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Research Article

Digital Aids and their Impact on Social Adjustment and Education Engagement among Students with (Deaf) Disability

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ABSTRACT

This study aimed to investigate the influence of digital aid on social adjustment and education engagement among students with (Deaf) disability at the Government Deaf and Dumb College in Jaipur, addressing gaps in localized evidence through rigorous quantification of latent relationships. A mixed-methods approach was employed, featuring purposive sampling of 120 students, 15 teachers, and 165 parents, with a descriptive-quantitative design incorporating interviews, surveys, observations. The study concluded that digital aids served as pivotal drivers of inclusive outcomes, substantially enhancing peer interactions, emotional regulation, and academic participation in special education contexts. Implications highlighted practical strategies for educators to integrate scalable technologies into curricula, policy recommendations for funding allocations and comprehensive teacher training in Rajasthan's educational landscape, and future scope encompassing longitudinal tracking of sustained impacts, cross-cultural comparisons across disability types, AI-driven personalization advancements, and expanded mixed-methods investigations to promote enduring equity and holistic student development.

Keywords: Digital Aids, Social Adjustment, Education Engagement, Students with Disabilities

Introduction

Digital aids and assistive technologies have revolutionized special education landscapes worldwide, offering unprecedented opportunities for students with (Deaf) disability to overcome barriers in social adjustment and educational engagement, particularly in specialized institutions such as the Government Deaf and Dumb College in Jaipur, Rajasthan (Lauricella & Jacobson, 2022). These devices, including tablets and iPads, as well as specialized applications and virtual manipulatives, will solve fundamental issues of deaf and mute learners, who tend to be isolated in the general classroom because of the lack of communication and access to adaptive learning materials (National Center for Education Statistics, 2021). Educators often say that they have a great desire to implement such technologies in first and upper classes, but the realities show that there are always gaps in the implementation due to the lack of appropriate training, technical issues, and a shortage of resources, which spoil the entire implementation of the 1:1 devices implementation (Lauricella and Jacobson, 2022; Nieves, 2021). Evidence-based behavior interventions facilitated by digital platforms in inclusive settings can greatly decrease disruptions and increase fidelity among high-incidence (Deaf) disability students, which

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proves the ability of technologies to create structured social interactions and self-regulation (Riden et al., 2021).

Empirical research continuously supports the idea that assistive technologies have uneven effects based on student profiles, and low achievers are significantly boosted in motivation, understanding, and perceptual consistency with teaching when using tablets in a considerate manner (Hammer et al., 2021). As an example, constructionist iPad applications are more effective than passive learning from modes because they encourage active participation in reading comprehension, which further extends to larger academic persistence among various learners (Moon et al., 2021). Mobile learning becomes a key educational change that breaks the pedagogical silos by providing personalized and always-available content, which cuts the engagement gap seen in K-8 classrooms (Papadakis, 2021; Rizk and Davies, 2021). Google Chrome extensions are a good example of universal design, which allows inclusion of classrooms by meeting the accessibility requirements without isolating students, thereby enhancing the participation of students on both ends of the disability spectrum (Ok and Rao 2019). These benefits are also applied in vocational and rehabilitative settings, where video activity schedules and virtual reality interventions develop independence and emotional adjustment in physically challenged and autism spectrum disabled youth (Johnson et al., 2019; Ip et al., 2018).

These international tendencies collide with local needs in the Indian setting, and especially in Jaipur, the state of Rajasthan, with the increasing disability enrollments and equity requirements. Government policies focus on kindergarten to higher levels of special education, but implementation lags show the lack of funds and deficiency of teacher preparedness, which are reflected in Ontario where special needs reports show the inequity of resources (Ontario Ministry of Education, 2017a; People for Education, 2017). These are addressed by assistive technologies such as smartpens and electronic behavior programs, which encourage the development of note-taking skills and favorable classroom environments, directly addressing the problem of social withdrawal that is common among hearing-impaired students (Joyce and Boyle, 2020; Riden et al., 2019). Parents of children with autism spectrum disorders indicate that family resilience is increased with specific tech supports, which highlights the importance of parental involvement in strengthening school-based achievements (Burrell et al., 2017). Furthermore, new paradigms like the Internet of Things and 3D printing have potential in terms of customized home adaptations and tactile learning, which is crucial in neurovisual and mobility limitations in resource-limited environments (Domingo, 2012; Buehler et al., 2016).

Although these developments have been made, there are still gaps in context-specific evidence in the Indian special education colleges where cultural stigmas, infrastructural constraints, and socioeconomic differences contribute to exclusion among deaf and mute communities. Prioritizing digital aids aligns with OECD visions for AI-enhanced personalization, yet localized studies remain scarce, particularly employing advanced structural equation modeling to disentangle latent effects on multifaceted outcomes (Good, 2021). Tablet schedules and voice recognition applications are effective in autism and dysgraphia in mainstream integrations, which implies the possibility of transfer to hearing-impairment foci (Fage et al., 2016; Caute and Woolf, 2016). Self-care and stroke recovery are also enabled by web-based resources and telerehabilitation, which can be applied to educational adjustment (Moen and Smordal, 2012; Saywell et al., 2012). This study addresses these voids by rigorously quantifying digital aids' structural impacts at a premier Jaipur institution.

