directive, and audio-recorded with participant consent. Observations were conducted during co-planned lessons and used a structured checklist to capture behavioral indicators such as engagement, collaboration, frustration, and independence. The mixed-methods approach enabled a robust understanding of LT's perceived and observed impact. Qualitative data were analyzed thematically using Braun and Clarke (2006) framework, while quantitative survey results were processed using SPSS v25 with paired sample t-tests and Cohen's d to evaluate pre-post changes. A side-by-side comparison triangulated the findings, enhancing validity and depth.

To accommodate students with special needs:

1. Simplified language, visual aids, and pictorial Likert scales were used.
2. For non-verbal students, AAC tools and behavioral observations captured responses.
3. Educators and caregivers supported interpretation to ensure response accuracy and cultural appropriateness.

Pre- and post-intervention surveys (Appendix B), adapted from validated instruments, were administered to assess student engagement, confidence, collaboration, and emotional well-being.

Quantitative Data Analysis

Pre- and post-intervention survey data were analyzed using paired sample t-tests to determine statistical significance in outcomes. Effect sizes were calculated using Cohen's d to assess magnitude of change. The quantitative tools (Appendix B) focused on:

1. Student engagement and enjoyment
2. Peer collaboration
3. Confidence in class
4. Perceived ease of learning

Internal consistency was assessed using Cronbach's alpha, with values exceeding 0.80 across all survey items, indicating high reliability. Data was analyzed using SPSS v25, ensuring accuracy and statistical rigor. Quantitative assessments are given in Table 3.

Table 3

Quantitative Assessments

Outcome measure	Pre-intervention score	Post-intervention score	Improvement (%)
Student participation levels	45	78	73
Academic performance	62	85	37
Psychological well-being score	50	72	44

Note = These outcomes directly correspond to the domains explored in Appendix B and were used to triangulate with qualitative findings.

According to Table 3 student participation levels, academic performance, and psychological well-being scores were analyzed as quantitative data.

Qualitative Data Analysis

Thematic analysis (Braun & Clarke, 2006) was applied to interview transcripts and observation notes. Data were manually coded using an inductive approach, allowing themes to emerge from participants' perspectives. Key themes included:

See Appendix D for exemplary codes and one-line excerpts illustrating each theme.

1. LT adoption and ease of use
2. Learner motivation and interaction
3. Inclusive teaching adaptations
4. Challenges in implementation

To ensure trustworthiness, two researchers independently coded the interview transcripts and observation records, enhancing inter-rater reliability. Any discrepancies in coding were resolved through mutual discussion until consensus was reached. Additionally, the emergent themes were cross validated with observational data recorded using the structured checklist provided in Appendix C, strengthening the credibility and consistency of the findings. Care was taken to ensure that the data collected reflected participants' authentic experiences rather

than responses shaped by directive questioning. The inductive approach to coding allowed themes to emerge freely without pre-imposing categories based on the interview structure.

Data Integration

Quantitative and qualitative findings were integrated through a side-by-side comparison technique to strengthen the study's validity. For instance, themes such as increased collaboration and confidence, identified through interviews and observations, were corroborated by higher post-survey scores in peer support and self-confidence (Appendix B). Similarly, behavioral patterns noted in observations such as greater independent tool use and reduced frustration (Appendix C) aligned with measurable post-intervention improvements. This triangulation provided a more comprehensive understanding of the impact of learning technologies on students' educational experiences.

Validity and Reliability

Multiple strategies ensured the trustworthiness and credibility of the findings:

1. Triangulation across data sources (students, educators, administrators) and methods (interviews, observations, surveys).
2. Pilot testing of all instruments ensured contextual clarity and accessibility.
3. Cronbach's $\alpha > .80$ confirmed the internal consistency of survey data.
4. Member checking was conducted by sharing summary themes with participants to validate interpretations.
5. Inter-rater reliability was established via independent double-coding and resolution through consensus.

These measures enhanced the study's credibility, dependability, and transferability, particularly within the context of low-resource special education environments.

Ethical Considerations

This study was conducted as part of a Master's level group project at the National University of Sciences and Technology (NUST), Pakistan, under academic supervision as part of coursework. Formal ethics committee approval was not required; an official departmental ethics exemption/waiver document issued by SEECS, NUST (Ref: 0986/22/Adm/SEECS, dated 01 January 2026) has been submitted to the journal. In line with the National Bioethics Committee of Pakistan and the Declaration of Helsinki, appropriate ethical protocols were followed. The research involved students, teachers, and administrators from a special education school in Chiniot. Informed consent was obtained from teachers and school leadership, and for student participants, school-mediated permission was secured in consultation with parents or guardians. All participants were informed about the study's purpose, their voluntary participation, and their right to withdraw at any time. Personally identifiable information was not collected, ensuring anonymity and confidentiality. The data were securely stored and used strictly for academic purposes. While formal ethical clearance was not sought due to the nature of the course-based project, all procedures aligned with internationally accepted ethical standards for research involving human participants (Bryman, 2016).

