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DIGITAL LEARNING APPLICATIONS AND THEIR POTENTIAL FOR INCLUSIVE EDUCATION OF STUDENTS WITH HEARING IMPAIRMENTS IN NIGERIAN SCHOOLS

ADEROJU Musiliu Adekola; OBIELODAN Omotayo O.; ABDULRAHMAN Mohammed Rabiu; NUHU Kehinde Muritala; ABDULFATAH Khashiyah; ASIYANBOLA Caleb
Aderoju.am@unilorin.edu.ng; tayoobielodan@unilorin.edu.ng; Abdulrahman.mr@unilorin.edu.ng; nuhu.km@unilorin.edu.ng; Abdulfatah.k@unilorin.edu.ng; calebtemi@unilorin.edu.ng
Corresponding Author: Aderoju.am@unilorin.edu.ng; 08106552720
Department of Educational Technology, University of Ilorin, Nigeria

Abstract
The integration of digital learning applications (DLAs) into special education presents a significant opportunity to bridge the educational gap for students with disabilities. In Nigeria, the potential of these tools for students with hearing impairments or deaf remains largely underexplored. This mixed-methods study investigated the availability, accessibility, utilization, and perceived potential of DLAs for fostering inclusive education for deaf students in Ilorin, Kwara State, Nigeria. Data were collected from 45 teachers and 60 senior secondary students across three purposively selected schools: To-Omo-Re Schools, Hill City Schools, and the Kwara State School for Special Needs. Quantitative data from teachers were gathered through structured questionnaire, while qualitative data from students through semi-structured interviews and classroom observations.. The findings revealed a significant scarcity of specialized DLAs, with only 11.1% of teachers reporting seldom use and 2.2% consistent use of such applications. Major barriers included a lack of teacher training (M=4.22), inadequate infrastructure (inconsistent electricity, lack of devices), and a curriculum that does not integrate technology. Despite these challenges, 92% of teachers and 85% of students expressed strong positive perceptions of the potential of DLAs to enhance engagement, literacy, and independent learning. The study concludes that while the current state of DLA integration is very low in schools, there is immense, untapped potential. It recommends a multi-stakeholder approach involving government investment in infrastructure, targeted teacher professional development, and the development of Nigerian sign-language-integrated digital content to transform the educational landscape for deaf students in Nigeria.
Keywords: Digital Learning Applications, Inclusive Education, Hearing Impairment, Special Education, Deaf Students, Assistive Technology

Introduction

Inclusive education refers to an educational approach where all learners, regardless of their abilities or disabilities, learn together in the same environment with appropriate support (Ainscow, 2020). It promotes equity, participation, and accessibility. Inclusive education is a global policy priority underscored by the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) which aims to ensure equitable access to quality education for all learners, regardless of their abilities or disabilities (United Nations, 2006). Nigeria, as a signatory to this convention, has made strides in policy formulation, such as the National Policy on Special Needs Education in Nigeria (Federal Ministry of Education, 2015) and National Policy on Albinism in Nigeria (Federal Ministry of Education, 2019). However, the translation of policy into practice remains a significant challenge, particularly for students with hearing impairments (HI).

These students often face formidable barriers in mainstream and special schools, including communication gaps, a lack of specialized teachers, and a pedagogical reliance on traditional, auditory-centric methods (Adebayo & Oyinloye, 2021; Olusegun & Adebisi, 2023).

Just like other students with special needs, students with hearing impairments and the deaf have historically been educated in segregated schools or simply excluded from the formal education system in Nigeria altogether. The Nigerian National Policy on Education (Federal Republic of Nigeria, 2013) advocates for the mainstreaming of learners with special needs into regular schools; however, implementation has been inconsistent and largely underfunded. Schools such as the Kwara State School for Special Needs in Ilorin represent the government's efforts to provide dedicated educational environments for students with disabilities, yet such institutions often struggle with inadequate resources, outdated instructional methods, and limited use of technology (*Aderoju et al 2019*).

Digital learning applications have emerged as transformative tools capable of addressing these challenges. These applications include speech-to-text software, captioned multimedia content, sign language translation tools, and interactive visual platforms that facilitate understanding and engagement. With increasing penetration of mobile technologies and digital platforms in Nigeria, there is a growing opportunity to leverage these tools to enhance learning outcomes for students with hearing impairments. Globally, research has demonstrated that DLAs can facilitate language development, improve academic engagement, and foster independence among students with Hearing Impairment (Alqahtani & Alqahtani, 2022; Rashid & Mahmood, 2024). For the Nigerian context, where the educational system grapples with resource constraints and a high student-to-teacher ratio, DLAs could serve as a powerful, scalable tool for personalizing learning and promoting inclusion (Akinola & Fashina, 2020).