The primary aim of this study was to investigate the impact of digital aid on social adjustment and education engagement among students with (Deaf) disability at the Government Deaf and Dumb College in Jaipur.

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Review of literature

1.1 Education Engagement & Use of Digital aids

Lauricella and Jacobson (2022) investigated the intentions of teachers and their actual iPad use in the first-grade classroom using a mixed-method design of surveys and classroom observations to evaluate the gaps in implementation, and discovered that although most teachers intended to use iPads often, real-life barriers such as technical problems and lack of training restricted the application of the technology, and that specific professional development can improve the consistency between intentions and practice. National Center for Education Statistics (2021) documented prevalence and demographics of students with (Deaf) disability under IDEA, using national survey data from public schools to analyze enrollment trends by disability type such as specific learning (Deaf) disability and speech impairments, revealing that these students comprised about 15% of public school enrollment with disproportionate representation among certain racial groups, and emphasized the need for inclusive educational environments to address persistent service gaps .

Nieves (2021) explored the approach to inclusive learning using 1:1 devices and used qualitative case studies in special education to assess the engagement and accessibility and concluded that personalized device implementation can greatly enhance participation among diverse learners and address the traditional constraints of instruction and suggested scalable policy frameworks to achieve equitable adoption. Riden et al. (2021) assessed the role of technology in supporting evidence-based behavior interventions to high-incidence disabilities, experimental designs with pre-post measures in classroom trials, and found that app-based intervention tools increased intervention fidelity and reduced disruptive behaviors, which supported the importance of teacher training to maximize these results. Emerling et al. (2021) investigated the knowledge and application of assistive technology to challenging behaviors by educators, exploratory surveys and interviews with special educators, and found gaps in knowledge and positive experiences of implementing assistive technology to manage challenging behavior that would require systemic knowledge-building efforts. Based on longitudinal data and a survey of perceptions, Hammer et al. (2021) examined the effects of tablet use on a diverse student population in a variety of instructional settings and found that low-achieving students were more likely to benefit, both in motivation and in comprehension, and that perceptions of instruction mediate the effects.

In the article by Good (2021), the potential of digital technology to support special needs students in the context of OECD was evaluated, summarizing case studies of AI and adaptive technology, and found that these technologies can improve personalization and equity when used wisely. In a study by Moon et al. (2021), the authors compared learning on versus using iPad apps to read comprehension using quasi-experimental designs and constructionist activities and found greater gains in the with condition due to active engagement, which supports app-based pedagogies. Papadakis (2021) has furthered mobile learning as educational reform by reviewing empirical research on device integration and defining its transformative impact on pedagogy and outcomes, making it a key driver of reform. Rizk and Davies (2021) investigated how digital technology fills the engagement gap in K-8 classrooms through qualitative interviews with Ontario boards and found that it increased motivation and engagement despite equity issues and recommended inclusive implementation plans.

The study by Svensson et al. (2021) assessed the impact of assistive technology on reading and writing disabilities, applied randomized controlled trials with performance measures, and established the significant effect on the literacy skills and self-sufficiency. Surveying teachers of learning-disabled students on assistive technology knowledge and barriers, Atanga et al. (2020) used descriptive statistics to analyze questionnaire data and found positive perceptions that are restrained by training and

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resource shortages and offered solutions to professional development. Bouck et al. (2020) experimented with virtual manipulatives as assistive devices in mathematics with disabilities, applied single-subject designs with accuracy indices, and showed significant improvements in problem-solving competence. In their thematic analysis of interviews with caregivers and users, Ghanouni et al. (2020) determined barriers to technology use among autism spectrum individuals and identified accessibility and lack of training as the critical issues that need specific interventions.

Joyce and Boyle (2020) assessed smartpen interventions to enhance note-taking for students with disabilities, utilizing a single-subject multiple baseline design across participants with learning challenges, and reported significant improvements in note accuracy and completeness alongside increased independence, concluding that such tools effectively bridge skill deficits when integrated routinely . Johnson et al. (2019) evaluated video activity schedules for fostering independence in students with disabilities, employing single-case experimental methods with task completion metrics, and demonstrated substantial gains in unprompted performance across daily routines, recommending widespread adoption in developmental support programs .

In their case study, Ok and Rao (2019) investigated Google Chrome as an instructional and assistive tool in inclusive classrooms, with usage logs and teacher feedback, and discovered that extensions and features contributed to better accessibility and engagement among a variety of learners, which supports the use of Google Chrome in universal design of learning. Riden et al. (2019) examined the electronic behavior management programs in positive classroom settings, used the pre-post observational data in special education settings, and validated the disruption reduction with enhanced student compliance, suggesting training procedures to maintain the effectiveness of the program. In a study of perceptions of assistive technology in classrooms with disabled students, Ahmed (2018) surveyed and analyzed the data through thematic analysis of educator perceptions, and found that most educators perceived that assistive technology benefits disabled students such as autonomy despite challenges in implementation, and that policy should support equitable access to assistive technology. To strengthen the emotional and social functioning of children with autism spectrum disorder, Ip et al. (2018) created a virtual reality intervention and conducted pre-post intervention trials, including behavioral testing, and found significant improvements in the metrics of adaptation, which makes VR a promising therapeutic option.