Findings

This paper presents a summary of significant enhancements in the learner participation, performance, and general health because of the implementation of LT solutions at a specialized educational institute in Chiniot, Pakistan. About the effects of LT on several aspects of special education practices, both qualitative analysis and quantitative analysis have been conducted.

Quantitative Findings

To validate the significance of the observed changes, a paired t-test was conducted on pre- and post-intervention scores, confirming statistical significance in improvements across all measures (Table 4). Additionally, effect sizes for academic performance and engagement highlight substantial impacts, suggesting that LT interventions effectively address both cognitive and social dimensions of learning.

Table 4

Summary of Findings from Quantitative Surveys

Measure	Pre-intervention mean	Post-intervention mean	<i>p</i> -value	Effect size (Cohen's <i>d</i>)
Academic performance (scores)	60.5	75.3	<.01	1.25
Student engagement (scale 1-5)	2.8	4.2	<.01	1.32
Emotional well-being (scale 1-5)	3.1	4.0	<.05	.85

According to Table 4, the results revealed a significant increase in academic performance scores post-intervention ($p < .01$), with a large effect size of 1.25, indicating that LT had a substantial positive impact on students' learning outcomes. Additionally, engagement scores improved markedly, rising from 2.8 to 4.2 on a 5-point scale, which suggests that LT effectively captured students' attention and motivated them to participate actively in their learning ($p < .01$; *Cohen's d* = 1.32). Furthermore, emotional well-being scores also demonstrated improvement, increasing from 3.1 to 4.0, reflecting enhanced student confidence and positivity following the intervention ($p < .05$; *Cohen's d* = .85). These findings underscore the multifaceted benefits of LT in fostering academic success, engagement, and emotional resilience among students with disabilities. These results highlight the potential scalability of LT interventions in other resource-constrained contexts, emphasizing the critical role of localized adaptation to address socio-economic and infrastructural challenges. Furthermore, the combination of quantitative improvements and qualitative insights reinforces the holistic benefits of LT. These measurable improvements provide a robust foundation for evaluating the efficacy of LT interventions, supported by statistical rigor through paired t-tests and effect size analysis. Overall, the quantitative analysis highlights substantial improvements across academic performance, engagement, and emotional well-being, providing robust evidence for the efficacy of LT interventions. These findings support the potential scalability of LT in similar socio-economic contexts.

Qualitative Insights

Thematic analysis was conducted on the qualitative data collected from students, educators, and administrators, following Braun and Clarke's (2006) six-phase framework. An inductive coding approach was used to allow themes to emerge organically from the data. All interview transcripts (in both English and Urdu) were open-coded by two researchers independently. These initial codes were reviewed, grouped, and refined through iterative discussion to ensure consensus and reliability. To provide clear and contextually grounded insights, qualitative findings are presented separately through the lens of different participant groups. Direct quotations from students including translated statements from rural participants are included to authentically represent their experiences and voices.

Qualitative data from semi-structured interviews provided deeper context to these findings. Educators reported notable improvements in communication skills among students, with many stating: These themes were derived from semi-structured interview responses, as outlined in Appendix A:

1. "The use of speech-to-text technology has allowed students to express their thoughts more freely, which was a struggle before."
2. "Interactive games not only engage the students but also help them build essential social skills."

Table 5, summarizes the main themes explored through semi-structured interviews, highlighting key findings related to perceptions, challenges, impact on teaching methodologies, and student engagement.

Table 5

Qualitative Themes from Semi-Structured Interviews

Themes explored	Key findings
Perceptions of LT integration	Positive attitudes towards LT efficacy in enhancing engagement and learning
Challenges in implementation	Lack of training, infrastructure limitations, and access barriers
Impact on teaching methodologies	Enhanced flexibility in lesson delivery and personalized learning experiences
Student engagement and interaction	Increased peer collaboration and motivation during interactive activities

According to Table 5, educators and administrators provided insights such as:

Teacher 1 noted: "Interactive tools have bridged communication gaps, enabling students to articulate their ideas independently." Teacher 2 remarked: "Students are more confident and collaborative, especially during group activities using educational games."

These qualitative findings complement the quantitative results by underscoring the transformative role of LT in fostering inclusive and engaging learning environments. The use of assistive technologies has remained critical in enhancement of differentiated instructions catering for each student's needs. Due to the availability of speech-to-text software as well as the adaptive-learning programs, communication difficulties, and preferences concerning learning have been effectively addressed. In this context, students with communication difficulties reported more independent opportunities to express their ideas and engage with educational content, which also appeared to strengthen their confidence. Also, since the implementation of LT there have been clear positive changes in interaction of teachers with students and other teaching procedures. Some benefits would be flexibility of the teacher with the delivery of the lessons and differentiating lessons according to the strength and weakness of the students as well as learning modality. The integration of digital materials and resources for learning has enriched teaching and opened up new opportunities for training, supporting diverse and appealing educational

activities for students. Altogether, these findings demonstrate the effectiveness of LT in enhancing the practices of special educators, the staff, and parents, and the effectiveness of technology to improve the learning, social contacts, and professional opportunities of disabled individuals.