Despite this promise, there is a palpable gap in empirical research concerning the actual state and potential of DLAs for inclusive education in Nigeria. Most existing studies are either theoretical, focused on Western contexts, or general assessments of assistive technology without a deep dive into specific applications and the lived experiences of teachers and students (Eleweke & Agboola, 2022). This study addresses this gap by providing an empirical investigation within the unique socio-cultural and infrastructural context of Ilorin, Kwara State. By examining current practices, challenges, and perceived potentials, this research aims to provide evidence-based insights that can inform policy, guide teacher preparation, and promote sustainable technological integration for inclusive education.

Literature Review

The integration of digital learning applications (DLAs) has increasingly reshaped inclusive education by providing targeted support for the linguistic and communicative needs of students with hearing impairments (Alit et al., 2025). A key aspect of this transformation is the use of real-time speech-to-text (STT) and automated transcription technologies, such as Google Live Transcribe and Otter.ai. These tools generate instant visual representations of spoken instruction, enabling learners to follow classroom interactions more effectively while reducing cognitive strain associated with lip-reading or note-taking. In addition to supporting real-time comprehension, STT technologies produce searchable and editable text records of lessons, thereby enhancing access to instructional content and promoting sustained engagement beyond the classroom.

Complementing transcription tools are specialized applications focused on sign language acquisition and multimedia accessibility. Platforms such as Spread Signs and Hand Talk Translator utilize extensive databases and 3D avatars to bridge the gap between spoken and signed languages, offering a vital resource for both students and educators in bilingual-bicultural settings (Berrezueta-Guzman *et al* 2025). Furthermore, dedicated educational repositories, such as the Described and Captioned Media Program (DCMP), provide a curated library of accessible content that adheres to rigorous captioning standards. These resources are essential for ensuring that visual media does not become a barrier to learning for those with hearing loss (DCMP n.d).

Recent advancements in mobile application development have also led to the creation of interactive literacy and vocabulary tools designed specifically for younger learners. For instance, applications like Hear-Me Read and Letsign integrate syntax highlighting and video-based sign language support to foster reading

comprehension and language development in a gamified environment. By leveraging high-contrast visuals, haptic feedback, and customizable interfaces, these digital interventions support independent learning and cater to the diverse degrees of hearing loss found in mainstream and specialized classrooms. As these technologies continue to evolve, their integration into Universal Design for Learning (UDL) frameworks remains critical for achieving true educational equity.

The typology of DLAs relevant to students with HI is broad. They include:

i. Communication and Transcription Apps: These applications convert spoken language into written text in real-time, allowing students to follow lectures independently (Shadiev et al., 2020). Examples include Google Live Transcribe, Otter AI, Yandex.talk and Tactiq

ii. Visual Learning and Literacy Apps: Interactive applications that use images, animations, and sign language avatars to teach vocabulary, reading, and comprehension (Rashid & Mahmood, 2024). They are Interactive platforms tailored for language development and specific academic subjects. Examples of such apps include V-Voice, Hear me Read, Book Flix, PocketSign

iii. Video-Based Communication Tools: Platforms that support sign language video dictionaries and facilitate remote learning through sign language interpretation (Alqahtani & Alqahtani, 2022).

iv. Sign Language Learning & Translation: These tools help students and teachers acquire sign language proficiency and translate between modalities. Examples include Handtalk, Spreadsigns, LetSign and DeafTawk

Studies from developed nations report that these tools lead to significant improvements in academic outcomes, self-esteem, and classroom participation (Mertens & Marschark, 2023). However, their efficacy is highly dependent on contextual factors such as reliable internet access, device availability, and teacher proficiency. In Nigeria, the education of students with HI is fraught with systemic bottlenecks, including a chronic shortage of certified special educators and a curriculum that often lacks the flexibility required for diverse learners (Olusegun & Adebisi, 2023). Although the National Policy on Education (FRN, 2013) explicitly advocates for inclusive practices, the translation of policy to classroom reality is frequently stalled by fiscal constraints and a lack of standardized oversight.