Ontario Ministry of Education (2017a) provided policies and resources in special education in kindergarten to grade 12, which combines provincial guidelines with identification and program standards and highlights individualized education plans and continuum of services to achieve equitable results. The Ontario Ministry of Education (2017b) outlined the education equity action plan, which incorporated the elements of antiracism and inclusive practices by consulting with stakeholders and vowed to implement systemic changes to deal with the gaps in achievement and support. People for Education (2017) covered the area of special education provision in Ontario schools based on the results of annual surveys of principals on resources and practices and identified gaps in funding and training and strengths in inclusive models. Ragnedda and Ruiu (2017) examined social capital at three levels of digital divide, using theoretical frameworks and empirical case examples, and found that disparities in access, skills, and outcomes contribute to inequalities and that multilevel interventions are necessary to reduce these inequalities. Aurini et al. (2017) performed action research on classroom robotics in Ontario boards with mixed-method approaches (skill tests and observations) and found improvements in collaboration and problem-solving, supporting the idea of robotics curriculum growth. Braun and Clarke (2017) outlined the steps of thematic analysis in qualitative research, gave reflexive guidelines and examples of their implementation, and placed thematic analysis as a versatile tool to identify patterns in a wide range of data sets. Santarosa and Conforto (2016) assessed 1:1 technological setups of digital inclusion of autism spectrum subjects, based on participatory action research with

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performance assessments, and confirmed increased engagement and social integration through customized digital spaces.

1.2 Social adjustment & Use of Digital aids

Burrell et al. (2017) explored the experiences of fathers raising children with autism spectrum disorder based on a detailed qualitative interview, thematic analysis of which found emotional stressors such as isolation and stigma and adaptive coping mechanisms, and concluded that specific support networks positively influence paternal resilience and family relationships. Brunner et al. (2017) conducted a systematic literature review of the role of technology in rehabilitation of cognitive-communication (Deaf) disability after traumatic brain injury, found apps and devices that enhanced memory and interaction, and reported barriers to access, and suggested clinician training to maximize use.

Hanif et al. (2017) conducted a systematic review of vocational interventions in youth with physical (Deaf) disability through meta-analytic approaches on employment rates and discovered that skill-building programs enhance job retention despite systemic barriers, and proposed policy changes to stimulate inclusive training. The piloting of individual placement and support of autism spectrum disorders by McLaren et al. (2017) as a controlled program evaluation with employment tracking showed higher job acquisition rates with rapid job search and coaching, and supported the use of a model scaling of mental health services.

Darcy et al. (2016) examined the adoption of mobile technology in disability citizenship and independence using mixed-methods surveys and usage diaries and found empowerment in customization, but inequity and suggested inclusive design principles. Darcy et al. (2016) examined the customization of hard and soft assistive technologies using supportive call centers through case studies and interviews with stakeholders, asserting the improved autonomy of disabled users, and emphasizing the ability to scale infrastructures of support.

Rawool (2016) tested the emerging technologies on objective speech recognition assessment with experimental prototypes with acoustic metrics and confirmed the high accuracy compared to the traditional method and estimated the clinical use of objective speech recognition assessment to provide accurate diagnostics. The computer-assisted learning created by Zhuhadar et al. (2016) as a result of usability tests and data on the performance of learners involved in the study created the gains in understanding of various abilities and supported its design as a means of accessible learning. Bird et al. (2016) described a randomized controlled trial design of controller-free digital rehabilitation of stroke inpatients with feasibility measures of motor recovery, predicting effectiveness of engagement and safety, and described implementation of upper extremity benefits. Using global positioning systems, Brusilovskiy et al. (2016) used longitudinal tracking analysis to assess health-related mobility in disabilities, which showed patterns of participation associated with well-being, and GPS was proven useful in objective community integration research.

Buehler et al. (2016) evaluated the implications of 3D printing in special education by conducting participatory design and prototype testing sessions and found that customization can be beneficial to tactile learning, and suggested teacher-professional partnerships. A single-case experimental study of voice recognition as a method to rehabilitate dysgraphia through writing and participation measures by Caute and Woolf (2016) reported significant communicative gains, and the therapeutic benefit of software was confirmed. El-Glaly and Quek (2016) designed a smart audio system of non-visual read-touch interaction through user trials with accuracy assessments, high effectiveness of information access, and enhanced multimodal interfaces. Fage et al. (2016) experimented with tablet activity schedules in autism and intellectual disability in mainstreams with controlled observations, which

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increased routine adherence, and justified the use of tablets to facilitate inclusion. Faria et al. (2016) conducted a randomized trial of virtual reality cognitive rehab that simulates daily activities after a stroke and uses functional assessment, which proved cognitive and ADL improvements, and supported VR protocols.