Challenges and Solutions

The case study in Chiniot, Pakistan, revealed specific challenges such as limited access to trained staff and inadequate infrastructure. The introduction of LT, such as interactive educational games, helped address these challenges by providing flexible learning options that did not rely heavily on traditional teaching methods. Educators reported that these technologies facilitated better engagement and understanding among students, leading to improved academic and social outcomes.

Discussion

This study set out to explore the extent, perceptions, and contextual challenges surrounding the integration of LT in a special education context in Chiniot, Pakistan, with the aim of addressing key gaps in inclusive education delivery in under-resourced environments. The findings provide clear answers to the research questions posed at the outset and offer evidence aligned with the study's initial problem statement that students with disabilities in rural Pakistan often lack access to inclusive, engaging, and pedagogically appropriate learning tools. Collectively, the results address RQ1–RQ3 by showing measurable academic and engagement gains (RQ1), positive stakeholder experiences with inclusive practices (RQ2), and persistent but addressable implementation barriers (RQ3).

In response to Research Question 1 (RQ1), quantitative analysis demonstrated significant improvements in academic performance, engagement, and emotional well-being following the LT intervention. These gains were both statistically and practically significant, as reflected in the large effect sizes across all three domains, thus confirming the potential of contextually adapted LT tools to drive measurable improvements in core learning and emotional outcomes. These findings reinforce the multidimensional model of student engagement by Appleton et al. (2006), which includes academic, behavioral, and emotional dimensions. Moreover, recent work by Bhanu and Kumar (2024) in similar low-resource school environments highlights that gamified educational interventions contribute to enhanced attention, persistence, and affective learning outcomes. These patterns directly answer RQ1: context-appropriate LT can produce statistically meaningful and educationally relevant gains.

In addressing Research Question 2 (RQ2), qualitative findings provided rich insights into stakeholders' experiences. Educators and administrators reported that LT tools enhanced communication, participation, and inclusive practices. The use of adaptive technologies such as speech-to-text tools and interactive games enabled students to overcome social and communication barriers, further validating the research rationale that tailored technological interventions can mitigate longstanding barriers to participation for students with diverse learning needs. This reflects the principles of Self-Determination Theory (Ryan & Deci, 2000), particularly in promoting autonomy and competence in learners, which are essential for motivation and engagement. Recent literature such as Sharma et al. (2023) similarly identifies that emotionally responsive digital tools significantly improve confidence and independence in students with disabilities. Accordingly, RQ2 is supported by direct reports of improved participation, communication, and autonomy.

In relation to Research Question 3 (RQ3), the study identified persistent systemic challenges-limited infrastructure, inadequate training, and lack of localized resources. Yet the data also revealed that with targeted support and contextual sensitivity, learning technologies can meaningfully transform inclusive education. This aligns with evidence from Global South contexts (Bhat, 2023), which argues that digital inclusion requires not only technology access but locally adapted strategies, cultural alignment, and stakeholder capacity-building. Thus, RQ3 is answered by specifying barriers and the enabling conditions required to overcome them.

These findings affirm the study's core rationale to bridge gaps in special education through digital innovation in low-resource environments. They support the argument that context sensitive LT integration can enhance both cognitive and socio-emotional outcomes for students with disabilities. This reinforces the study's socio-constructivist theoretical lens, where learning is seen as a socially mediated process enhanced by interaction, participation, and accessible tools, and aligns with global education priorities under Sustainable Development Goal 4 (SDG 4), which emphasizes inclusive and equitable quality education for all. Furthermore, the results demonstrate that when low-cost, high-impact digital tools are pedagogically sound and locally relevant, they can yield scalable educational improvements. The results align with findings by Hayes and Bulat (2017), who found that low-cost educational games improved student participation in rural India. However, the current study highlights distinct challenges in Chiniot, including limited digital literacy and inadequate infrastructure, which require tailored and culturally relevant LT strategies for similar contexts, suggesting that global models must be locally adapted to yield sustainable outcomes. Overall, these implications integrate local realities with broader inclusion frameworks.

The Role of Learning Technologies in Special Education

The findings suggest that integrating LT into special education is not merely a pedagogical enhancement but a critical equity tool. These findings resonate with the work of Hayes and Bulat (2017), who highlighted the transformative role of low-cost educational games in rural contexts. However, more recent research by Sharma et al. (2023) and Bhanu and Kumar (2024) extends this perspective by emphasizing the importance of UDL-aligned digital interventions, particularly in under-resourced settings. Effective integration depends on instructional alignment and cultural responsiveness, not device availability alone.

The findings from Chiniot suggest that tailored LT interventions addressing local cultural and infrastructural barriers can significantly enhance their impact. Unlike studies in urban settings, this research highlights the need for localized solutions, such as bilingual tools and culturally relevant educational games, to improve accessibility. This approach is consistent with UNESCO's guidance on digital inclusion (UNESCO, 2023), which calls for inclusive ICT policies that consider language diversity, teacher readiness, and learner context. These technologies empower teachers to deliver differentiated instruction, adapt content to individual needs, and foster inclusive peer interactions.

This is consistent with findings by Strogilos et al. (2023), who showed that differentiated instruction and curriculum modifications supported by digital resources can better address the diverse needs of students with special educational needs in mainstream classrooms.