Eleweke and Agboola (2022) characterize this as a "digital divide" within the special education sector, where even foundational assistive technologies remain a luxury rather than a standard resource. Furthermore, while mobile penetration is high in Nigeria, research indicates that teachers primarily utilize mobile devices for administrative or social functions rather than as pedagogical instruments (Akinola & Fashina, 2020). A significant, often overlooked barrier is the linguistic-cultural mismatch. Nigeria’s rich linguistic tapestry which comprises of over 500 indigenous languages, is poorly represented in the DLA market. Most globally available apps are optimized for English and American Sign Language (ASL), often ignoring the nuances of Nigerian Sign Language (NSL) and local dialects (Ogunyemi & Olubor, 2024). Consequently, the adoption of DLAs in schools for the deaf in Ilorin and beyond is not merely a matter of hardware provision, but of cultural and linguistic synchronization. This study seeks to map these specific barriers and identify the latent potential for DLAs to serve as a bridge to educational equity in Nigeria.

Purpose and Research Questions

The primary purpose of this study was to empirically investigate the current state and potential of digital learning applications for facilitating inclusive education for students with hearing impairments in selected schools in Ilorin, Kwara State, Nigeria. Specifically, this study:

1. determined availability and accessibility of digital learning applications for students with hearing impairments in the selected schools

2. determined the level of utilization of these digital learning applications by teachers

3. identified major barriers and challenges hindering the effective integration of DLAs for inclusive education in these schools

4. examined the perceptions of teachers regarding the potential of DLAs to enhance inclusive education for students with hearing impairments?

The study was guided by the following research questions:

1. What digital learning applications are currently available and accessible for students with hearing impairments in the selected schools?

2. What is the level of utilization of these digital learning applications by teachers?

3. What are the major barriers and challenges hindering the effective integration of DLAs for inclusive education in these schools?

4. What are the perceptions of teachers regarding the potential of DLAs to enhance inclusive education for students with hearing impairments?

Methodology

This study employed a convergent mixed-methods design, integrating quantitative survey data with qualitative interviews and observations to provide a comprehensive understanding of the phenomenon (Creswell & Creswell, 2018). The research was conducted in Ilorin, the capital of Kwara State, Nigeria. The target population comprised all teachers of students with hearing impairments and all senior secondary students with hearing impairments in the state. The accessible population was drawn from three purposively selected schools: To-Omo-Re Schools (a private inclusive school), Hill City Schools (a private mainstream school with a special education unit), and the Kwara State School for Special Needs (a public special school). These schools were selected to provide a diverse representation of school types (public/private, special/inclusive).

A purposive sampling technique was used to select the three schools. Subsequently, a census approach was used to recruit all teachers (n=45) working directly with students with hearing impairment in these schools. For students that were interviewed, a simple random sampling technique was used to select 60 students (20 from each school) from the senior secondary classes to ensure representation across different grade levels. Three instruments were developed:

1. Teachers' Digital Learning Applications Questionnaire (TDLAQ): A 35-item questionnaire with sections on demographics, availability of DLAs (checklist), level of utilization (4-point Likert scale: 1=Never, 4=Always), barriers (5-point Likert scale: 1=Strongly Disagree, 5=Strongly Agree), and perceptions of potential (5-point Likert scale). The instrument was validated by three experts in special education and educational technology. A pilot study with 15 teachers and sign language translators in University of Ilorin, Ilorin yielded a reliability coefficient (Cronbach's alpha) of 0.87.

2. Students' Digital Learning Applications Interview Guide (SDLA-IG): A semi-structured interview guide designed in collaboration with a sign language interpreter to explore students' experiences, challenges, and perceptions. Questions were adapted for clarity and age-appropriateness.

Data collection was conducted over four weeks. Researcher and research assistants administered the TDLAQ to teachers during staff meetings. For students, the SDLA-IG was administered individually with the assistance of a qualified sign language interpreter to ensure accurate communication. Classroom observations were conducted unobtrusively to check teachers' integration of digital learning resources into teaching.

Quantitative data from the TDLAQ were analyzed using the Statistical Package for the Social Sciences (SPSS) version 21. Descriptive statistics (frequencies, percentages, means, standard deviations) were used to answer RQs 1, 2, and 3. Qualitative data from interviews and observation notes were transcribed and analyzed using thematic analysis, following the six-phase framework by Braun and Clarke (2021). Themes were identified and coded to provide depth and triangulation for the quantitative findings

Results and Discussion

This section presents the findings structured according to the research questions.

1. What digital learning applications are currently available and accessible for students with hearing impairments in the selected schools?