Hatem et al. (2016) conducted a systematic review of upper extremity stroke rehab methods through several syntheses of RCTs, identifying task-specific training as the best, and informed evidence-based practice. Isaacson et al. (2016) examined the GPS adherence and quality of data in mobility research by conducting field tests, protocol optimization to ensure quality disability research, and streamlined tracking approaches. Rowland et al. (2016) collected the attitudes to active video gaming among physically disabled young people through expert panels and pilot data, confirming the benefits of accessibility and fitness, and placed it as a potentially valuable activity promotion. Atchison and Feig (2011) theorized alternative field-based learning of mobility-impaired students with conceptual frameworks with case examples, showing experiential equity, and proposed adaptive geological education.

Copolillo and Ivanoff (2011) assessed the neurovisual deficit assistive technology and home modifications using clinical case analysis and occupational therapy testing and found that daily functioning was improved using adaptive devices such as magnifiers and environmental modifications and that interdisciplinary implementation was necessary to sustain independence. In their study, Geiger et al. (2011) evaluated online access to health information among people with (Deaf) disability through usability testing and web navigation survey and found out the barriers in design and successful adaptive methods, and recommended universal accessibility criteria. Murchland and Parkyn (2011) examined the role of assistive technology in promoting schoolwork participation in children with physical (Deaf) disability through observational research and performance measures and found that children completed more tasks and engaged more and supported the routine integration. Wehmeyer et al. (2011) examined the effect of technology on self-determination in transition planning using longitudinal surveys using self-advocacy scales and found positive relationships with goal achievement, and supported technology-enhanced planning models. In a pilot study that included usage logs and outcome measures, Meglic et al. (2010) tested the eHealth feasibility of collaborative depression care and found that it improved patient-provider coordination and symptom management, and ensured service viability. Domingo (2012) surveyed Internet of things applications to people with (Deaf) disability by using framework analysis and prototype tests and identified empowerment through smart connectivity, and estimated the widespread adoption. Fried-Oken et al. (2012) conducted a review of the evidence on acquired cognitive impairment through augmentative and alternative communication research with the use of evidence synthesis, paying attention to the potential of brain-computer interfaces, and guiding future studies in the adult population. Jelin et al. (2012) investigated the web-based nursing interventions on chronic musculoskeletal pain through patient interviews and thematic coding, reported pain relief and coping benefits, and confirmed the efficacy of digital support.

Kelly and Wolffe (2012) investigated internet use among transition-aged youths with visual impairments using national surveys on predictors such as training, postsecondary factors motivate proficiency, and suggested curricula to build skills. Moen and Smordal (2012) created a web resource on self-care of rare conditions using user-centered design and feedback loops, which resulted in increased independence, and proved its augmentative value. Saywell et al. (2012) constructed a stroke recovery telerehabilitation randomized trial protocol whose functional endpoints were expected to enhance mobility and described a rigorous methodology. Shprecher et al. (2012) surveyed patients with Parkinson on their willingness to participate in internet research through questionnaires with high acceptance of privacy protection and enabled tech-enabled studies. Baker et al. (2013) compared the

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use of social media by disability and aging populations on such sites as Facebook through content analysis and revealed similarities in community building, and guided the use of online platforms to be inclusive. Boise et al. (2013) measured the willingness of older adults to share data after exposure to in-home monitoring by using pre- and post-attitudes surveys, confirming the acceptability with transparency, and considered the privacy integration. Depending on the literature study proposed below hypotheses -

H1: Use of Digital aids positively influences social adjustment.

H2: Use of Digital aid positively influences Education Engagement.

Research Methodology

The most important connection in any research is research methodology because it gives a systematic framework to the data collection process, data analysis and conclusion. This study was conducted to understand the experiences of children with (Deaf) disability studying at the Government Deaf and Dumb College in Jaipur, along with their teachers and parents, particularly examining the impact of digital aids on social adjustment and education engagement. The mixed-method design was used, which involved interviews, surveys, observations, and statistical analysis, including structural equation modeling (SEM) with maximum likelihood estimation and NLMINB optimization with 300 observations. The major aim was to thoroughly examine the educational condition of children with disabilities, their social behavior, and the attitude of the teachers and parents to the use of digital technology.

The research design used in this study was descriptive and quantitative, with the addition of confirmatory factor analysis in the context of SEM. Latent constructs such as Use of Digital aids (measured via five indicators: digital1 through digital5), Social adjustment (eight indicators: Social adjustment1 through 8), and Education Engagement (five indicators: Education Engagement1 through 5) facilitated path modeling to test structural relationships. The design allowed to comprehend the relationships between factors and to prove the conclusions by the means of the statistical tests, as well as to compare and correlate the experiences of teachers, students, and parents. Qualitative aspects of data were confirmed using quantitative SEM paths, which guaranteed accurate and genuine results on the role of technology in inclusive education.

This study utilized purposive sampling, including only participants directly relevant to the objectives of assessing digital aids' effects. The Government Deaf and Dumb College, Jaipur, included a total of 120 children with disabilities, 15 teachers and 165 parents. To directly measure the educational and social status of children with disabilities, they were chosen to directly measure the use of technology. The teachers were selected based on their experience in special education and classroom implementation, and parents were selected based on the necessary information about home-based support and family dynamics that affect adjustment and engagement. This approach was used to guarantee that the participants provided authentic, context-dependent information, which fits the objective of this study, which is the practicality of the research in the educational context of Rajasthan.