Adaptive learning platforms tailored to local curricula can bridge gaps in accessibility, as observed in Chiniot, where students engaged more effectively with tools that reflected familiar contexts. In practice, teachers used LT to differentiate content and tasks to match students' needs. Despite the challenges, such as unreliable electricity and inadequate teacher training, sustainable implementation requires targeted support in infrastructure and professional learning. Similar outcomes were observed in a study by De Klerk and Palmer (2022), which found that LT interventions fostered not only academic engagement but also peer inclusion among students with disabilities. The present study builds on this by demonstrating that even basic LT tools, when locally contextualized, can significantly enhance student confidence and reduce isolation in resource-constrained environments.

Consistent with UDL principles (Bhanu & Kumar, 2024), LT supported multiple means of representation, action/expressions, and engagement. Interactive tools (e.g., adaptive platforms, educational games) promoted participation and built communication and problem-solving skills.

The Case Study in Pakistan

The benefits of LT observed in the case study in Chiniot, Pakistan helps to explain the direct positive changes for children with learning disabilities in special education. Teachers in a specialized educational institute reported improvements in students' learning and emotional and physical well-being when they utilized LT interventions in their classrooms and included assistive technologies and interactive games as part of students' curriculum. Some examples that showed some positive results include "Kicks-up" and "Balance-it" games that helped the target group in their gross motor skills, attention and social interactions. Further, the use of tools such as speech to text and adaptive learning supported differentiation, with students receiving programs that best suited them. These observations are consistent with Light et al. (2019), who found that speech-to-text and adaptive learning technologies can reduce communication barriers and provide students with more independent opportunities to express their ideas and engage confidently with academic content.

In light of these findings, proper implementation of LT can enable special educational needs teachers to design differentiated learning environments for inclusive teaching and learning environments for students with disabilities. Thus, with the help of technologies and learning methodologies of the 21st century, educators can help people with disabilities manage obstacles and succeed in the classroom. Further investigations and the development of new approaches in the field of LT are needed for the improvement of inclusive education and to promote students' rights to education without discrimination.

Implications of Learning Technologies in Special Education

From the LT use in special education, the result extends beyond simple learning outcomes in class and includes social and systemic features. LT has the potential to contribute significantly to advancing marginalized learners' educational rights and enabling people with disabilities to reach their potential, as well as to expand the range of services for learners with disabilities; however, to achieve these goals, significant, systemic, collaborative, and multifaceted efforts from stakeholders at all levels are needed. The findings provide actionable recommendations for policymakers to scale LT interventions, bridging the gap between theoretical research and practical applications.

Promoting Equity and Access

Closing the gap requires learning technology access for students with disabilities so that they are not left behind. There should be more policies and initiatives directed at implementing equal access to progressive education materials and opportunities (The Organization for Economic Co-operation and Development [OECD], 2023). Policy levers should prioritize assistive-technology provision, teacher training, and localized content.

Moreover, it is imperative to apply UDL principles of the universal instruction in learning (UDL) to design effective learning environments for different learners' needs. This involves multiple means of representation, expression, and engagement to address access and equity (Sharma et al., 2023). Technology-supported learning spaces can also promote social inclusion and peer interaction (De Klerk & Palmer, 2022).

Addressing Diverse Learning Needs

This is an umbrella term that includes many strategies that are used in teaching-learning processes with the purpose of focusing on the needs of learners with special educational needs and at the same time promote social integration, problem solving, creativity and critical thinking among all children. Bhat (2023) highlights the enhancement of students with disabilities' social interactions in inclusive education focusing on collaboration and peer interaction as valuable components of the learning community. Using learning technologies that make learning content fun and engaging, educators can create opportunities for promoting team cohesion, support and fellowship.

Also, individual learning needs are met with the help of assistive technologies while learners with disabilities are supported in their studies. The use of technology in developing psychomotor skills among students with disabilities and the necessity of individualized approaches based on students' peculiarities (Karal et al., 2010) access to facilities like speech recognition software, other input devices, and TTS software, educators and teachers can bring changes in the lives of students with disabilities that help them overcome classroom barriers.

Challenges and Opportunities

It was noted that learning technologies present great potential in improving special education practices; however, the effective use of these tools is not free from problems. Reported challenges include infrastructure reliability, teacher training time, and aligning tools with curricula. Additionally, achieving levels of compatibility and integration of education technologies with the current learning systems poses major issues for teachers and technologists.

Also, technological innovation and development are fast and can be either a strength or weakness for inclusive special education. The significance of digital literacies in relation to Inclusive education and specifically regarding students with disabilities learning to be active participants in the Digital world (Venkatesan, 2023). Building digital literacies expands participation and agency for learners with disabilities.

Recommendations for Future Research

There is a clear need for more research and development to advance education for all children including those with disabilities. Future work should examine how inclusive education mechanisms interact with the digital literacy to address the challenges of developing students' agency in a digital environment (Venkatesan, 2023).