Table 1: Availability and Accessibility of Digital Learning Applications for Students with Hearing Impairments

S/N	Digital Learning Application / Technology	Availability (n)	Percentage (%)	Remarks
1	Specialized DLAs (e.g., sign language apps, speech-to-text tools)	10	22.2	Majority reported absence of specialized applications Indicates high scarcity of assistive digital tools
2	YouTube (video-based learning platform)	31	68.9	Used mainly for visual learning, not specifically designed for HI
3	WhatsApp (communication platform)	37	82.2	Widely used for sharing notes and communication
4	Nigerian Sign Language (NSL) Application (Tablet-based)	1 (school)	—	Limited access; device shared among ~40 students; frequently faulty
5	Interactive Whiteboards	0	0.0	Not available in observed classrooms
6	Assistive Listening Devices	0	0.0	Completely absent
7	Dedicated Computer Labs for HI Students	0	0.0	Not observed in any of the selected schools

Table 1 shows analysis from the quantitative data from the TDLAQ, and it revealed a stark picture of scarcity. Of the 45 teachers, 10 (22.2%) reported that their schools have specialized DLAs designed for students with HI (e.g., sign language dictionary apps, speech-to-text software). The most common technologies available were generic video platforms like YouTube (accessible to 68.9% of teachers) and basic WhatsApp communication groups (82.2%). Only one school, Kwara State School for Special Needs, had 4 mobile tablets with a pre-installed Nigerian Sign Language (NSL) application, but it was reported as "frequently broken" and "shared among 40 students." Classroom observations confirmed this, noting the absence of any interactive whiteboards, assistive listening devices, or dedicated computer labs for students with HI. These findings align with Eleweke and Agboola (2022), who noted the pervasive lack of AT in Nigerian special education settings.

2. What is the level of utilization of these digital learning applications by teachers and students?

Table 2: Level of Utilization of Digital Learning Applications by Teachers

	Never (%)	Rarely (%)	Sometimes (%)	Always (%)	Mean	SD
Use DLAs during lesson delivery	28 (62.2)	11 (24.4)	5 (11.1)	1 (2.2)	1.53	0.76
Assign DLA-based activities to students	31 (68.9)	9 (20.0)	4 (8.9)	1 (2.2)	1.44	0.72
Use DLAs to create instructional materials	24 (53.3)	12 (26.7)	7 (15.6)	2 (4.4)	1.71	0.87
Use DLAs for student assessment	35 (77.8)	7 (15.6)	2 (4.4)	1 (2.2)	1.31	0.63
Overall utilisation mean					**1.54**	**0.51**

Benchmark Mean = 2.5

Table 2 shows the level of utilisation of DLAs by teachers in inclusive schools in Ilorin metropolis. The level of utilization was found to be minimal. The mean score for teacher utilization of DLAs was 1.54 (SD = 0.51) on a scale of 4, indicating a level between "Never" and "Rarely." Specifically, 87.5% of teachers stated they "Never" or "Rarely" integrate any DLA into their lesson delivery. Qualitative interviews with teachers revealed a common theme of “non-availability of hardware and specialized DLAs”.

Conversely, students, through their interviews, showed a higher inclination towards using mobile phones for learning. A student at Kwara State school for special Needs signed, *"I use my phone to watch educational videos on YouTube. But it's not for school; it's what I find myself."* This suggests a disconnect between students' informal digital literacy and formal pedagogical integration, a finding consistent with Ogunyemi and Olubor (2024).

3. What are the major barriers and challenges hindering the effective integration of DLAs for inclusive education in these schools?

The analysis of barriers revealed several significant factors. Table 3 presents the mean scores of key barriers as perceived by teachers.

Table 3: Mean Ratings of Barriers to Integration of DLAs

Barrier	Mean	SD	Rank
Lack of teacher training on using DLAs for HI	4.22	0.65	1
Inadequate infrastructure (e.g., power, internet)	4.15	0.72	2
High cost of devices and data	3.98	0.81	3
Curriculum does not integrate technology	3.85	0.79	4
Lack of apps in Nigerian Sign Language (NSL)	3.81	0.88	5
Insufficient administrative support	3.52	0.92	6

Table 3 shows that all identified factors are significant barriers to the integration of Digital Learning Applications (DLAs), as their mean scores are above the 3.0 benchmark on a 5-point Likert scale. The most critical barrier is the lack of teacher training on the use of DLAs for learners with hearing impairments (M = 4.22), indicating inadequate digital and pedagogical skills among teachers. This is closely followed by

inadequate infrastructure such as poor power supply and internet access (M = 4.15), highlighting systemic challenges.