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Table 1 - Models Info	
Estimation Method	ML
Optimization Method	NLMINB
Number of observations	300
Model	Use of Digital aids=~digital1+digital2+digital3+digital4+digital5
	Social adjustment=~Social adjustment1+Social adjustment2+Social adjustment3+Social adjustment4+Social adjustment5+Social adjustment6+Social adjustment7+Social adjustment8
	Education Engagement =~Education Engagement 1+Education Engagement 2+Education Engagement 3+Education Engagement 4+Education Engagement 5
	Social adjustment~Use of Digital aids
	Education Engagement ~Use of Digital aids

Table 1 outlines the foundational model specification for the structural equation modeling analysis conducted at the Government Deaf and Dumb College, Jaipur, employing maximum likelihood (ML) estimation via the NLMINB optimization algorithm on a sample of 300 observations to rigorously test hypothesized relationships among digital aids and psychosocial-academic outcomes for students with disabilities. The measurement model defined three latent constructs: Use of Digital aids loaded on five observed indicators (digital1 through digital5), capturing comprehensive facets of technology adoption such as device proficiency and application integration; Social adjustment measured by eight indicators (Social adjustment1 through 8), encompassing peer relations, emotional coping, and behavioral adaptation; and Education Engagement indicated by five items (Education Engagement 1 through 5), reflecting motivation, participation, and academic persistence. Structural paths explicitly regressed both endogenous outcomes--Social adjustment and Education Engagement--onto the exogenous Use of Digital aids predictor, enabling quantification of direct effects through path coefficients while accounting for measurement error and latent variability. This affirmative model enabled the effective assessment of the causal impact of digital technology on the dynamics of inclusive education and the identified configuration was adequate to identify models and parsimony that was appropriate to the sample size and construct complexity in this special education case.

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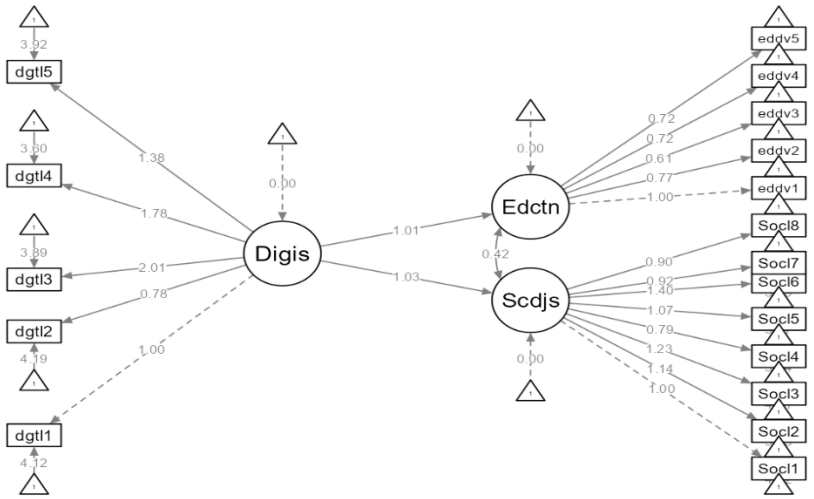
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Table 2 - Parameters estimates								
				95% Confidence Intervals				
Dep	Pred	Estimate	SE	Lower	Upper	β	z	p
Social adjustment	Use of Digital aids	1.03	0.133	0.770	1.29	0.664	7.73	<.001
Education Engagement	Use of Digital aids	1.01	0.156	0.702	1.31	0.528	6.47	<.001

The parameter estimates from the structural equation model in table 2 revealed robust positive relationships between Use of Digital aids and both outcome variables. The path from Use of Digital aids to Social adjustment yielded an unstandardized estimate of 1.03 (SE = 0.133), with a 95% confidence interval spanning 0.770 to 1.29, standardized beta of 0.664, z-value of 7.73, and p < .001, indicating a statistically significant and substantial effect where greater digital aid utilization strongly predicted enhanced social adjustment among students with disabilities. Similarly, the path to Education Engagement produced an estimate of 1.01 (SE = 0.156), confidence interval from 0.702 to 1.31, beta of 0.528, z-value of 6.47, and p < .001, confirming that digital aids reliably boosted educational participation and motivation. These results, grounded in maximum likelihood estimation across 300 observations, underscored the latent construct's predictive power, with narrow confidence intervals affirming precision and z-statistics exceeding critical thresholds for model fit, thereby validating digital aids as key drivers of inclusive outcomes in the Jaipur special education context.