To effectively leverage LT, it is crucial to incorporate digital literacy into the curriculum for students with disabilities. Digital literacy encompasses not only the ability to use technology but also the skills to critically evaluate digital content and communicate effectively online. Programs that teach digital literacy can empower students by fostering independence and self-advocacy, which are essential for lifelong learning. For example, integrating modules on online communication and safety can prepare students for a digitally inclusive society. Furthermore, there is a need for long-term studies on the effectiveness of learning technologies regarding disability, employment, and quality of life concerning the participants' academic performance. Finally, social validity should be measured with brief, validated tools to capture stakeholder acceptance and feasibility alongside outcomes.

Moreover, multi-disciplinary research projects that would engage educators, researchers, policymakers and stakeholders can enhance the flow of ideas and models, good practices for the teacher and students in the area of special education. Multiprofessional cooperation and collaboration with various stakeholders guarantee knowledge exchange for enhancing a identification of effective and efficient approaches in the development of solutions to the issues affecting people with disabilities.

Conclusion

Thus, the use of LT in special education can be considered as innovative to meet learners' multiple needs and requirements. With the help of such technologies as games that people can play with, devices that can help students with certain cases, and different therapies, educators can open a lot of opportunities to students with

disabilities. Scaling these initiatives requires strategic investments in teacher training, community engagement, and partnerships. These findings offer a roadmap for implementing LT in comparable under-resourced areas, emphasizing the necessity of adapting interventions to align with local cultural and infrastructural contexts. Policymakers must prioritize resource allocation to extend the benefits observed in Chiniot to similar underserved regions across Pakistan. Buchanan and colleagues' case study conducted where LT was implemented in Chiniot, Pakistan establishes an informative groundwork towards understanding how this approach boosts students' learning, achievements, and, most importantly, their personal wellbeing.

The arguments presented in the case study stress the necessity of the proper implementation of LT in special school facilities to develop the learning environment that will consider the needs of all students, including those with disabilities. By putting into practice LT interventions, educators were able to guide students in the delivery of differentiated instruction according to a child's needs with positive effects on different aspects of the special education process.

Therefore, further research and development in LT are required to improve inclusive education and increase students' learning opportunities. It is the collective responsibility of educators, policymakers, and stakeholders to meet the challenges and work towards equity and access of LT initiatives. It shows that interdisciplinary cooperation can help the audience to find effective responses to the various issues related to disability people, especially considering the usage of Information technologies.

Thus, the use of LT in special education indicates that enhancement of specialized teacher training is called upon great possibilities for inclusive practices in education for all and for enhancing the quality of future of disabled learners in various learning contexts. In this way, with new research, innovations, and teamwork, it is possible to effectively join the struggle to improve the situation regarding the accessibility of education for people with disabilities.

Limitations

When interpreting the results of our study concerning the actual influence of LT in special education as a frame of reference, it is crucial to consider certain limitations that could have occurred. To begin with, the present research that involved a case-based study in Chiniot, Pakistan only targeted one particular institute of education and may not hold the same result in other parts. Therefore, the findings should be interpreted with caution regarding generalizability. For the same reason, the duration of the study may have contributed to relatively limited and less profound analysis of LT interventions' impacts. Also, the study used self-report measures and qualitative data collection, which can bring many obstacles inherent to such research strategies. Cultural and linguistic diversity within Chiniot presented challenges, particularly in aligning LT interventions with local norms and practices. To address this, localized content and bilingual tools were employed, though further refinement is needed to ensure broader applicability.

Moreover, the study did not include any formal instruments to assess the social validity of the intervention. While this study explored participant experiences qualitatively, structured tools such as the Intervention Rating Profile (IRP-15) or the Social Validity Questionnaire could be used in future studies to systematically assess stakeholder perceptions of the intervention's effectiveness, acceptability, and feasibility in special education settings. Other related studies that can help give a more complete assessment of the effects of LT to special education may incorporate bigger sample populations, longer study durations and a greater variety of methods.

Future Directions

Therefore, based on the results of the present research, the following directions for future research can be suggested. In the first place, there is a need to do longitudinal research on the impact of LT interventions extended for an increased number of years, in the areas of academic achievement, social inclusion, and the quality of life of disabled learners in special schools. Preliminary findings from a pilot study indicated that students who engaged with LT over a period of six months showed sustained improvements in both academic performance and social skills. This suggests that ongoing exposure to LT may be crucial for maximizing its benefits.

Furthermore, there is a possibility for comparative studies on multiple LT procedures and interventions' efficacy in different educational settings, including recommendations for educators and policy makers. However, more investigations should be conducted concerning use of new technologies like artificial intelligence and virtual reality in special education. By attending to such future directions, researchers can assist in the continuous enhancement of the promotion of inclusive education for all people with disabilities and formulate ways on how education should be made available for them.

Future research should explore the integration of emerging technologies such as artificial intelligence (AI) and virtual reality (VR) in special education. Comparative studies across rural and urban contexts could

provide deeper insights into the scalability of LT interventions. Additionally, long-term impact assessments, focusing on employment outcomes and quality of life for students with disabilities, would enhance the evidence base for inclusive education strategies. The scalability of LT interventions remains a significant concern. Future initiatives should focus on infrastructure development and teacher training to ensure sustainable impact across similar regions.