Other notable barriers include the high cost of devices and data (M = 3.98) and the lack of curriculum integration of technology (M = 3.85), suggesting economic and structural limitations. The absence of applications in Nigerian Sign Language (NSL) (M = 3.81) further reflects issues of accessibility and inclusiveness. Although insufficient administrative support (M = 3.52) is ranked lowest, it still contributes to the overall challenge. The qualitative data corroborated these findings. Classroom observations consistently noted the absence of functioning computers or projectors. The unreliability of electricity was a recurring theme, with one teacher at the Kwara State School for Special Needs noting,

> *"We have one laptop in the office and computers in computer Lab, but with the power situation, it's not feasible to bring use it for class."*

The lack of Nigerian Sign Language (NSL) content was a profound barrier for students. A student interviewed expressed frustration:

> *"The apps are all in ASL. It's totally different. I want an app that signs to me in NSL."*

This highlights the critical need for localized content, as also argued by Alqahtani and Alqahtani (2022) in their study on culturally responsive Assistive Technology.

4. What are the perceptions of teachers and students regarding the potential of DLAs to enhance inclusive education for students with hearing impairments?

Table 4: Mean Ratings of Teachers' and Students' Perceptions of the Potential of DLAs for Inclusive Education

S/N	Perception Statement	Mean (M)	SD	Interpretation
1	DLAs can make lessons more engaging for students	4.45	0.58	Strongly Agree
2	DLAs can support students' literacy and language development	4.30	0.61	Strongly Agree
3	DLAs can promote students' independence in learning	4.21	0.64	Strongly Agree
4	DLAs can enhance participation of students with hearing impairments in class	3.84	0.66	Agree
5	DLAs can improve communication between teachers and students with hearing impairments	4.10	0.69	Agree
	Overall Mean	**4.18**	**0.62**	**Strongly Agree**

Decision Rule: Mean ≥ 3.00 = Agree; Mean ≥ 4.00 = Strongly Agree

Despite the barriers, there was overwhelming optimism about the potential of DLAs. The mean perception score from the TDLAQ was 4.18 (SD = 0.62) on a 5-point scale, indicating strong agreement. Key areas of perceived potential included: "DLAs can make lessons more engaging for students" (M=4.45), "DLAs can support students' literacy and language development" (M=4.30), and "DLAs can promote students' independence" (M=4.21). The qualitative data provided rich narratives to support these figures. Many teachers expressed a strong desire for training. A teacher from one of the schools stated,

> *"If we had the tools and I knew how to use them, I could teach so much more. The students are already on their phones; we just need to channel that."*

Students shared this sentiment, with one signing,

> *"I feel left out when the teacher talks. If there was a screen with words or signs, I could follow. I would feel like I am part of the class."*

This powerful sentiment underscores the potential of DLAs to foster true inclusion, moving beyond physical presence to active participation. These findings resonate with international studies like Rashid and Mahmood (2024) who documented similar perceptions of empowerment and engagement among students with HI using DLAs.

Conclusion

This study set out to investigate the potential of digital learning applications for inclusive education of students with hearing impairments in Nigerian schools. The findings lead to a clear conclusion: while the promise of DLAs is widely recognized and fervently desired by teachers and students, the current reality in Ilorin, Kwara State, is one of significant under-resourcing and systemic neglect. The study confirms a "digital divide" within special education, where students who could most benefit from the visual and interactive capabilities of technology are the least likely to have access to it. The major barriers (lack of training, poor infrastructure, and absence of localized content) are interconnected and require a coordinated response. However, the overwhelmingly positive perception among stakeholders is a powerful catalyst for change. The potential of DLAs to transform the educational experiences of students with HI is not just theoretical; it is a tangible hope for the teachers and students in this study. Therefore, unlocking this potential is an educational imperative and a matter of social justice.

Recommendations

Based on the findings, the following recommendations are made:

1. Government and Policymakers should commission the development of digital learning applications that are integrated with Nigerian Sign Language (NSL) and aligned with the Nigerian curriculum, as advocated by Ogunyemi and Olubor (2024).

2. Teacher Training for Continuous Professional Development (CPD) should be established for in-service teachers through training workshops and mentorship programs focused on practical, hands-on skills for using specific DLAs with students with Hearing Impairment.

3. School Administrators should create a phased plan for acquiring and maintaining assistive technologies, with a dedicated budget and encourage teacher experimentation with technology

4. The lack of localized applications in Nigerian Sign Language (NSL) highlights the need for context-specific content development. Educational technology developers, in collaboration with language experts, should design and deploy DLAs that incorporate NSL to ensure cultural and linguistic relevance for learners

5. The evident scarcity of specialized digital learning applications and assistive technologies suggests an urgent need for government and institutional investment in inclusive educational technologies. Schools should be equipped with essential tools such as speech-to-text applications, sign language learning platforms, interactive whiteboards, and assistive listening devices to support students with hearing impairments effectively. In addition, provision of dedicated computer laboratories and functional digital devices for students with hearing impairments should be prioritized to enhance access and participation.

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