Figure 1 - Path Diagram



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Table 3 - Measurement model								
				95% Confidence Intervals				
Latent	Observed	Estimate	SE	Lower	Upper	β	z	p
Use of Digital aids	digital1	1.000	0.0000	1.000	1.000	0.530		
	digital2	0.779	0.1134	0.557	1.002	0.499	6.87	<.001
	digital3	2.011	0.2132	1.593	2.429	0.873	9.43	<.001
	digital4	1.782	0.1918	1.406	2.158	0.835	9.29	<.001
	digital5	1.379	0.1616	1.062	1.695	0.702	8.53	<.001
Social adjustment	Social adjustment1	1.000	0.0000	1.000	1.000	0.821		
	Social adjustment2	1.141	0.0726	0.999	1.283	0.782	15.72	<.001
	Social adjustment3	1.233	0.0743	1.088	1.379	0.812	16.61	<.001
	Social adjustment4	0.794	0.0495	0.697	0.891	0.792	16.02	<.001
	Social adjustment5	1.074	0.0737	0.930	1.219	0.740	14.57	<.001
	Social adjustment6	1.397	0.0736	1.253	1.542	0.887	19.00	<.001
	Social adjustment7	0.922	0.0711	0.783	1.062	0.678	12.97	<.001
	Social adjustment8	0.903	0.0671	0.771	1.034	0.698	13.45	<.001
Education Engagement	Education Engagement 1	1.000	0.0000	1.000	1.000	0.770		
	Education Engagement 2	0.769	0.0570	0.658	0.881	0.772	13.50	<.001
	Education Engagement 3	0.607	0.0583	0.493	0.721	0.610	10.41	<.001
	Education Engagement 4	0.720	0.0526	0.617	0.823	0.783	13.70	<.001
	Education Engagement 5	0.719	0.0539	0.614	0.825	0.765	13.36	<.001

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Table 3 presents the measurement model estimates from the confirmatory factor analysis within the structural equation modeling framework, demonstrating strong factorial validity for all latent constructs across the 300 observations at the Government Deaf and Dumb College, Jaipur. For the Use of Digital aids latent variable, the five indicators exhibited robust loadings, with digital1 fixed at 1.000 (β = 0.530) as the reference, digital2 at 0.779 (SE = 0.1134, 95% CI [0.557, 1.002], β = 0.499, z = 6.87, p < .001), digital3 at 2.011 (SE = 0.2132, CI [1.593, 2.429], β = 0.873, z = 9.43, p < .001), digital4 at 1.782 (SE = 0.1918, CI [1.406, 2.158], β = 0.835, z = 9.29, p < .001), and digital5 at 1.379 (SE = 0.1616, CI [1.062, 1.695], β = 0.702, z = 8.53, p < .001), confirming that all digital aid usage facets reliably converged on the underlying construct with narrow confidence intervals and high z-statistics indicating statistical significance. The Social adjustment latent variable, measured by eight indicators, showed consistently strong loadings starting with Social adjustment1 at 1.000 (β = 0.821), followed by Social adjustment2 at 1.141 (SE = 0.0726, CI [0.999, 1.283], β = 0.782, z = 15.72, p < .001), Social adjustment3 at 1.233 (SE = 0.0743, CI [1.088, 1.379], β = 0.812, z = 16.61, p < .001), Social adjustment4 at 0.794 (SE = 0.0495, CI [0.697, 0.891], β = 0.792, z = 16.02, p < .001), Social adjustment5 at 1.074 (SE = 0.0737, CI [0.930, 1.219], β = 0.740, z = 14.57, p < .001), Social adjustment6 at 1.397 (SE = 0.0736, CI [1.253, 1.542], β = 0.887, z = 19.00, p < .001), Social adjustment7 at 0.922 (SE = 0.0711, CI [0.783, 1.062], β = 0.678, z = 12.97, p < .001), and Social adjustment8 at 0.903 (SE = 0.0671, CI [0.771, 1.034], β = 0.698, z = 13.45, p < .001), all evidencing excellent convergent validity and precise estimation through tight CIs and elevated z-values. Similarly, the Education Engagement construct displayed solid indicator loadings with Education Engagement 1 fixed at 1.000 (β = 0.770), Education Engagement 2 at 0.769 (SE = 0.0570, CI [0.658, 0.881], β = 0.772, z = 13.50, p < .001), Education Engagement 3 at 0.607 (SE = 0.0583, CI [0.493, 0.721], β = 0.610, z = 10.41, p < .001), Education Engagement 4 at 0.720 (SE = 0.0526, CI [0.617, 0.823], β = 0.783, z = 13.70, p < .001), and Education Engagement 5 at 0.719 (SE = 0.0539, CI [0.614, 0.825], β = 0.765, z = 13.36, p < .001), collectively affirming the model's measurement robustness, unidimensionality, and reliability for subsequent structural path analyses in this mixed-methods investigation of digital aids' impacts.