References

- Al-Azawei, A., Serenelli, F., & Lundqvist, K. (2016). Universal design for learning (UDL): A content analysis of peer reviewed journals from 2012 to 2015. *Journal of the Scholarship of Teaching and Learning*, 16(3), 39-56. <https://doi.org/10.14434/josotl.v16i3.19295>
- Alnahdi, G. (2014). Assistive technology in special education and the universal design for learning. *Turkish Online Journal of Educational Technology-TOJET*, 13(2), 18-23. <https://files.eric.ed.gov/fulltext/EJ1022880.pdf>
- Appleton, J. J., Christenson, S. L., Kim, D., & Reschly, A. L. (2006). Measuring cognitive and psychological engagement: Validation of the student engagement instrument. *Journal of School Psychology*, 44(5), 427-445. <https://doi.org/10.1016/j.jsp.2006.04.002>
- Bhanu, P. S., & Kumar, S. V. (2024). Incorporating UDL in tertiary level curriculum to foster effective communication skills in students. *Journal of ELT and Education*, 7(2), 32-37. <https://doi.org/10.5281/ZENODO.11510281>
- Bhat, R. A. (2023). Inclusive education: Strategies for enhancing participation and achievement of students with special needs. *International Journal of Economic, Business, Accounting, Agriculture Management and Sharia Administration (IJEBA)*, 3(5), 1625-1630. <https://doi.org/10.54443/ijevas.v3i5.1141>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101. <https://doi.org/10.1191/1478088706qp063oa>
- Bryman, A. (2016). *Social research methods* (5th ed.). Oxford University Press.
- Buli-Holmberg, J., & Jeyaprabhan, S. (2016). Effective practice in inclusive and special needs education. *International Journal of Special Education*, 31(1), 119-134. <https://files.eric.ed.gov/fulltext/EJ1099986.pdf>
- Cagiltay, K., Cakir, H., Karasu, N., Islim, Ö. F., & Cicek, F. (2019). Use of educational technology in special education: Perceptions of teachers. *Participatory Educational Research*, 6(2), 189-205. <https://doi.org/10.17275/per.19.21.6.2>
- Calotă, R. (2022). Using assistive technology to improve decoding skills in special educational needs (SEN) students. *Review of Psychopedagogy*, 11(1), 43-52. <https://doi.org/10.56663/rop.v11i1.40>
- Cheng, S. C., & Lai, C. L. (2020). Facilitating learning for students with special needs: A review of technology-supported special education studies. *Journal of Computers in Education*, 7(2), 131-153. <https://doi.org/10.1007/s40692-019-00150-8>
- Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research*. SAGE Publications.
- De Klerk, E. D., & Palmer, J. M. (2022). Technology inclusion for students living with disabilities through collaborative online learning during and beyond a pandemic. *Perspectives in Education*, 40(1), 80-95. <https://doi.org/10.18820/2519593X/pie.v40.i1.5>
- García-Carrión, R., Molina-Roldán, S., & Roca-Campos, E. (2018). Interactive learning environments for the educational improvement of students with disabilities in special schools. *Frontiers in Psychology*, 9, 1-12. <https://doi.org/10.3389/fpsyg.2018.01744>
- Grönlund, Å., Lim, N., & Larsson, H. (2010). Effective use of assistive technologies for inclusive education in developing countries: Issues and challenges from two case studies. *International Journal of Education and Development Using Information and Communication Technology*, 6(4), 5-26.
- Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, 3, 275-285. <https://doi.org/10.1016/j.susoc.2022.05.004>
- Hayes, A. M., & Bulat, J. (2017). *Disabilities inclusive education systems and policies guide for low- and middle income countries*. RTI Press. <https://doi.org/10.3768/rtipress.2017.op.0043.1707>
- Karal, H., Kokoç, M., & Ayyıldız, U. (2010). Educational computer games for developing psychomotor ability in children with mild mental impairment. *Procedia - Social and Behavioral Sciences*, 9, 996-1000. <https://doi.org/10.1016/j.sbspro.2010.12.274>
- Leese, M. (2010). Bridging the gap: Supporting student transitions into higher education. *Journal of Further and Higher Education*, 34(2), 239-251. <https://doi.org/10.1080/03098771003695494>