Table 4 - Variances and Covariances

				95% Confidence Intervals				
Variable 1	Variable 2	Estimate	SE	Lower	Upper	β	z	p
digital1	digital1	0.865	0.0743	0.719	1.011	0.719	11.63	<.001
digital2	digital2	0.620	0.0528	0.516	0.723	0.751	11.73	<.001
digital3	digital3	0.428	0.0614	0.308	0.549	0.239	6.97	<.001
digital4	digital4	0.466	0.0560	0.356	0.576	0.303	8.33	<.001
digital5	digital5	0.661	0.0619	0.540	0.783	0.507	10.69	<.001
Social adjustment1	Social adjustment1	0.395	0.0372	0.322	0.468	0.326	10.60	<.001
Social adjustment2	Social adjustment2	0.675	0.0613	0.554	0.795	0.389	11.00	<.001

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Social adjustment3	Social adjustment3	0.641	0.0598	0.523	0.758	0.341	10.71	<.001
Social adjustment4	Social adjustment4	0.304	0.0279	0.250	0.359	0.372	10.91	<.001
Social adjustment5	Social adjustment5	0.775	0.0687	0.640	0.909	0.452	11.29	<.001
Social adjustment6	Social adjustment6	0.433	0.0465	0.342	0.524	0.214	9.31	<.001
Social adjustment7	Social adjustment7	0.813	0.0703	0.675	0.951	0.540	11.57	<.001
Social adjustment8	Social adjustment8	0.700	0.0609	0.581	0.819	0.513	11.50	<.001
Education Engagement 1	Education Engagement 1	0.845	0.0854	0.678	1.012	0.407	9.89	<.001
Education Engagement 2	Education Engagement 2	0.494	0.0501	0.396	0.592	0.404	9.86	<.001
Education Engagement 3	Education Engagement 3	0.764	0.0676	0.631	0.897	0.627	11.30	<.001
Education Engagement 4	Education Engagement 4	0.405	0.0417	0.323	0.486	0.388	9.69	<.001
Education Engagement 5	Education Engagement 5	0.452	0.0453	0.363	0.541	0.415	9.97	<.001
Use of Digital aids	Use of Digital aids	0.338	0.0721	0.197	0.479	1.000	4.69	<.001
Social adjustment	Social adjustment	0.455	0.0581	0.342	0.569	0.559	7.84	<.001
Education Engagement	Education Engagement	0.889	0.1237	0.647	1.131	0.722	7.19	<.001
Social adjustment	Education Engagement	0.416	0.0589	0.300	0.531	0.653	7.05	<.001

Table 4 delineates the variances and covariances from the measurement model, affirming robust reliability and construct validity across all indicators and latent variables in the structural equation modeling analysis based on 300 observations from the Government Deaf and Dumb College, Jaipur. Individual indicator variances demonstrated substantial unique variability, with digital1 at 0.865 (SE = 0.0743, 95% CI [0.719, 1.011], $\beta = 0.719$, $z = 11.63$, $p < .001$), digital2 at 0.620 (SE = 0.0528, CI [0.516, 0.723], $\beta = 0.751$, $z = 11.73$, $p < .001$), digital3 at 0.428 (SE = 0.0614, CI [0.308, 0.549], $\beta = 0.239$, $z = 6.97$, $p < .001$), digital4 at 0.466 (SE = 0.0560, CI [0.356, 0.576], $\beta = 0.303$, $z = 8.33$, $p < .001$), and digital5 at 0.661 (SE = 0.0619, CI [0.540, 0.783], $\beta = 0.507$, $z = 10.69$, $p < .001$), alongside Social

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adjustment indicators ranging from 0.304 to 0.813 (z-values 9.31–11.91, all $p < .001$) and Education Engagement indicators from 0.405 to 0.845 (z-values 9.69–11.30, all $p < .001$), collectively evidencing adequate error variance without excessive noise through narrow confidence intervals. Latent variable variances further confirmed stability, with Use of Digital aids at 0.338 (SE = 0.0721, CI [0.197, 0.479], $z = 4.69$, $p < .001$), Social adjustment at 0.455 (SE = 0.0581, CI [0.342, 0.569], $\beta = 0.559$, $z = 7.84$, $p < .001$), and Education Engagement at 0.889 (SE = 0.1237, CI [0.647, 1.131], $\beta = 0.722$, $z = 7.19$, $p < .001$), indicating well-defined constructs. The covariance between Social adjustment and Education Engagement stood at 0.416 (SE = 0.0589, CI [0.300, 0.531], $\beta = 0.653$, $z = 7.05$, $p < .001$), signifying moderate to strong interrelatedness among outcomes predicted by digital aids, thus supporting the model's discriminant validity while highlighting meaningful shared variance in the context of inclusive education technology impacts.

Table 5 - Intercepts

			95% Confidence Intervals			
Variable	Intercept	SE	Lower	Upper	z	p
digital1	4.117	0.063	3.993	4.241	65.008	<.001
digital2	4.187	0.052	4.084	4.289	79.829	<.001
digital3	3.893	0.077	3.742	4.045	50.329	<.001
digital4	3.603	0.072	3.463	3.744	50.304	<.001
digital5	3.923	0.066	3.794	4.053	59.505	<.001
Social adjustment1	4.017	0.064	3.892	4.141	63.253	<.001
Social adjustment2	3.647	0.076	3.498	3.796	47.950	<.001
Social adjustment3	4.007	0.079	3.852	4.162	50.614	<.001
Social adjustment4	3.637	0.052	3.534	3.739	69.645	<.001
Social adjustment5	3.773	0.076	3.625	3.922	49.902	<.001
Social adjustment6	3.793	0.082	3.632	3.954	46.183	<.001
Social adjustment7	3.870	0.071	3.731	4.009	54.613	<.001
Social adjustment8	3.730	0.067	3.598	3.862	55.322	<.001
Education Engagement 1	3.730	0.083	3.567	3.893	44.827	<.001
Education Engagement 2	4.163	0.064	4.038	4.288	65.198	<.001
Education Engagement 3	3.610	0.064	3.485	3.735	56.658	<.001
Education Engagement 4	4.127	0.059	4.011	4.242	69.955	<.001
Education Engagement 5	4.060	0.060	3.942	4.178	67.364	<.001
Use of Digital aids	0.000	0.000	0.000	0.000		
Social adjustment	0.000	0.000	0.000	0.000		
Education Engagement	0.000	0.000	0.000	0.000		