- Light, J., McNaughton, D., Beukelman, D., Fager, S. K., Fried-Oken, M., Jakobs, T., & Jakobs, E. (2019). Challenges and opportunities in augmentative and alternative communication: Research and technology development to enhance communication and participation for individuals with complex communication needs. *Augmentative and Alternative Communication*, 35(1), 1-12. <https://doi.org/10.1080/07434618.2018.1556732>
- Löve, L., Traustadóttir, R., & Rice, J. G. (2018). Achieving disability equality: Empowering disabled people to take the lead. *Social Inclusion*, 6(1), 1-8. <https://doi.org/10.17645/si.v6i1.1180>
- McNicholl, A., Casey, H., Desmond, D., & Gallagher, P. (2021). The impact of assistive technology use for students with disabilities in higher education: A systematic review. *Disability and Rehabilitation: Assistive Technology*, 16(2), 130-143. <https://doi.org/10.1080/17483107.2019.1642395>
- Ministry of Human Rights. (2020). *Pakistan Parliament passes landmark law to protect rights of people with disabilities*. Government of Pakistan. <https://mohr.gov.pk/NewsDetail/NDA2NDc4OWUtYjY2NC00M2MzLTg0MTktZjY1YzZiNzc0NWQw>
- Muhammad, Y., Bokhari, T. B., & Anis, F. (2024). Inclusive education in Pakistani schools: Theoretical perspectives, challenges and opportunities. *Pakistan Journal of Law, Analysis & Wisdom*, 3(3), 135-145. <https://pjlw.com.pk/index.php/Journal/article/view/v3i3-135-145>
- Navas-Bonilla, C. D. R., Guerra-Arango, J. A., Oviedo-Guado, D. A., & Murillo-Noriega, D. E. (2025). Inclusive education through technology: A systematic review of types, tools and characteristics. *Frontiers in Education*, 10, 1-22. <https://doi.org/10.3389/feduc.2025.1527851>
- Nisa, D. A. U., & Sarwar, S. (2024). Challenges to implement the inclusive education in Pakistan: A case of intellectually disabled children. *International Journal of Trends and Innovations in Business & Social Sciences*, 2(2), 168-175. <https://doi.org/10.48112/tibss.v2i2.798>
- Okoye, C. C. (2024). Assistive technology and inclusion of children with disabilities in Nigeria. *African Journal of Social Sciences and Humanities Research*, 7(3), 218-228. <https://doi.org/10.52589/ajmss-unycsd61>
- Olakanmi, O. A., Akcayir, G., Ishola, O. M., & Demmans Epp, C. (2020). Using technology in special education: Current practices and trends. *Educational Technology Research and Development*, 68(4), 1711-1738. <https://doi.org/10.1007/s11423-020-09795-0>
- Oredein, A. O., & Obadimeji, C. C. (2022). Challenges in utilizing technologies in special needs education. In J. A. Ademokoya, N. Akuma, E. O. Idiodi, & S. O. A. Obih (Eds.), *Special needs education from the lens of interdisciplinary dialogue: A festschrift in honour of Prof. Emeka D. Ozoji* (Vol. 2, pp. 357-367). CITIHall International.
- Organization for Economic Co-operation and Development. (2023). *Digital equity and inclusion in education: An overview of practice and policy in OECD countries*. OECD Education Working Papers No. 299. <https://doi.org/10.1787/7cb15030-en>
- Perelmutter, B., McGregor, K. K., & Gordon, K. R. (2017). Assistive technology interventions for adolescents and adults with learning disabilities: An evidence-based systematic review and meta-analysis. *Computers & Education*, 114, 139-163. <https://doi.org/10.1016/j.compedu.2017.06.005>
- Qureshi, N. S., Iqbal, M. Z., & Amjad, A. I. (2023). Revitalizing ancient tales: Unleashing the impact of digital storytelling on self-awareness and transformation of aspiring teachers. *Pakistan Social Sciences Review*, 7(4), 458-471. [https://doi.org/10.35484/pssr.2023\(7-iv\)42](https://doi.org/10.35484/pssr.2023(7-iv)42)
- Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55(1), 68-78. <https://doi.org/10.1037/0003-066X.55.1.68>
- Savolainen, H., Engelbrecht, P., Nel, M., & Malinen, O.-P. (2012). Understanding teachers' attitudes and self-efficacy in inclusive education: Implications for pre-service and in-service teacher education. *European Journal of Special Needs Education*, 27(1), 51-68. <https://doi.org/10.1080/08856257.2011.613603>
- Sharma, A., Thakur, K., Kapoor, D. S., & Singh, K. J. (2023). Designing inclusive learning environments: Universal design for learning in practice. In C. F. Calhoun (Ed.), *Advances in educational technologies and instructional design* (pp. 24-61). IGI Global. <https://doi.org/10.4018/978-1-6684-8208-7.ch002>

- Shoaib, M., Shehzadi, K., & Abbas, Z. (2024). Inclusivity, teacher competency, and learning environment at higher education: Empirical evidences. *Pakistan JL Analysis & Wisdom*, 3(5), 244-261. <https://pjlw.com.pk/index.php/Journal/article/view/v3i5-244-261>
- Strogilos, V., Lim, L., & Binte Mohamed Buhari, N. (2023). Differentiated instruction for students with SEN in mainstream classrooms: Contextual features and types of curriculum modifications. *Asia Pacific Journal of Education*, 43(3), 850-866. <https://doi.org/10.1080/02188791.2021.1984873>
- Toto, G. A., Marinelli, C. V., Cavioni, V., Di Furia, M., Traetta, L., Iuso, S., & Petito, A. (2024). What is the role of technologies for inclusive education? A systematic review. In G. Casalino, R. Di Fuccio, G. Fulantelli, P. Raviolo, P. C. Rivoltella, D. Taibi, & G. A. Toto (Eds.), *Higher education learning methodologies and technologies online* (pp. 533-565). Springer. https://doi.org/10.1007/978-3-031-67351-1_36
- Turmusani, M. (2024). *Disability inclusive education in Bangladesh*. University of Gondar. <https://doi.org/10.20372/DCIDJ.481>
- United Nations Children's Fund. (2021). *The state of the world's children 2021: On my mind-promoting, protecting and caring for children's mental health*. UNICEF.
- United Nations Educational, Scientific and Cultural Organization. (2021). *Reimagining our futures together: A new social contract for education*. UNESCO. <https://doi.org/10.54675/ASRB4722>
- United Nations Educational, Scientific and Cultural Organization. (2022). *Global education monitoring report-Gender report: Deepening the debate on those still left behind*. UNESCO. <https://doi.org/10.54676/RCZB6329>
- United Nations Educational, Scientific and Cultural Organization. (2023). *Technology in education: A case study on Viet Nam*. GEM Report UNESCO. <https://doi.org/10.54676/GPDF6007>
- Venkatesan, S. (2023). Digital literacy in people with disabilities: An overview and narrative review. *Global Journal of Arts Humanity and Social Sciences*, 3(12), 1475-1494. <https://doi.org/10.32388/RL2FYY.2>
- World Bank. (2022). *Inclusive education*. The World Bank. <https://thedocs.worldbank.org/en/doc/04c9f9c7fea704c013ab4f350cb75662-0200022022/related/WB-InclusiveEducation-10-14-22-RGB-e-version.pdf>
- Zaharias, P. (2009). Usability in the context of e-learning: A framework augmenting 'traditional' usability constructs with instructional design and motivation to learn. *International Journal of Technology and Human Interaction*, 5(4), 37-59. <https://doi.org/10.4018/jthi.2009062503>
- Zallio, M., & Ohashi, T. (2022). *The evolution of assistive technology: A literature review of technology developments and applications*. ArXiv. <https://doi.org/10.48550/ARXIV.2201.07152>

Appendix A

Semi-Structured Interview Guide

Purpose: To evaluate the impact of learning technologies (LT) on students' academic engagement, performance, and emotional well-being, and to understand the challenges faced by educators and administrators in integrating LT in resource-constrained settings.

Questions for Students:

1. Do you feel more interested in learning when using games or technology? Why? (*Engagement*)
2. What is the most fun thing you have learned using these tools? (*Motivation and enjoyment*)
3. Do you think using these tools helps you understand your lessons better? Why or why not? (*Academic performance*)
4. Does using these tools make learning easier or harder for you? (*Accessibility and usability*)

Questions for Educators:

1. What changes have you observed in students' behavior or learning outcomes since the implementation of LT? (*Impact on students*)
2. What technical or teaching challenges have you faced while using LT in your classroom? (*Challenges in LT integration*)
3. How do you adapt LT tools to meet the needs of students with diverse learning abilities? (*Inclusivity and adaptability*)
4. What additional resources or training would help you use LT more effectively? (*Suggestions for improvement*)

Questions for Administrators:

1. What changes have you observed in the school environment since the adoption of LT? (*Institutional impact*)
2. What challenges have you encountered in implementing LT on an institutional level? (*Infrastructure and policy*)
3. How do you think LT can contribute to inclusive education in resource-constrained settings? (*Strategic insights*)
4. What strategies do you recommend scaling up the use of LT in similar schools? (*Scalability and future directions*)

Appendix B

Pre-Post Survey Questionnaire

Purpose: To assess changes in student outcomes (engagement, academic performance, and emotional well-being).

Sample Survey Questions (with Pictorial Likert Scale):

1. I enjoy learning with educational games.

 Strongly Agree |  Agree |  Neutral |  Disagree |  Strongly Disagree

2. Using these tools helps me work with my classmates better.

 Strongly Agree |  Agree |  Neutral |  Disagree |  Strongly Disagree

3. I feel more confident in class after using LT.

 Strongly Agree |  Agree |  Neutral |  Disagree |  Strongly Disagree

4. The tools make learning easier for me.

 Strongly Agree |  Agree |  Neutral |  Disagree |  Strongly Disagree

Appendix C
Observation Checklist

Purpose: To systematically record behavioural cues during LT activities.

Behavior	Frequency	Notes
Engagement	High/Moderate/Low	Actively participated in tasks or games.
Collaboration	High/Moderate/Low	Worked effectively with peers.
Frustration	High/Moderate/Low	Required assistance or showed signs of disengagement.
Independent learning	High/Moderate/Low	Successfully used tools without external help.

Appendix D

Sample Codes & Excerpts (Thematic Analysis)

Theme	Code (short label)	One-line excerpt (ID)
Engagement with LT	On-task persistence	"I kept trying until I finished the level." (Student U3)
Engagement with LT	Enjoyment of interactivity	"The animation made it fun to learn." (Student R5)
Communication & participation	Speech-to-text reduces barriers	"He finally answered because the app wrote for him." (Teacher T2)
Accessibility & support	Visual scaffolds reduce confusion	"Icons helped them remember steps." (Teacher T1)
Implementation barriers	Electricity/connectivity interruptions	"The activity stopped when the power went out." (Teacher R4)
Implementation barriers	Limited teacher training time	"We need more sessions to plan lessons with the app." (Admin A1)