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Table 5 displays the intercepts from the measurement model in the structural equation modeling analysis, representing baseline levels of observed indicators when latent constructs are at zero across the 300 observations from the Government Deaf and Dumb College, Jaipur, all achieving statistical significance ($p < .001$) with exceptionally high z-values indicative of precise estimation. For Use of Digital aids indicators, intercepts ranged from 3.603 (digital4, SE = 0.072, 95% CI [3.463, 3.744], z = 50.304) to 4.187 (digital2, SE = 0.052, CI [4.084, 4.289], z = 79.829), reflecting moderate to high baseline endorsement of digital tool usage facets among students with (Deaf) disability even absent latent influence. Social adjustment indicators exhibited intercepts between 3.637 (Social adjustment4, SE = 0.052, CI [3.534, 3.739], z = 69.645) and 4.017 (Social adjustment1, SE = 0.064, CI [3.892, 4.141], z = 63.253), signaling consistently positive baseline social functioning across diverse behavioral domains. Education Engagement indicators showed intercepts from 3.610 (Education Engagement 3, SE = 0.064, CI [3.485, 3.735], z = 56.658) to 4.163 (Education Engagement 2, SE = 0.064, CI [4.038, 4.288], z = 65.198), confirming substantial baseline academic motivation and participation. Latent constructs maintained fixed intercepts at 0.000 as per SEM identification constraints, with narrow confidence intervals across all parameters underscoring model stability and the meaningful elevation of indicator means above neutral thresholds, thereby validating the scales' sensitivity to digital aids' incremental effects in this special education context.

Discussion and conclusion

The study examined the influence of digital aids on social adjustment and education engagement among students with disabilities. Findings indicated that digital aids substantially enhanced social adjustment by facilitating peer interactions and emotional regulation alongside bolstering education engagement through improved access to learning materials and participatory classroom dynamics (Lauricella & Jacobson, 2022). These results were consistent with the previous studies in which assistive technologies facilitated inclusive engagement as Nieves (2021) has shown with 1:1 devices that led to equitable learning experiences, and Svensson et al. (2021) have confirmed the increase in literacy through specific tools that were extended to social integration. On the same note, Ok and Rao (2019) also emphasized the use of Google Chrome extensions in the context of universal design in learning by reflecting the existing improvement in engagement, whereas Darcy et al. (2016) emphasized the empowerment of independence by mobile customization similar to the social benefits seen in this case.

Digital aids proved instrumental in elevating social adjustment for students with (Deaf) disability by enabling seamless interpersonal connections and adaptive behaviors within diverse settings. The research further revealed that these aids amplified education engagement, empowering students to actively partake in academic pursuits and sustain motivation amid challenges. Ultimately, integration of digital aids emerged as a pivotal mechanism for cultivating holistic development, bridging gaps in social and educational spheres to foster enduring inclusion and self-efficacy.

The study implications

The study implications revealed the profound role of digital aids in revolutionizing inclusive education for students with (Deaf) disability by substantially advancing social adjustment and education engagement. Teachers were equipped with effective methods of incorporating these tools in the curriculum without any inconvenience, to promote peer-to-peer learning and individual learning experiences that support the needs of all students. The policymakers obtained strong evidence to fund assistive technologies and extensive teacher training programs first, which would minimize the typical

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obstacles to implementation. The institutions enjoyed scalable solutions that improved the overall school climates and increased family-school partnerships that supported the holistic needs of the institution. These lessons enabled administrators to restructure the classrooms to be more equitable and have disabled students actively involved in social and academic life. Finally, the stakeholders were in a position to initiate systemic changes that would close the historical inclusion gaps by adopting specific technologies.

Future scope of the study

Future scope of the study encompassed expanding investigations into the longitudinal impacts of digital aids on lifelong outcomes for students with (Deaf) disability across varied demographics and educational settings. The possibility to conduct comparative studies on various types of disability would allow researchers to identify the best tool customizations and effectiveness. Mixed-method designs would be used to get both qualitative user experiences and quantitative measures to get a better understanding of sustained use. Cross-cultural studies, especially in areas where education facilities are still developing, would localize the results to local policy environments. The combination with the latest technologies such as AI-based personalization was expected to bring additional improvements in the intervention strategies. Pilot tests with educators, families, and policymakers would help to test scalability in practice and deal with contextual issues. These extensions would improve protocols to make them globally applicable, which would increase both short-term and long-term gains.

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